A. Vibert Douglas

Miscellaneous

Miscellaneous Notes 68

Prof. Johnston's Selection for Students in Astr. 1.

VENUS: EVENING AND MORNING STAR

From Tennyson's In Memoriam, Canto 121

Sad Hesper o'er the buried sun,
  And ready, thou, to die with him,
  Thou watchest all things ever dim
And dimmer, and a glory done:

The team is loosened from the wain,
  The boat is drawn upon the shore;
  Thou listenest to the closing door,
And life is darkened in the brain.

Bright Phosphor, fresher for the night,
  By thee the world's great work is heard
  Beginning, and the wakeful bird;
Behind thee comes the greater light:

....

Sweet Hesper-Phosphor, double name
  For what is one, the first, the last,
  Thou, like my present and my past,
Thy place is changed; thou are the same.

The Evening Star - Longfellow

Just above yon sandy bar,
As the day grows fainter and dimmer,
Lonely and lovely a single star
Lights the air with a dusky glimmer.

"Now twilight lets her curtain down
And pins it with a star."

Epigram to Plato - Shelley

Thou wert the morning star among the living,
  Ere thy pure light had fled;
Now have died, thou art as Hesperus giving
  New splendor to the dead.

Twilight - Edgar S. Nye

Soft stepping down the western way
  Her gray robes trained in rosy light
She comes to lead the weary Day
  Thru the dim portals of the Night.

Beyond the gently rippling beach
The placid waters of the bay;
Beyond the bay, the curving reach
Of land that bars the open sea;
And then the ocean, spreading free
To the horizon, dim and far;
Then faint and pale, one glimmering star;
Beyond the star.......ah, who can say?

Kent Knowlton

THE COMET

Spectral, mysterious, flame-like thing
   Cleaving the western night,
Waking from chrysalis-dream to fling
Out of your spirit's long chastening
   Far-flashing streams of light.

Tell us your thought of the things that are;
   How does the morning sing?
What have you seen in the worlds afar?
Tell us your dream, O silvery star,
   Bird with the white flame-wing.

What though the glow of your fading ray
   Dim and elusive seem,
Constant you are to the sun's bright sway,
Faithful and true in your tireless way,
   True in your spectral gleam.

Rising anew from your ancient pyre,
   Vapour and dust your frame,
Still you are Psyche, the soul's desire,
Wingless save when in reefs of fire
   Mounting in shafts of flame.

A. D. Watson.

Faustus - (having summoned Helen of Troy before him)

"Was this the face that launched a thousand ships,
And burnt the topless Towers of Ilium?
Sweet Helen, make me immortal with a kiss:
Her lips suck forth my soul, see where it flies.
Come Helen, come, give me my soul again,
Here will I dwell, for heaven is in these lips,
And all is dross that is not Helena.
I will be Paris, and for love of thee,
Instead of Troy shall Wittenberg be sacked,
And I will combat with weak Menelaus,
And wear thy colours on my plumed crest.
Yea, I will wound Achilles in the heel,
And then return to Helen for a kiss.
O thou art fairer than the evening's air,
Clad in the beauty of a thousand stars:
Brighter art thou than flaming Jupiter,
When he appeared to hapless Semele:
More lovely than the Monarch of the sky
In wanton Arethusa's azure arms,
And none but thou shalt be my Paramour."

"The night has a thousand eyes,
  And the day but one,
Yet the light of the bright world dies,
  With the dying sun.
The mind has a thousand eyes,
  And the heart but one,
Yet the light of a whole life dies
  When love is done."

Francis Bourdillon.

"Silently one by one, in the infinite meadows of heaven,
Blossomed the lovely stars, the forget-me-nots of the angels."

Longfellow's Evangeline

Emerson says "One might think the atmosphere was made transparent to give man, in the heavenly bodies, the perpetual presence of the Sublime."

If the stars should appear only one night in a thousand years, how man would believe and adore and preserve for many generations the remembrance of the City of God, which had been shown.

"One sun by day - by night ten thousand shine
And light us deep into the Deity."

"Where ends this mighty building? Where begin
The Suburbs of Creation? Where the wall
Whose battlements look o'er into the Vale
Of non-existence! Nothing's strange abode!
Say at what point of space Jehovah dropp'd
His slackened line and laid his balance by,
Weigh'd worlds, and measured Infinite no more?"

Young - Night Thoughts

"The wildered mind is tost and lost
O sea in thy eternal tide;
The reeling brain essays in vain,
O stars to grasp the vastness wide!
The terrible tremendous scheme
That glimmers in each glancing light,
O night, O stars, too rudely jars
The finite with the infinite!

J. H. Dell

The Question

Will my tiny spark of being
Wholly vanish in your deeps and heights?
Must my days be dark by reason,
O ye Heavens, of your boundless nights,
Rush of Suns and roll of systems,
And your fiery clash of meteorites?

The Answer

Spirit near you dark portal
At the limit of thy human state,
Fear not thou the hidden purpose
Of that Power which alone is great,
Nor the myriad world, His shadow,
Nor the silent Opener of the Gate.

Tennyson.

Distance of moon

Diameter " "

Siderial period of moon

Synodic " " "

Diameter of Mercury

" " Venus

" " Earth

" " Mars

" " Jupiter

" " Saturn

Number of moons of Mercury

" " " " Venus

" " " " Mars

" " " " Jupiter

" " " " Saturn

Distance of sun

Diameter " "

Name of nearest naked eye star

Distance " " " " "

Name of nearest star

Distance of nearest star

Name of apparently brightest star

Distance " " " "

Velocity of light in miles per sec.

~~Number of miles in a light year~~

Number of naked eye stars in bowl of Dipper

Number of photographic stars in bowl of Dipper

Number of naked eye stars visible at one time to one observer.

Average distance of 10 nearest stars

" " " " brightest stars

" spacing of stars in galaxy

Name of any visual binary

" " " spectroscopic binary

" " " eclipsing binary

" " " long period variable

" " " irregular variable

" " " open star cluster

" " " globular cluster

" " " B type star

" " " A " "

" " " F " "

" " " G " "

" " " K " "

" " " M " "

" " " white dwarf

" " the largest star known

" " " densest " " "

" " any nova

" " " planetary nebula

" " diffuse nebula with dark-line spectrum

" " " " " bright-line spectrum

Approx. diam. of our galaxy

" thickness " " "

Estimated number of stars in galaxy

Dist. of sun from centre of galaxy

Period of rotation of galaxy

Distance of Andromeda spiral

Approx. aver. spacing of galaxies

" present limit of telescopic power used photographically

Autumn by the Sea.

We'll hear the uncompanioned murmur of the swell,
  And touch the drift wood, delicately gray,
And with our quickened senses smell
  The sea-flowers all the day!

We'll count the white gulls pasturing on meadows brown,
  And gaze into the arches of the blue,
Till evening's ice comes stealing down
  From those far fields of dew;

And slow the crimson Sun-god swathes his eye, and sails
  To sleep in his innumerable cloak;
And gentle heat's gold pathway fails
  In autumn's opal smoke!

Then long we'll watch the journey of the soft half-moon
  A gold-bright moth slow-spinning up the sky!
And know the dark flight--all too soon--
  Of land-birds passing by.

Through all the dark wide night of stars our souls shall touch
  The sky, in God's own quietude of things,
And gain brief freedom from the clutch
  Of Life's encompassings.

Galsworthy

White! The coming endless,
Earth's whole mantle
Changed by crystal clusters.
Morning dawned and
All was perfect.

Colour vanished, vanquished.
One walks, shadow grey,
And only white, white freshness.
How lovely to behold!
How new! How clean.

No continuity is here,
For white has conquered all.
And yet on white
A red leaf is seen
Excluded from its brothers' rest.

Colour here! The yesterday remains.
Oh yes, the old remains.
They step muttering through
The million lovely forms.
Still do we all wonder ---

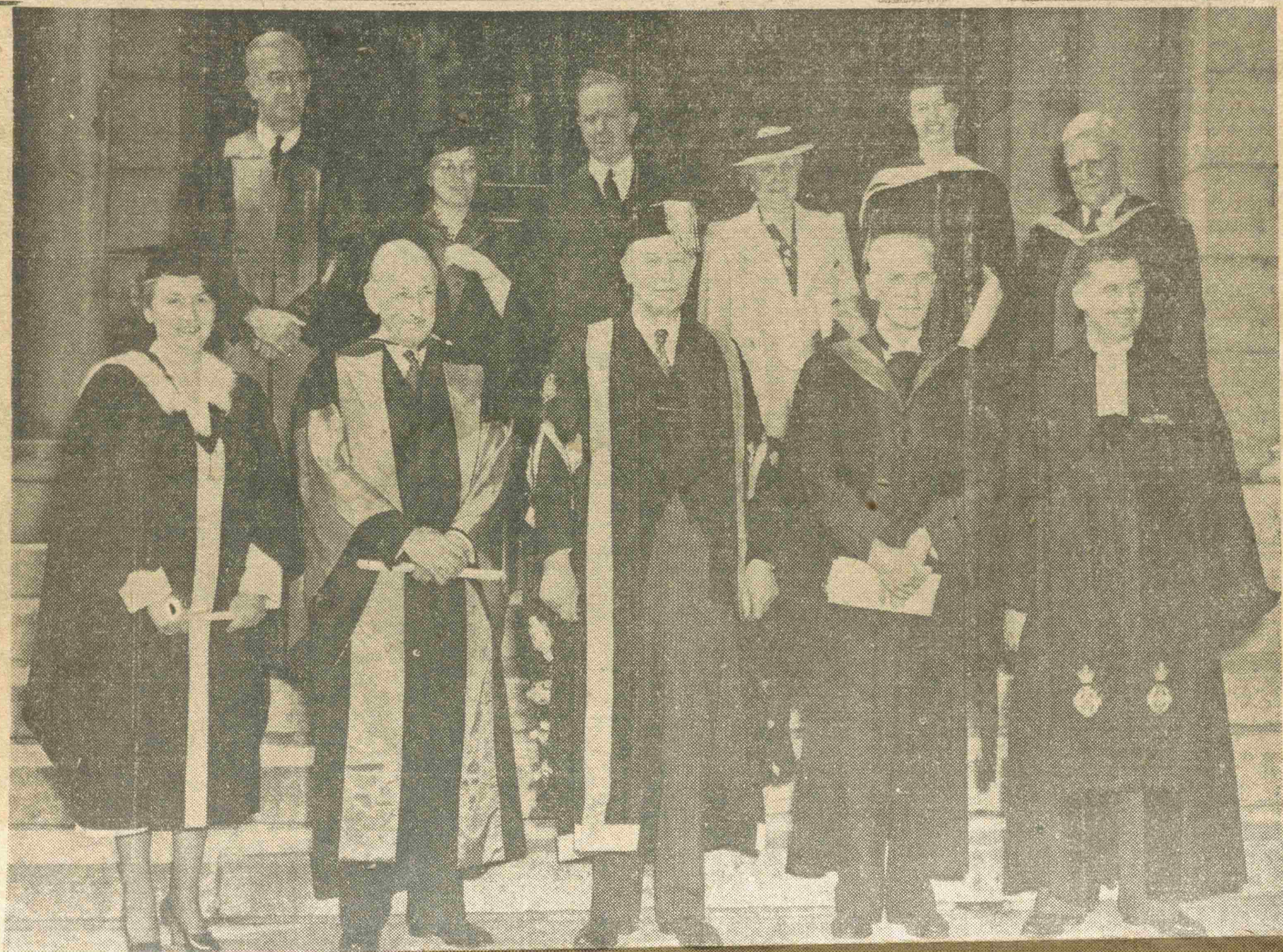
The children wonder not.
"Je vais te lancer au mer!"
Dit le petit Français en joie
A sa petite soeur qui jete
Une balle de neige neuve.

The snow is new, children also,
And to them it is sheer delight.
Shall we not join them with
spirit new?

G.P.C.V.D.
Nov. 1951

he Kingston Whig-Standa

ECTION MONDAY, JUNE 6, 1949 PAGE



FORMAL GROUP is pictured after Saturday's Medical Convocation at Queen's University. In the front row, left to right, are Miss Dorothy M. Riches, director, School of Nursing; Dr. Duncan Graham, who received an honorary degree of Doctor of Laws; Vice-chancellor R. C. Wallace, who presided; Dr. J. Spencer Melvin, dean of the Faculty of Medicine; and Rev. A. M. Laverty. In the rear row, left to right, are Dr. J. H. Orr, secretary of the Faculty of Medicine; Miss Jean Royce, registrar; J. F. Foster of London, England, secretary of the Association of Universities of the British Commonwealth, who was a distinguished guest at the ceremonies; Miss L. D. Acton, superintendent of nurses, Kingston General Hospital; Miss J. M. Weir, lecturer in public health nursing; Dean D. S. Ellis of the Faculty of Applied Science.

MEMBERS of the graduating class from the School of Nursing at Queen's University are pictured at Convocation Saturday afternoon. They are, front row, left to right, June Godkin, Kingston; Helen Devlin, winner of the medal, Perth; Marion Sunberg, Pleasantdale, Sask.; Rosalind May, Picton. In the rear, left to right, are Miss Dorothy Riches, director of the school; Evelyn Freeman, Battersea; Mary Potts, Ottawa; Barbara Chase, Port Williams, NS; Jean Littlejohn, Wallacetown; and Miss Jenny Weir, lecturer in public health nursing.

aris Sun Togs

NEA)—Orange linen, which takes
from the sun, will go down to the
ris this summer.
en, for example, makes the duster-
coat (centre) which tops a swim
-and-green of Jacques Fath's de-
riped linen makes cuffs for the
sun-shade hat.
ary-styled blouse (right) is of
which picks up one of the vibrant
multicolor-striped slacks with
ss "sun bra" (left) with "pirate
le of orange linen. The pirate
Fath's new idea in beach shorts,
ik-print on orange, green and
n.

Bay people in the Community Hall, Elgin.

The June meeting will be held at the home of Mrs. F. M. Stanton. Plans for a bazaar to be held in August will be discussed. Mrs. William Welsh and Mrs. John Banks will be conveners.

During the afternoon several ladies quilted on a quilt which had been made ready for quilting by Mrs. Pinkerton, while others worked on blocks to be used later.

A vote of thanks was tendered Mrs. Pinkerton for all the work she had done on the quilt and for her gracious hospitality in entertaining the ladies.

A dainty lunch was served by Mrs. H. Mustard and Mrs. F. M. Stanton assisted by Mrs. S. Smith.

NEWBORO WA

The May meeting of the Women's Auxiliary of St. Mary's Church, Newboro, was held recently at the home of Mrs. Peter Botting with eight members and one visitor present.

The president, Mrs. Ben Tett, presided, assisted by the secretary-treasurer, Mrs. R. H. Braman.

The scripture lesson, Acts 1 1-14, was read followed by the roll call which was answered by the paying of pledges and a verse of scripture in which is found the word "Blessed."

The Dorcas secretary reported that the quilt had been finished and ready for sale and the president offered to try to get a buyer. Other quilt blocks and lining were donated and blocks will be seen at the June meeting to be held at the home of Mrs. M. A. Bolton and her daughter, Mrs. E. Ryan.

Mrs. Braman gave a most interesting report of the annual held in Kingston and the editorial regarding the placing of the pledge money among the different schools and parishes, found in the May edition of the Living Message was read. An article "The Church Goes to the Bush," was read by Mrs. F. J. Tett.

Refreshments were served by the hostess and a social half hour was enjoyed.

COLD PLUNGE

NAPINKA, Man.—(CP)—While returning from town across flooded flats recently, two local farmers driving a wagon and team, ran over the end of a submerged culvert, upset and lost groceries and

Farm Wife Finds Career Rewarding

KITCHENER — (CP) — Can women have a career in agriculture?

An answer to that question can be found in the person of Mrs. John Steckle of Williamsburg, near here, part of a husband-and-wife team outstanding in agricultural circles. She was the first woman graduate of the Ontario Agricultural College at Guelph.

Her interest in farming, especially fruit farming, has been lifelong. It goes back to the days when she was Susanna Chase, better known as Sue, living in Nova Scotia's Annapolis Valley. The farm of her father, the late Oscar Chase, near Port Williams, contained 80 acres planted in fruit trees, as well as other land for mixed farming.

Here in the "apple belt," she saw the scientific care needed in cultivate, spraying, picking, grading and packing fruit for market.

Young Sue Chase decided she would train herself for it and took the two-year course at the Nova Scotia Agricultural College in Truro. The only other girl in her class later went to MacDonald Institute.

"My father had gone to the OAC and I wanted to come up here, too," explained Mrs. Steckle. This ambition prompted her to apply for entrance, but she recalls that she waited several weeks in Nova Scotia for an answer. The college president told her later that the matter of admitting a woman had to be thoroughly considered.

* * *

Taking the horticultural option course, she graduated in 1921 with the degree of bachelor of science in agriculture. Since she pioneered at the college, a considerable number of women have followed.

For the next seven years she farmed at home, where her father died in 1924 and where she shared the responsibility with her brother, Robert Chase. During this time, she served for a year as president of the Nova Scotia Fruit Growers' Association.

Romance was not left out of the picture. While attending OAC she had become acquainted with John Steckle, another student, who was specializing in animal husbandry. After her seven years in Nova Scotia she came as his bride to their comfortable farm home at Williamsburg.

In addition to their 165 acres, five acres have been set apart where the tall, lithe Nova Scotian with a twinkle in her eye can grow all the fruit she likes.

She is busy, too, with her duties as president of the Jubilee Women's Institute and member of the YWCA board of directors, and is a member of Trinity United Church Woman's Association in Kitchener.

Mr. and Mrs. Steckle's two children, Robert and Jean, are following in the parental footsteps. In his first year, Robert is the first OAC student whose parents are both graduates of the college. Jean is in the first year of the new four-year home economics degree course at MacDonald Institute.

Mrs. Steckle's work was recognized recently by Nova Scotia fruit growers, who presented her with an honorary membership.

The scroll reads: "Susanna Chase Steckle has been duly elected as an honorary member of the Nova Scotia Fruit Growers' Association in recognition of her worthy contribution to the fruit industry."

Keep Suntanned Legs Smooth

To keep legs free of stubble this girl is using a new water-soluble depilatory.

By Alicia Hart
NEA Staff Writer

Before you start drawing the sun's gold to your legs, rid their skin of superfluous hair.

No tan can be tawny enough to hide stubble that indicates a lack of fastidious grooming.

No matter what method you use for removing hair, use it often. Good grooming during a season when legs are out in the open calls for close scrutiny of skin surfaces every day or two to see if recurrent growth needs cropping.

Added to this summer's large list of dependable hair removers, designed to simplify grooming, is an improved depilatory which promises a quick clean-up with a minimum of fuss. What recommends this lotion is the ease with which it is applied—you simply pour enough into the palm of your hand to spread over the leg. When hair is dissolved by the quick-acting lotion, the plain water that's used to take it off also takes off the stubble.

Ribbons Prettify Pumps for Party

By Alicia Hart
NEA Staff Writer

You can make daytime pumps double as Cinderella slippers, if your budget says "no" to another pair of evening shoes.

The trick of "glamming up" daytime pumps—this goes for shoes of black suede, of colored linen and of "graduation" white satin or kid—is to strap them to your feet with matching-color ribbon laces.

Ribbon laces sewed to the binding around the edge of pumps and laced across instep and ankles will not only dress up daytime pumps for evening wear but will hold such shoes more securely to your feet for dancing.

If there is no particular need for tying pumps more securely to your feet, you can skip the sewing chore altogether. By strapping your stockinged feet with ribbon laces before you put on your pumps—strap first across the instep and then around the ankle where the ribbon is tied—you can achieve the same effect of glamorizing daytime pumps without sewing a stitch.

FROM WAR TO PEACE

LLANSANLET, Wales — (CP) — Lead recovered from the "Pluto" gasoline pipeline from Britain laid under the English Channel to France during the war will be used on house roofs in Wales.

MAN SAVES F
FROM DROWN

WHERE GREAT SCIENTISTS SIT AS PUPILS

At Pasadena, Einstein and Others Study Riddles Of the Universe

Associated Press Photos.

Savants in the Schoolroom—The Stars Learn About Astronomy.

By CHAPIN HALL

PASADENA.

UNIQUE among modern institutions of learning is the International School of Advanced Science at Pasadena, which is just concluding its annual two months' Winter term. One need only say that here Einstein is both professor and pupil to suggest that this is such a school as the sun has rarely shone upon. Not since Plato walked the groves of the Academe, more than twenty-three centuries ago, has there been such a concerted attack by the world's most eminent thinkers on the problems that most puzzle mankind as that which now takes place every year in the little California city that used to be known chiefly for its Tournament of Roses and its climate.

If mind alone could move matter, the annual drama of the International School would make the universe, to the furthest limits of space, pulse like a beating heart. Constellations and nebulae would rush hither and yon, space would bend and straighten like a willow in the wind, stars would be born and grow old and die, and time would loom like observatory-crowned Mount Wilson, or roll in upon the cosmic shores like the great surges of the Pacific. For this school is the mind of man grappling with the naked realities of creation.

Here come those who have long since mastered the cosmic ABC's to assail the profounder mysteries of the XYZ's and so far, as all of them admit, in vain. The final equation has yet to be written. The pursuit of it is perhaps man's greatest intellectual adventure. The teachers and pupils of the Pasadena School are more eager in their voyages of discovery than any Balboa cutting his way through the jungle to feast his eyes upon the Pacific or any Magellan sailing into unknown harbors of the South Seas. Some day they, or their successors, may drop anchor in the port of ultimate truth and know at last whether the universe is dying or merely being born and whether the mind of man, which craves that truth, is a meaningless accident, a cruel joke, or a full-fledged partner in creation.

This is a learners' more than a teachers' school, for science, not many years ago reasonably certain of the main facts about the universe, is now in a state of chaos. The sessions at Pasadena might be compared with those of the League of Nations at Geneva. In each case there are conflicting claims to be reconciled. In each case the old is dying and the new has yet to be born. Since scientists are, as a whole less pugnacious than statesmen, there is no danger of armed warfare at Pasadena. But there is a clash of intellects that strike sparks brighter than any that ever showered down in the half-darkness of a blacksmith's shop.

* * *

THE International School came into being, not because of the charm of the California scenery and climate but because the laboratories and other facilities of the California Institute of Technology and the Mount Wilson Observatory furnished equipment and attracted research workers not to be found elsewhere. The Institute of Technology, under the direction of Dr. Millikan, theorist of the cosmic ray, has become one of the great world centres for graduate work in pure science. Before long it will have a 200-inch telescope with the aid of which astronomers, gazing and turning photographic lenses into the brilliance of the California night, will be able to push back nobody knows how many additional light-years the present frontiers of known space. Mount Wilson, with its 100-inch telescope, fruit of the enthusiasm of Dr. George E. Hale, will still have the second largest gun in the battery of celestial artillery.

Scientists come from all over the world, not to squint through a great telescope—that, seriously considered, is a job for specialists—but to study the results of the astronomers' observations and to meet with other scientists who have come on the same errand. The meeting, the exchange of ideas, the substitution of conversations and lectures for published papers which often take months or even years to make the rounds—these are the purposes and the essence of the International School.

And what a list of faculty and students it has to offer! Consider names like these:

Professor ALBERT EINSTEIN of Berlin, first to expound the theory of relativity.

Dr. ROBERT A. MILLIKAN, Nobel Prize winner, who holds out hope that matter is building up in space instead of breaking down.

Dr. HARLOW SHAPLEY of the Harvard Observatory, authority on the distribution of stars.

Dr. EDWIN P. HUBBLE of the Mount Wilson Observatory, famous for his studies of "island universes."

Dr. RICHARD C. TOLMAN of the California Institute of Technology, who has carried the theory of relativity so far as almost to make Einstein himself seem a conservative.

Sir JAMES JEANS, the British physicist and astronomer, who opposes to Millikan's cosmic-ray theory the belief that the universe is running down like a clock, which no one can wind.

Dr. PAUL EHRENFEST of the University of Leiden.

Dr. PAUL S. EPSTEIN, Einstein's associate in Berlin.

Professor HENRY NORRIS RUSSELL of Princeton, recognized as one of the finest mathematical astronomers this country has ever produced.

Dr. W. DE SITTER of Leiden, a real mathematical virtuoso, a student of Einstein and a teacher to whom Einstein is glad to listen.

These names are only samples of the scientific aristocracy which is either in residence in or near Pasadena or which resorts there to go to school during the first two months of each year. As many as twenty members of the American Academy of Sciences, almost one-tenth of the total membership, have been in Pasadena on a given date. As research workers and as staff members of the local scientific institutions are young men whose names may not yet be in "Who's Who," but who will undoubtedly furnish some of the outstanding scientific leaders of the next decade. One of them, Dr. Carl Anderson, 26 years old, recently secured photographic evidence of the smashing of atomic nuclei by cosmic rays—a phenomenon which has a good deal of bearing on, among other things, the length of "the long, long time the world shall last."

* * *

ASTRONOMY, physics and chemistry find a common meeting ground at the International School, for each has something to contribute toward an explanation of the universe. If the explanations do not jibe, if what the subatomic physicists see as they peer into their inconceivably little worlds cannot be reconciled with what the astronomers see as they gaze across the light-years at their astonishingly distant nebulae, so much the more necessary are these meetings and so much more fruitful may they become.

The term "school" is no figure of speech, though there are no examinations, no credits and no degrees. The physical setting is academic. Some sessions are held on the Institute of Technology campus in the Norman Bridge Laboratory of Physics. This year and last Dr. Einstein has had his workshop in Room 306 on the third floor of this building. There is no passenger elevator and he and the audience of thirty fellow-scientists to whom he has sometimes lectured in this room have to walk up. Larger gatherings are held in a lecture hall on the second floor of the same structure. Dr. Einstein lives in the Athenaeum (the institute's million-dollar faculty club) near by. To get to his office from his living quarters he has to walk across the raw new campus on a temporary boardwalk.

* * *

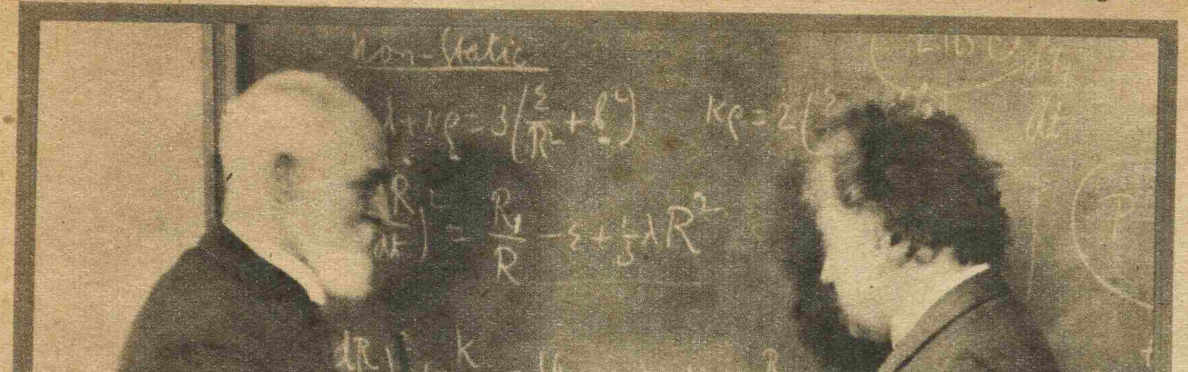
ADJOINING the Norman Bridge Laboratory is the still uncompleted building which is to house the 200-inch telescope now under construction. Near by, also, is the Guggenheim Laboratory of Aeronautics, where Millikan's son, Dr. Clark Millikan, and Dr. A. L. Klein are working out problems of wind resistance to make flying safer. Some of the class meetings are held in the Pasadena laboratory of the Mount Wilson Observatory, about a mile from the institute. Sometimes the scientists visit the observatory itself, nine miles away and 5,000 feet nearer the stars.

Dr. Einstein loves mechanical apparatus, though he is no expert in using it. One night, clad in a borrowed fur coat, he was gazing through the Mount Wilson telescope. Suddenly he pointed to the cement floor, twenty feet below, which seemed to be revolving in the moonlight that fell through the slit in the lofty dome. "Why, the mountain is spinning!" he exclaimed. Director Adams smilingly replied: "It's the dome that's revolving and carrying you with it. Relativity, you know."

* * *

TEACHING at the Pasadena school outwardly resembles teaching anywhere else. There are a class, a lecturer, a pointer, some chalk and a blackboard, or perhaps stereopticon pictures thrown on a screen. An announce-

(Continued on Page 20)



Genius at the Blackboard—Dr. de Sitter Shows Dr. Einstein a Few Equations.

ACROSS THE SAHARA AND INTO AN INFERNO

Two Frenchmen Tell of a Dash to Taudeni, Where Slaves Toil Hopelessly

Man and Machine Power in the Sahara—"Moving Very Slowly and Sore and Nerve-Racked by the Wind, We Forged On."

In the middle of the Sahara lies Taudeni of the salt mines, where slaves work and perish. Few white men, except the French military guard that escorts the great caravan which freights once a year between Timbuctoo and the mines, have ever visited it. But recently two Frenchmen, army reserve officers, made their way to Taudeni by motor across the uncharted sands. They have written the story of their adventure, and it will appear in The Times Magazine in two chapters. In the first, which follows, they tell of the dash across the desert. The second, which describes Taudeni and its horrors, will by published next Sunday.

By LEO GERVILLE-REACHE and J. ROGER-MATHIEU

TAUDENI! To most people the name, with its musical sound, means nothing. Yet it donates, in the depths of the Sahara, one of the blackest spots in human misery. It was in Timbuctoo several years ago that we first heard of it. The incandescent sun and the shadows of buildings joined great squares of white and black in the narrow streets of the town. We looked out on a great field of sand which seemed to boil in the heat. "It is from there that the Azalai strikes out for Taudeni," Governor Carde said. "It returns with salt from the mines."

There rose in our minds the vision of this immense caravan which for centuries has made one journey across the silent desert. Once every year it starts out—between 3,000 and 10,000 camels. It takes two months to traverse these immense leagues of sand and two more months to return with the blocks of salt hewn from the mines by men who must hew or die; who are held in bondage of the worst kind; who work exposed to the fierce Sahara sun by day and sleep in tiny mud huts during the bitter Sahara night; whose only hope is that by the time the caravan comes again they will have gathered enough salt to pay for food to sustain them another year.

If the caravan does not come, they die. And sometimes the caravan has failed; sometimes it is set upon by bandits, broken up and destroyed. When that has happened, more men must be sent to the mines. They are recruited as men were impressed for the navy in the old days—by force, by guile, by sale. For the salt is precious and sacred. On the banks of the Niger it is a supreme luxury to the natives and a necessity for the animals in the surrounding pasture lands.

Taudeni! To some of the band of great Saharans, to those who have navigated the great distances and the fine sands of the Reg, we turned for advice. How could we go there? This was their answer: If your bodies are made to fit the dislocating trot of the camel; if you do not fear forty days' march in dreadful heat or forty nights in more dreadful cold on a bed of sand; if you can be satisfied with dates and rice and can quench your thirst with tepid stale water; if you are willing to exchange Paris for two months of silence and monotonous effort—then you can join the caravan.

But what of the airplane or the automobile? As well sign your death warrant as try to fly, we were told. If you fall, you are as certainly lost as those who have dropped in the Atlantic. As for the automobile, the southern route is barred by the dunes. It is far from Timbuctoo to Taudeni and the sand is not a roadway for automobiles.

Then what of a land approach from the North? If we could open a new route, if we could bring Taudeni to within five or six days of the Algerian frontier, to within four or five days of Reggan, and prepare the way for the establishment of a military post there, could we not do something to remove this plague spot from the map?

We sought out Georges Estienne. He is young in years, but an old Saharan. These infinite seas of sand are his playground. As some men have an air sense, so he has the sense of the desert. His vagabond humor is to map out and subdue this savage immensity. He looked at us with half-closed eyes. "Have you stomach enough?" was all he asked. We told him we believed we had. "All right," he said, "let us get ready."

Preparing an expedition is the dullest work and the most pestilential any man can undertake. There are so many things to go wrong. But at last our train pulled into Colomb Bechar, all exhausted and out of breath from having picked up twenty minutes of the nine hours it was behind schedule. It is there that the railway ends, on the frontier of civilization. From there no one can go further into the desert without the permission of the military. Our two automobiles, with their mechanicians, were waiting at Reggan, 500 miles away.

We had to wait until the road to Reggan should be reported clear. We spent our time getting advice and renewing acquaintance with the working of machine gun, compass and sextant. Rezzous had been sighted—those bands of marauders who still make the Sahara unsafe, as if nature had not sufficiently done so. Then Colonel Trinquet told us we could go. He gave a party for us that night, but Orion's belt was still high in the heavens and the night was deadly cold when we turned out to cover the first stage to Beni Abbes in one of the comfortable cars of the Compagnie Transsaharienne.

Three years ago we had passed along that route. Then it was a sandy waste, but now there was a road—more than a road; an avenue, a boulevard—for 160 miles. Africa is certainly yielding to treatment. Along this road there is a constant procession—it seems that the desert is densely populated. Military and civilian automobiles dash past, lorries filled with merchandise. Arab shepherds with cries and blows drive their sheep out of our way; every now and then we had to slow down to let a caravan of camels pass.

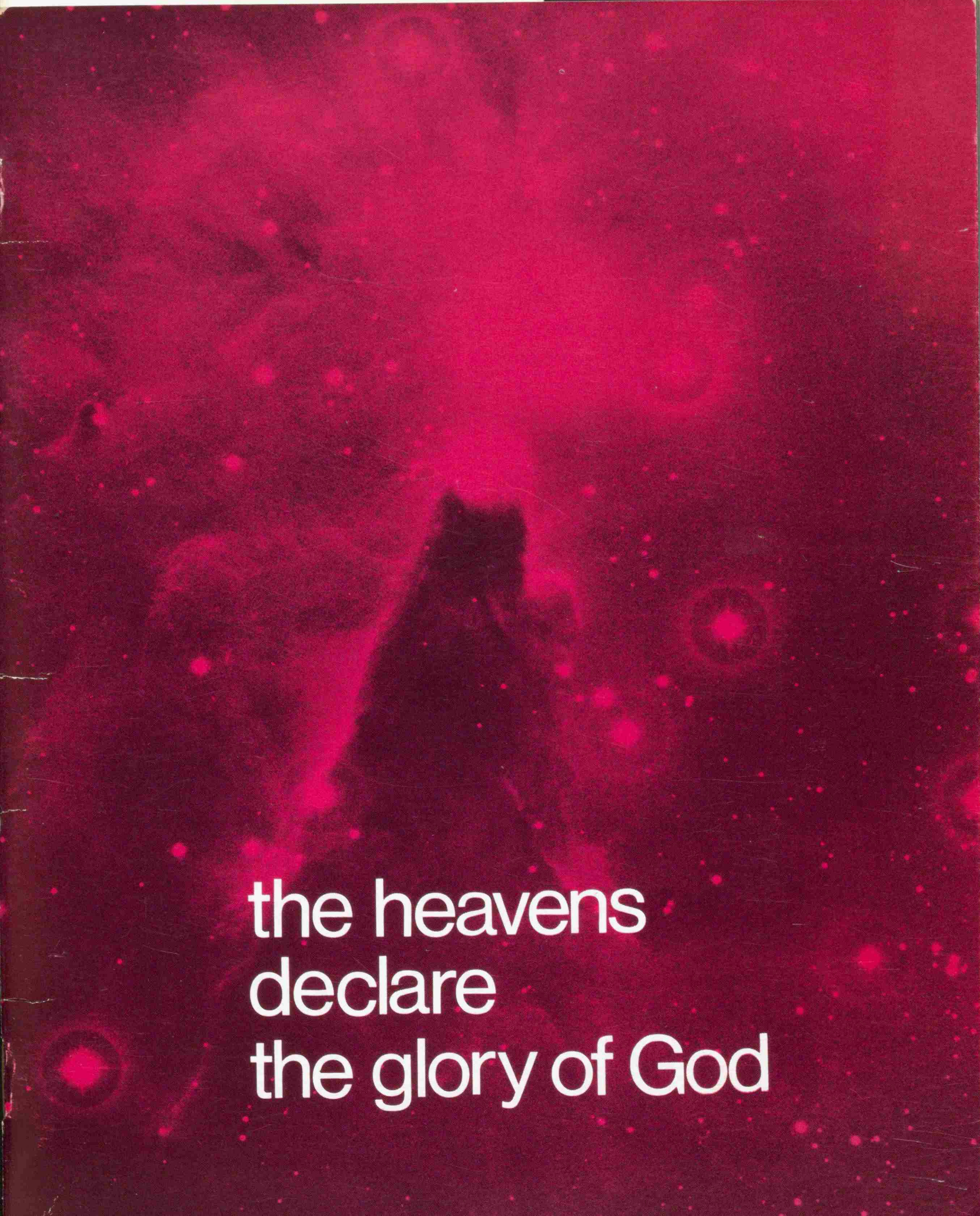
* * *

NEXT day, from Beni Abbes to Reggan, the tale was different. There is no road along this stretch. At 3 o'clock in the morning we were off again over the sand. It took seventeen hours and night had come again before we reached that last French outpost. But there, between the dismal solitudes of Touat and the thirsty plains of Tanezruft, we found a hotel with electric light, with bathrooms and an American bar. There is nothing besides the hotel, absolutely nothing but sand for hundreds of miles, but in the bar Abdullah cools his bottles by wrapping them in wet towels and one can shake for drinks with poker dice. Yes, civilization is making constant progress.

In front of us was Taudeni, still 500 miles away—500 uncharted miles. Our two automobiles were ready and soon after our arrival Georges Estienne joined us; he had come from Gao on the Niger by the Transsaharan air route. Our two mechanics, Brulard and d'Annouville, had everything ready. But before starting we added to our troop two Chambaa natives, Bou Kresba and Abd-el-Kader. (We had to have two because the one who knew the road best claimed to speak nothing but his native dialect, and so the other was needed as interpreter. It was only later that we found that in moments of excitement the interpreter could utter and understand no word of French, while the one who spoke only Arabic was heard to pronounce quite clearly in excellent French: "Je suis complètement dégouti.")

It seems to be the custom in the Sahara to start for any place at 4 o'clock in the morning. Abdullah wakened us at 3. It was as dark as the inside of a black leather bag. The stars were as large as candles in a room, but they seemed to give

Camels and Men That Endure "Forty Days in Dreadful Heat and Forty Nights in More Dreadful Cold."



the heavens declare the glory of God

the heavens declare the glory of God

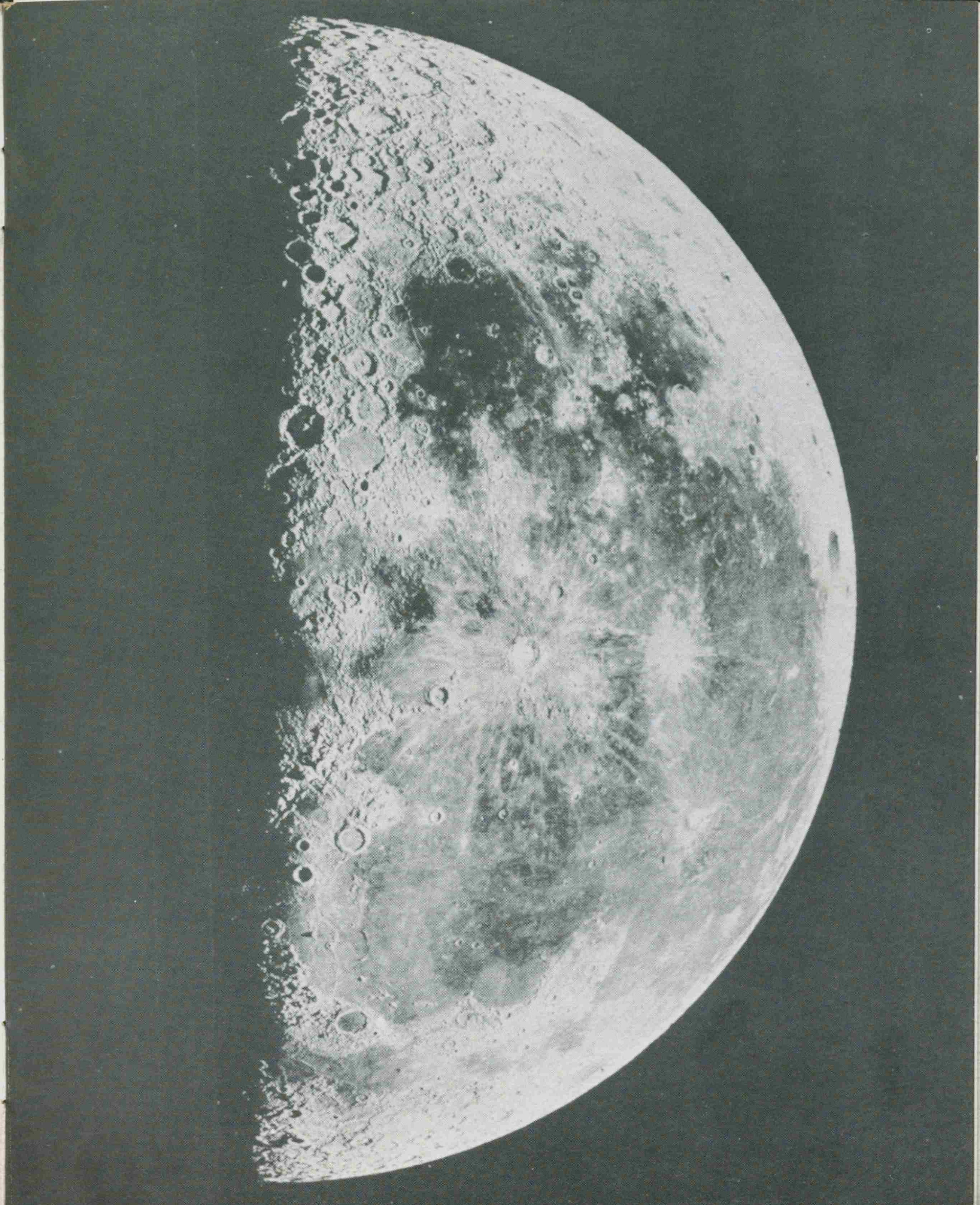
by

Reverend M. W. Burke - Gaffney, S. J.
professor of Astronomy
Saint Mary's University
Halifax, Nova Scotia

our cover photo

Nebulosity in Monocerus. Situated in south outer region of NGC 2264. Photographed in red light. 200-inch photograph.

All photographs in this publication are from the Mount Wilson and Palomar Observatories.



Saint Mary's University

HALIFAX, CANADA

Dec 30, 1969

Best wishes for 1970.- Hope to see you at Brighton.-

I was in hospital Dec 5, until to-day,- with a little heart trouble.-

M. W. Burke-Gaffney

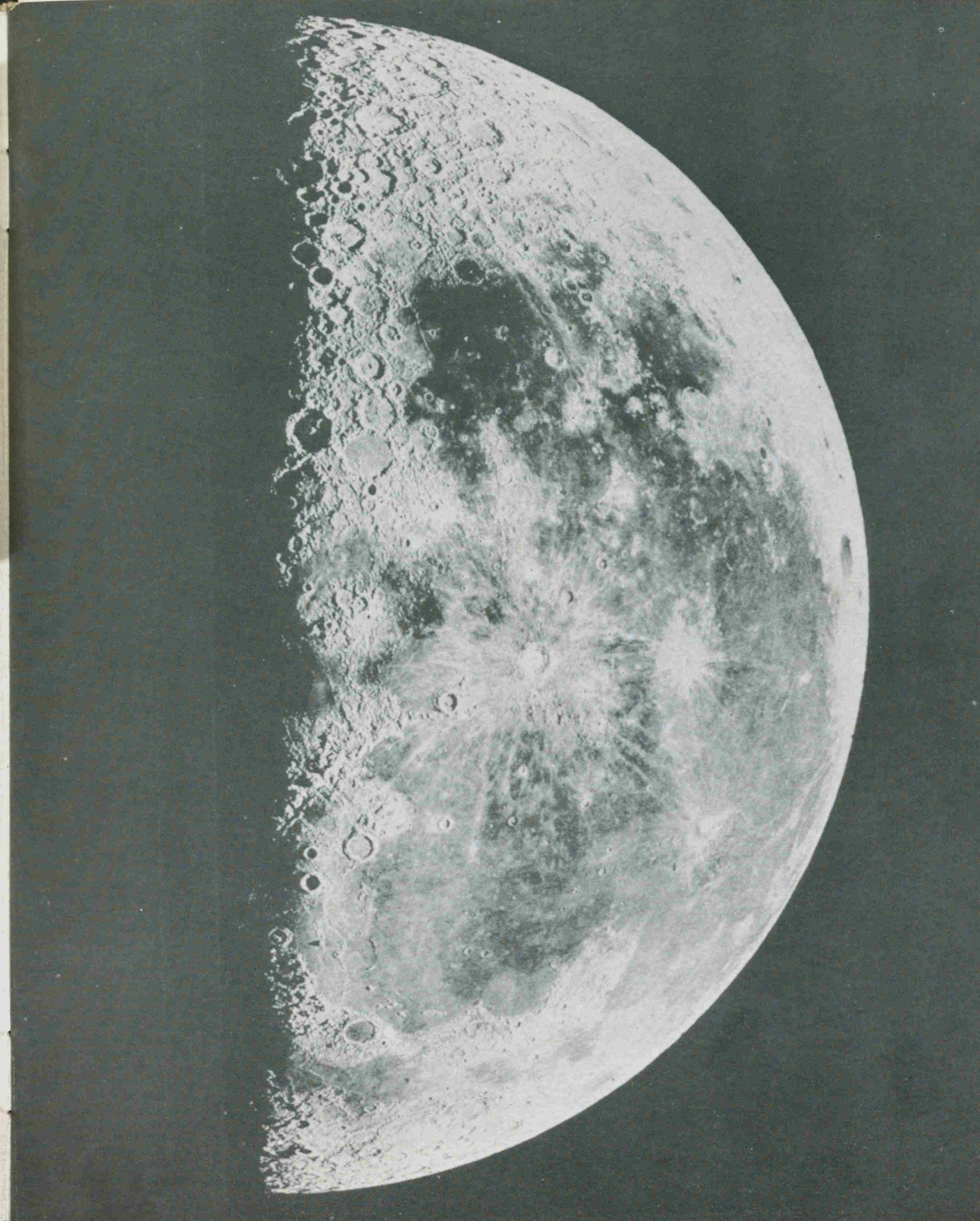
the heavens declare
the glory of God

by
Reverend M. W. Burke - Gaffney, S. J.
professor of Astronomy
Saint Mary's University
Halifax, Nova Scotia

our cover photo

Nebulosity in Monocerus. Situated in south outer region of NGC 2264. Photographed in red light. 200-inch photograph.

All photographs in this publication are from the Mount Wilson and Palomar Observatories.



The psalms of David are coloured by the memories of his youth. As a youth, he used to tend his father's sheep. Some evenings, David would be in the pastures as the sun set. He would see the western horizon turning red, and the redness mounting in the sky, and tinting small floating clouds. Then, the colour in the sky would recede and fade. As darkness came, the sheep would know that it was time to rest. One by one the stars would appear in the sky. First, the brightest, and, eventually, the faintest. David would strum his harp and sing: "Stars of heaven, bless the Lord. Praise Him all you shining stars".

In the course of the night, as David faced the south, the stars seemed to move, slowly, from left to right. Those in the west set. In the east, others rose. God knew the name of each and every one. And their number was beyond the power of counting.

The night passed all too rapidly. There was not sufficient time to welcome each and every star. As morning approached, the fainter stars started to fade from the sky. There was a glow in the eastern sky, which grew into the wondrous reddening of the dawn. With the rising of the golden Sun, the night was over. And David sang: "The heavens declare the glory of God, and the firmament of stars proclaim the work of His hands".

Our Father, Who is in heaven, is a good Father. And He is a patient teacher. To all His children, down through the ages, He has spoken, and speaks, a language accommodated to our minds, and always, as we advance in knowledge, He has other lessons for us.

NGC 3031 Spiral nebula in Ursa Major. Messier 81. 200-inch photograph.

A few centuries after David's time, the Greeks were masters of the world. Their mentality was not that of the Hebrews. Where the Hebrews saw a forest, the Greeks saw trees. Looking at the evening sky, the Greeks were intrigued by the wanderings of the planets among the stars. Indeed, it was they who called them "Planets", or, in Greek, **Planetai,** which means "Wanderers".

The Pythagoreans recognised the fact that the Morning Star was the Evening Star moved into the morning sky. Plato did not quite understand this, but he wrote: "At least, astronomy compels the soul to look upwards and leads us from this world to another".

About one hundred years after Plato's time, Aristarchus of Samos explained that the planet Venus (which is closer to the Sun than we are) circled round the Sun. For about nine months we might see it as an evening star, in the south-western sky, to the left of the Sun. Then for nearly a month we might not see it at all, because it was nearly between us and the Sun. The next time we would see it, it would be in the morning sky, to the right of the Sun, where it would be for about nine months. What Aristarchus remarked twenty-two hundred years ago, we can notice to-day.

The arguments of Aristarchus for his heliocentric system did not convince his colleagues. They were too accustomed to the homocentric system, devised by Eudoxus and expounded by Aristotle. The homocentric system was made altogether plausible, about the year 150 anno domini, by the ingenious mathematical exposition of Ptolemy of Alexandria.

The Ptolemaic system was adopted by the Arabs, who captured Alexandria in the year 640, and went on to cross North Africa, and bring their conquest, and their lore, into Spain, - where they retained a foothold until the 15th century.

In religion, the Arabs were Moslems. They carried with them great reverence for God. The opening verse of the Koran, their bible, reads: "Praise be to God, the Lord of the Universe".

The Arabs travelled great distances across the deserts. At times, they travelled by night, to avoid the heat of the day. They were familiar with the stars. To them, the stars were as unchanging as their Maker, the Lord of the Universe. But they found an exception. They noticed one star which varied in brightness. Some nights they saw it as a bright second magnitude star, and other nights as a faint third magnitude star. There seemed to be no telling when it would be bright or faint. They called it **Algol,** which means "The Demon". The star's seeming variations in brightness remained a mystery until an eighteenth century English astronomer made the suggestion that it was one star periodically eclipsed by another revolving about it. This hypothesis was later verified, but we still call it by the name given to it by the Arabs, **Algol,** The Demon, the fickle one.

In the 14th century, when the Arabs were losing their hold in Western Europe, Christian poets had time to dream dreams, and mystics had quiet to contemplate their visions.

Dante was both poet and mystic. His greatest work is a description of a vision in which he is led through Hell, Purgatory and Heaven. Purgatory is a rising mountain. Its top is the terrestrial paradise, - the launching pad for heaven. From there, Dante soars through the seven heavens of the Moon and Sun and five Planets, to the heaven of the stars, - which is the empyrean, or abode of God.

Led by Dante, we go higher and higher, until we meet our Lady, and we rise again. There is suspense, as we seem to be on the verge of seeing God. At length the vision comes. It is described in one line, the last line of the long poem. We see: "The love that moves the Sun and other stars".

To inquiring minds, it was not enough to say that God moved the Sun and other stars. They would like to have order of their movements. Ptolemy's system served well for short-term predictions. But centuries of observations failed to verify its objective truth. A substitute was sought. Copernicus, a Catholic cleric, in the 16th century, showed that the wanderings of the planets could be more exactly explained by supposing that they, and the Earth, circled round the Sun.

In the 17th century, Kepler pointed out that the system of Copernicus was not quite accurate. He showed that it was in ellipses, and not in circles, that the Planets must move, if their wanderings were to be precisely explained.

Kepler's discovery was based on the observations of Brahe, who was the last eminent astronomer to die before the invention of the telescope. Brahe had better instruments than any man before him ever had. With them he measured the position of the stars in the sky relative to one another. He was fired with the ambition to prepare a complete and accurate catalogue of the stars. He would list every star in the heavens visible from his observatory. After thirty years, his observational work was completed, but his cataloguing was not completed, when he died.

Kepler, Brahe's successor as Imperial Mathematician, undertook to prepare Brahe's catalogue for publication. It was not until the year 1605 that the long awaited catalogue was off the press. It proved to be a boon to astronomers, some of whom felt as though they now had the world by the tail. .... Four years later, Galileo turned a telescope to the sky, and discovered that there were more stars in the firmament than man had ever dreamed of.

If we believe that our Father in heaven is gently educating us, then we might say that Lesson One, in Astronomy, ended with the publication of Brahe's catalogue. Lesson Two commenced with the telescope.

The discoveries of the telescope filled men's minds with wonder.

Even as Newton wrote his theory of universal gravitation and Halley used it to predict the return of a comet, the faith of men was deep, and the souls of poets were stirred. It was in the days of Newton and Halley that Joseph Addison wrote:

"The spacious firmament on high,
With all the blue ethereal sky,
And spangled heavens, a shining frame,
Their great ORIGINAL proclaim".

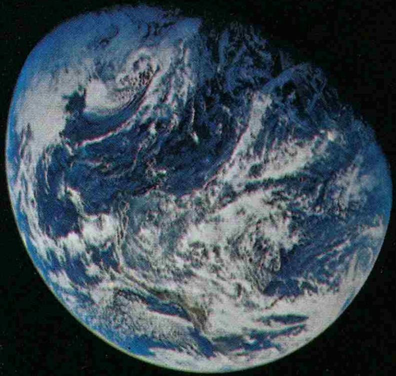
NGC 891 Spiral nebula in Andromeda seen edge on. 60-inch photograph.

And Henry Vaughan professed:
"I saw eternity the other night,
Like a great ring of pure and endless
light".

For the past three hundred and fifty years, the history of astronomy has been, largely, the story of the building of bigger and better telescopes. But, meanwhile, there came to the astronomer other assistance. Photography proved to be a greater aid than had been anticipated. In the early days of the camera, attempts were made to find the exposure necessary to give us the best pictures of the stars, as seen through the telescope. Inevitably, some photographs were over-exposed. On these, there were found stars not seen when looking through the telescope. Stars too faint to be seen by the human eye, even through the telescope, make their imprint on the photographic film after long exposure. To-day, it is common practice to search for faint objects by long exposure. Some of the most beautiful photographs of comets, star-clusters, galaxies and nebulae, show the objects as never seen by human eye, even aided by the telescope.

Besides the camera, another instrument which has proved useful to the astronomer is the spectrograph. It has enabled us to discover not only what elements are in the body of a star, giving bright lines on its spectrum, but also what elements are in its atmosphere, giving dark lines. Also, it enables us to tell whether a source of light is approaching us or receding from us.

Before the World



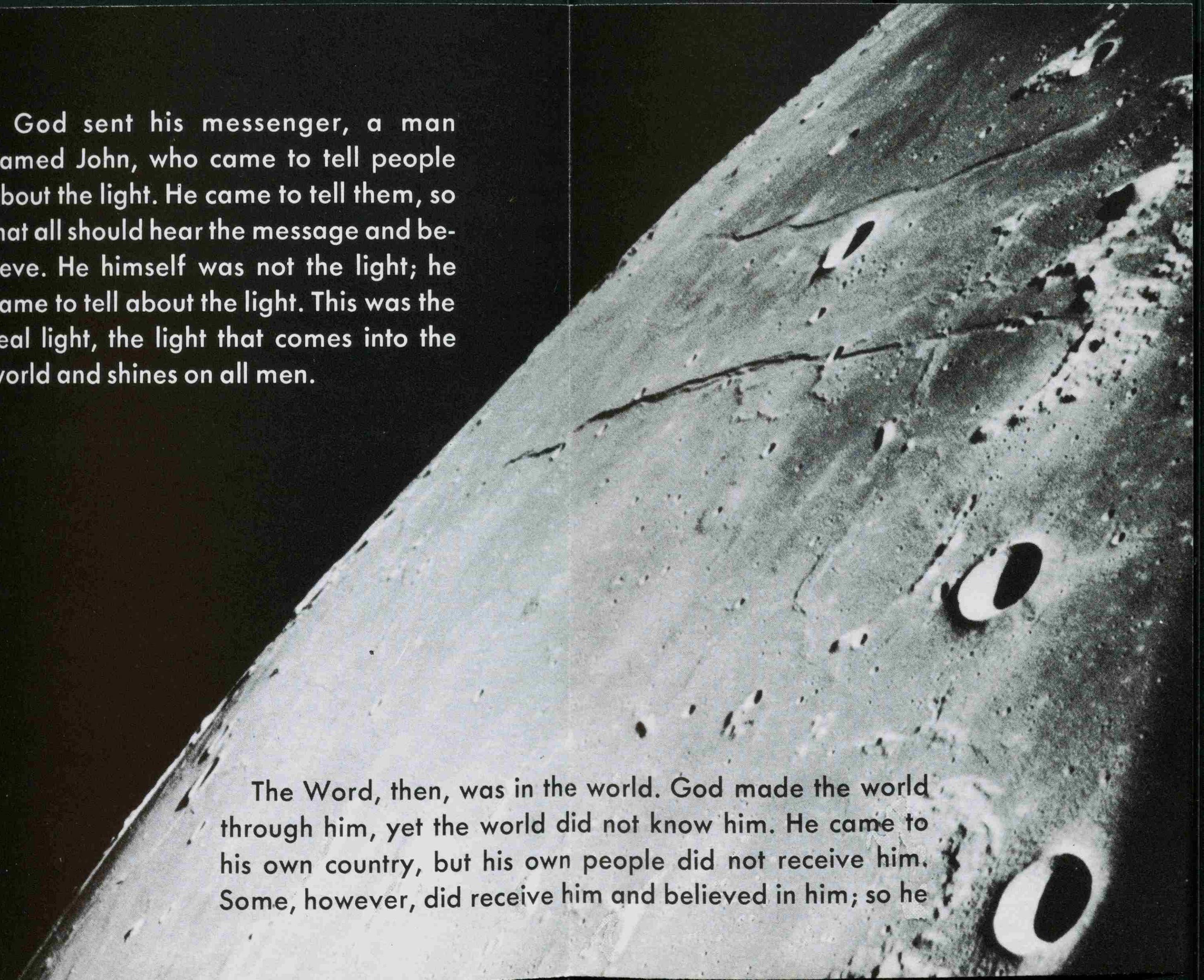
The Word of Life

Before the world was created, the Word already existed; he was with God, and he was the same as God. From the very beginning, the Word was with God. Through him God made all things; not one thing in all creation was made without him. The Word had life in himself, and this life brought light to men. The light shines in the darkness, and the darkness has never put it out.

The Word of Life

Before the world was created, the Word already existed; he was with God, and he was the same as God. From the very beginning, the Word was with God. Through him God made all things; not one thing in all creation was made without him. The Word had life in himself, and this life brought light to men. The light shines in the darkness, and the darkness has never put it out.

God sent his messenger, a man named John, who came to tell people about the light. He came to tell them, so that all should hear the message and believe. He himself was not the light; he came to tell about the light. This was the real light, the light that comes into the world and shines on all men.



The Word, then, was in the world. God made the world through him, yet the world did not know him. He came to his own country, but his own people did not receive him. Some, however, did receive him and believed in him; so he gave them the right to become God's children. They did not become God's children by natural means, by being born as the children of a human father; God himself was their Father.

The Word became a human being and lived among us. We saw his glory, full of grace and truth. This was the glory which he received as the Father's only Son.

This selection of Holy Scripture consisting of John 1.1-14 in Today's English Version is a part of the New Testament of our Lord Jesus Christ. We urge you next to read the entire New Testament, which may be secured from your religious book store or the American Bible Society.

GOD'S WORD FOR A NEW AGE

CANADIAN BIBLE SOCIETY
Auxiliary of
The British and Foreign Bible Society
1835 Yonge Street
Toronto 7, Ontario
Canada

Eng. Sel. TEV880P Printed in U.S.A. ABS-1969-25,000-525,000-Q-2-06606

After Relativists, in the year 1927, announced the theory of the Expanding Universe, the spectrograph was used to verify the theory. It found that all the distant galaxies seemed to be receding from us, and that the further away they were, the faster they went. The picture of an Expanding Universe captured the fancy of men, and they marvelled.

In the year 1928, to the American Revision of the Book of Common Prayer, was added the prayer:
"O heavenly Father, Who hast filled the world with beauty: open, we beseech Thee our eyes to behold Thy gracious hand in all Thy works, that rejoicing in Thy whole creation, we may learn to serve Thee in gladness".

From the enthusiastic writings of the observational astronomers, the general public picked up the notion that our Universe was "ever-expanding". In fact, the evidence of the observations is only that the Universe is now expanding. The time will come when it will no longer have the energy to expand. It will contract. After contracting for a while, it will be smaller and its energy will be sufficient to make it expand again. Our Universe is an Oscillating Universe, which is, at present, expanding.

While theorists were studying the macroscopic, they did not lose sight of the microscopic. Early in this present century, our theory of the nature of the atom told us that its particles, such as electrons and protons, must needs be held together by powerful forces. Splitting of the nucleus of the atom should release enormous energy.

Astronomers made the most of nuclear theory. We had been unable to account for the energy of the sun and other stars. Now, we had an adequate explanation. Between the years 1918 and 1939, astronomers worked out in detail the processes of nuclear energy. They found that stellar energy could be explained by what we now call a chain reaction of nuclear explosions.

Furthermore, as early as the year 1931, it was estimated that to create the Universe, it would be sufficient for the Creator of all things to create only one great mass, contracting all the time, until it set off a supercolossal nuclear explosion, which would send the matter and energy, of which stars and galaxies are composed, flying through space to form the Universe.

According to the "big bang" theory of the origin of our present Universe, as expounded in 1931, there would be some galaxies so far away that they would be out of range of the 100 inch mirror on Mount Wilson, which was, in 1931, the largest telescope in the world. The need for a large telescope became urgent. The 200 inch was designed for Mount Palomar. It has never seen objects as faint as it was designed to see. Objects just a little brighter have been photographed with long exposure. Longer exposure with the 200 inch telescope gives only a better picture of the general background, a picture of starlight in the sky. So, it was discovered that the light of all the stars together, when seen through our atmosphere, appears about as bright as a twenty-fourth magnitude star. We could no more hope to photograph a twenty-fourth magnitude object, when the stars are shining, than we could hope to photograph the stars when the sun is shining. Astronomers were desolate.

Not even bigger telescopes could solve their problem. It seemed that we could never hope to see the most distant galaxies.

It was time for our Father in heaven to give us Lesson Three. This third lesson was not long underway, when the hearts of astronomers were singing in gratitude and saying with David: "What is man that Thou art mindful of him?".

During the Second World War, radar came into use. Large antennae were built to warn of the approach of enemy planes. Radar receiving sets were plagued with extra-terrestrial noises. During the war, the High Command deemed it sufficient to distinguish these natural noises from any noise emanating from a contrivance of the enemy. To study the sources of these noises was deemed unnecessary.

Among the technical personnel in the Services were graduate physicists and astronomers itching to do some research. Many of them, quite independently, decided that after the war they would investigate the sources and nature of the extra-terrestrial radiations. Most of them lived up to their resolve. In Australia, in Britain and in Canada, ex-service men acquired, from War Surplus, large radio antennae. Thus the science of Radio Astronomy was born. Its promises were great. With bigger and bigger antennae, the radio telescope could penetrate deeper into space than the optical telescope.

Most of the radio sources discovered by the radio telescope have been identified. Some of them are distant galaxies, others, inter-stellar clouds, others, the remnants of exploded stars. The possibility of any of them being ordinary single stars was, after a few years of experience, ruled out. We do receive radiation, on radio wavelengths, from the Sun (which is a star), but the reception from the Sun is so weak, that if the Sun was as far removed from us as the nearest of the stars seen in the evening sky we could not receive its radiation with our present antennae.

There was, however, a number of radio sources which seemed to coincide with the position of a star. The radio astronomers were at first willing to concede that the radio source was something a little to the left or to the right of the star. But when many radio objects were classified as Quasistellar Objects, it was time to investigate.

Fortunately, the position of one of these objects lay on the path of the moon. At a certain split second of time, on a certain night, the moon would be seen to occult the star. Actually, a short time before the occultation the radio reception started to weaken. After the star was hidden by the moon, there was still weak radiation for a while. Shortly before the star emerged from behind the moon, the radio reception started again, first weakly and then more strongly. It did not reach full strength again until a short time after the star had emerged. Evidently, the radio source was more extensive than the star, and the star was, roughly, in about its centre. The 200 inch telescope was brought to bear upon the object. Photographs showed it as though it were a distant galaxy with the star as its bright core. The spectrum of the star was photographed. The lines of

NGC 6205 Globular star cluster in Hercules.
Messier 13. 200-inch photograph.

its spectrum were extensively shifted towards the red. The quasi stellar object, or quasar, was receding from us with great speed.

Other fainter quasars were studied. Each one was further away. The furthest, receding at a speed of 150,000 miles per second is estimated to be, perhaps, 8,000 million light years away. To account for the radiation received from this quasar, it must be radiating energy at the rate of ten-to-the-power-sixty ergs per second. This would be equivalent to the conversion of about one hundred times the Sun's mass into energy every year.

In December, 1963, an International Symposium was held at Dallas to discuss the new quasi stellar objects. The physics of these objects posed problems. No one of the preferred solutions was unanimously accepted. There was, however, common agreement that these objects were very distant, but that their nuclei were very bright and producing energy more rapidly than we could understand. The failure to reach universal agreement moved the chairman, J. Robert Oppenheimer to say, in his summation: "At least, these objects are the record of unprecedented events of great splendor and wondrous beauty". To me, and to many, Oppenheimer's words were but a twentieth century American echo of the words of David of Bethlehem: "The heavens declare the Glory of God".

Immediately after the Second World War, in the years when the radio astronomers were pioneering, there were theoretical astronomers thinking about the Oscillating Universe. Some of them did not like it, because it was losing energy, and would, eventually come to an end.

A group at Cambridge University thought up an alternative theory. The chief spokesman of the group was Fred Hoyle. When Hoyle worked out the loss of energy per annum in the Universe it was relatively small. In order to keep the Universe going forever, it would suffice to add relatively few atoms of hydrogen to the Universe every year, so Hoyle adopted the notion of continuous creation, already suggested, in another context, by a German named Jordan. Computation showed that the amount of matter that should be added yearly to the Universe in order to keep it expanding, was the amount required to keep the density of the Universe constant. According to this steady-state theory, there was a time when the volume of the Universe was very small, and the amount of matter in it was very small. There was no need for a big bang to start it expanding.

In his mathematical papers, Hoyle explained the so-called creation of matter by supposing what he called a C-field, capable of producing mass. He justified his C-field by pointing out that many different types of fields are known: the gravitational field, the electromagnetic field, the nuclear field. From time to time, new fields are discovered by experiments in the laboratory, as, for example, the meson field. Could there not be a field which would produce not gravitation nor magnetism, but mass?

Needless to say, there were plenty of astronomers who did not like Hoyle's introduction of a field for which there is neither experimental nor observational evidence. It was agreed, however, that the possibility of his suggestion should be admitted, until such time as there was found evidence against it.

The first to come forward with observational evidence against the steady-state theory was Ryle, a radio astronomer at Cambridge University. In February, 1961, he read before the Royal Astronomical Society, a paper which had been prepared by himself and five associates. They had observed thousands of radio galaxies. Of these, more were far away than near. The most distant were four or five times further away than the most distant optical objects. Applying statistical methods, the evidence was that the far-reaches of our Universe were more thickly populated than could be allowed by Hoyle's theory.

Hoyle maintained that the number of observations by Ryle and his companions was insufficient to be convincing.

This was the state of affairs when, early in 1963, the news of quasi stellar objects broke upon the astronomical world. Many saw in them evidence to favour Ryle.

Hoyle was present at the symposium held at Dallas in December, 1963. He suggested that perhaps the large red-shift observed in the spectra of the quasars was due, not to recession, but to gravitational collapse. The observed width of the spectral lines ruled out this possibility. As Hoyle left Dallas, he had something about which to think.

The discovery of more and more quasars in the years 1964 and 1965, each further away than the other, reinforced Ryle's argument that the Universe was not in a steady state. Hoyle capitulated. In a paper read at the annual meeting of the British Association for the Advancement of Science, in September, 1965, he conceded that the steady state theory must be abandoned. He went on to say that, at the moment, an oscillating model of the Universe seemed to fit the data best, but, he added, that he was not yet convinced that the Big Bang theory was the only way to account for an oscillating universe.

In December, 1965, a symposium was held at Miami Beach on recent observations pertaining to Cosmology. Observations were reported by optical astronomers and by radio astronomers. The data was discussed by physicists, mathematicians and cosmologists. Papers were read by men working in the United States, Puerto Rico, England, France, Israel and Australia. There was agreement that both observation and theory favoured an oscillating universe. There was intriguing evidence for the Big Bang theory of the origin of the observable universe.

Assuming that the Universe expanded from a highly contracted phase, Professor Dicke, a physicist at Princeton University had set himself the task of re-examining the thermal history of the Universe. He found that the early Universe would have been so dense that it would reach thermal equilibrium with the matter. There would follow the spreading of black-body radiation throughout the Universe. This radiation should retain its thermal, black-body character to the present day, but be very much cooled by the expansion of the Universe. We should now look for it in the microwave band.

Two of Dicke's associates constructed a radio telescope (consisting of radiometer and receiving horn) capable of measuring radiation at a wavelength of three centimeters. Before the instrument was in operation, two researchers at the Bell Telephone laboratories, reported that, when preparing for the Telstar program, they had picked up what they called a background thermal radiation, with intensity equivalent to about three-and-one-half degrees absolute temperature. They had been perplexed by it. Their report as much as asked the Princeton man: is this what you are looking for? It did, indeed, seem to be radiation of the fireball generated by the Big Bang. The Princeton instrument, when ready, detected it. Its existence was, later, verified by radio astronomers at Cambridge University.

Speaking in an imaginative way, we may say that the reception of this newly discovered radiation is the feeling of the heat of the primordial big bang of our present Universe, or the seeing of the effect of its flash.

Nearly twenty years ago, Hoyle wrote: "No literary genius could have invented a story one-hundredth part as fantastic as the sober facts that have been unearthed by astronomical science."

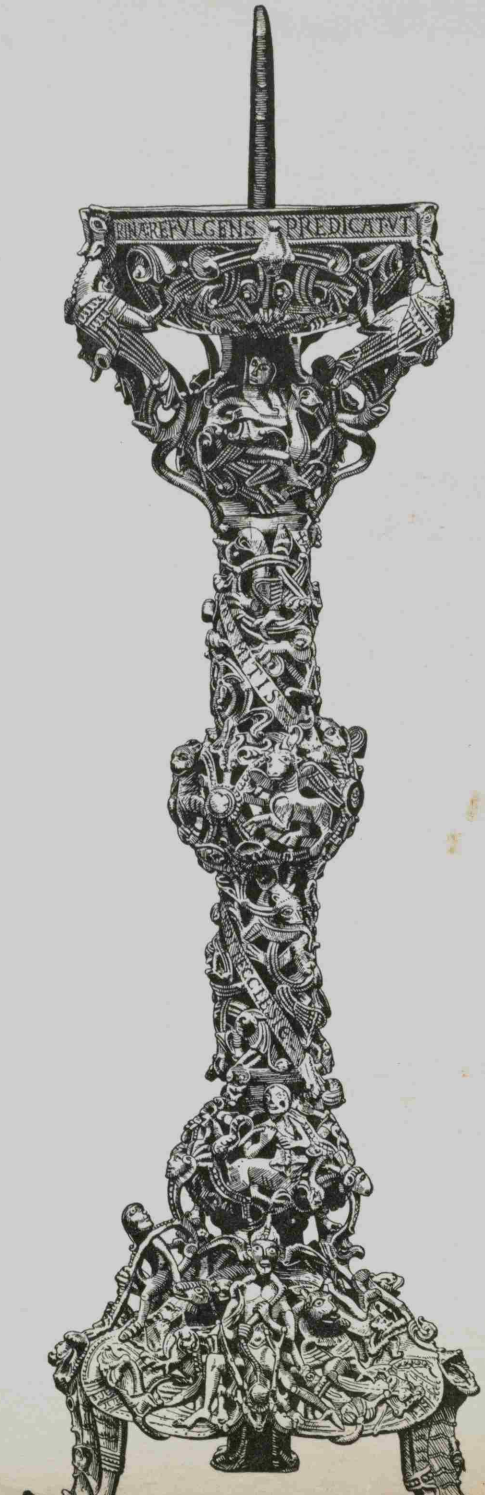
The fantastic facts now outweigh the fantasy of fiction by an enormous margin.

Astronomers are filled with wonder.

Knowledge has awakened appreciation of God's intelligence.

Today, in a deeper sense than ever before, the heavens declare the glory of God.

NGC 6523 Nebula in sagittarius. Messier 8, "Lagoon" Nebula. Photographed in red light. 200-inch photograph.


FVLGENS PREDICAT VT

A History of Technology

Editors: CHARLES SINGER, E. J. HOLMYARD *Deputy Editor:* A. R. HALL

Thames House, Millbank, London, S.W.1 and Kilmarth, Par, Cornwall

WITH BEST WISHES OF THE SEASON

from Charles and Dorothea Singer

This candlestick was given by one Peter, who was Abbot of Gloucester from 1104 to 1113, to the Church of St. Peter at Gloucester, which afterwards became Gloucester Cathedral. Later it passed to the Cathedral of Le Mans in France and subsequently into private possession, whence it reached the Victoria and Albert Museum, London, where it now is. It is 23 inches high and of gilded bronze, cast in one or perhaps two pieces. The skill shown in casting this intricate piece by the cire perdue *process is unexcelled among works of the period. Our figure has been specially drawn from the object by D. E. Woodall for Volume II of* A History of Technology, *of which Volume I has just been published by the Clarendon Press, Oxford. Victoria and Albert Museum; Crown Copyright.*

LETTERING ON LIBRARY BOOKS

Published June 1, 1919, by the Bookbinding Committee of the American Library Association

---

The hand lettering on books in some libraries is so poorly formed that readers and assistants can with difficulty identify books. In most libraries good lettering could be done by apprentices or by "pages" instead of by trained assistants, if instructions such as the following were placed before them for practice.

(Valuable Suggestions, and Figs. 2 and 4 are taken from French's "Engineering Drawing" by courtesy of McGraw-Hill Book Company.)

For use on Library books, lettering is required that shall be (1) Highly legible; (2) Rapidly and easily done. This card is meant to instruct in the skilled use of a lettering called Condensed Light Line Gothic, which is simple and highly legible. Its lines are of one thickness everywhere so that they can be made with one stroke of the ordinary pen, and it is therefore rapidly done.

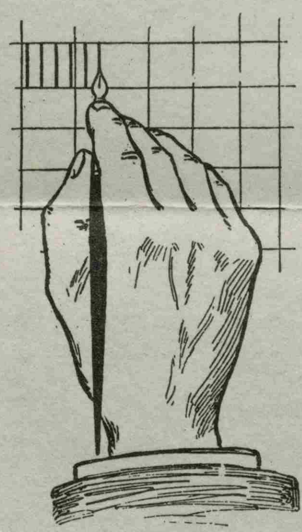


Fig. 1

PENS. A round pointed pen should be used. A stub pen is not suitable for lettering books, because (a) all the strokes of each letter should be of equal thickness; (b) the thin strokes of the stub have to be filled in at a loss of time; (c) a stub pen tends to make upright lettering lean backward, which is worse than leaning forward. Hold the pen as shown in Fig. 1. The term "single stroke" does not mean that the entire letter is made without lifting the pen, but that the width of the stroke of the pen is the width of the stem of the letter. Pens must be selected to give the necessary width of strokes for lettering of different sizes.

OTHER MATERIAL

Penholders with cork grips; Carter's white ink No. 441 (with quill), or Bissell's Show card color (white); Higgins' black india ink (with quill); Pen wiper cloths; A cloth for pasting, etc.; Steel eraser; Blotters; Pyrox, or best white shellac (preferable in Huntting jar); Brushes for shellac ¾ inch, 2 inch (with hooks if to hang in Huntting jar); Bottle of denatured alcohol.

LEONARDT 516 F

HUNT 512: Gillott 1032

Gillott 404: Spencerian No. 1

Gillott 303 For very fine lines Gillott 170 and 290

Fig. 2--Strokes of various pens

PRACTICE IN LETTERING

SAMPLE ALPHABET. Following is the complete alphabet ("upper and lower case") and figures. Note the simplicity and the proportion of the letters, especially G, J, K, M, N, R, Z, 2, 7. At a distance the eye does not confuse these letters with others that resemble them.

A B C D E F G H I J K L M N O P Q R S T
U V W X Y Z

a b c d e f g h i j k l m n o p q r s t u v w x y z
1 2 3 4 5 6 7 8 9 0 & . , : ; " " - ! ?

CAPITAL LETTERS. Rule some lines about ¼-inch apart and practice the capital letters. Some parallel vertical lines will help in getting true strokes. Printed "cross-section" paper, if conveniently secured, is good for practicing on. Letter with a uniform, easy motion and do not press heavily enough to spread the nibs of the pen. Learn the form and peculiarity of each of the letters.

Practice on the letters in the following groups: I, H, T; L, E, F; N, Z, X, Y; V, A, K, 4; M, W. So far all the strokes are straight. Practice for steady lines, even heights and spacing, and for joining the strokes at the right points as shown by the Sample Alphabet. Note that the outer strokes of M and N are parallel and the middle point of M reaches the bottom line; that the vertical line through the point of V and A should find as much space on one side as the other; that the upright and cross line in 4 are exactly vertical and horizontal, and that there is no curve or bend in these letters. Practice then some words in which these letters are combined.

Practice next the following groups O, Q, C, G; D, U, J; P, R, B; S, 8, 3; 0, 6, 9; 2, 5, 7, &. Practice for even curves and correct proportions of the letters B and R; observe that the tail of R does not start at the vertical line; that the two curves of B coincide into a horizontal line a little above the center of the space; that J has no top; that the upper part of S, 8, and 3 are smaller than the lower parts; that a flat top on 3 would make it look like a five at a distance; that 6 and 9 are good to look at when evenly balanced and not otherwise; that the bottom line of 2 is straight, and the tops of 5 and 7 straight too. Practice words in capitals.

LOWER CASE LETTERS. Rule some practice lines for lettering in "small" or "lower case" letters. The bodies of small letters are two thirds the height of the capitals. Rule some vertical pencil lines also as a guide to uniform lettering. Practice the following groups, i, l, k; j, t; y, f; v, w, x, z; o, c, e; s, g, a; b, d, p, q; h, m, n, r, u. Practice for true vertical and horizontal lines, even curves, right proportions according to the Sample Alphabet. Note that there are no "hooks" or cross lines on the terminals of any of the letters; that b, d, p, q are made from perfect ovals; that the curves of h, m, n, finish in straight down strokes.

PRACTICE WITHOUT GUIDE LINES. Next practice printing words, sentences, book titles, call numbers, etc., using the guide lines and not leaning the letters backward or forward. After plenty of practice with the guide lines, try using only the base line as a guide, working for even height and spacing.

SUGGESTIONS ON PEN WORK. In using a small-necked ink bottle, ink the pen with a quill or brush rather than dipping it in the bottle. Do not get too much ink on the pen, or the result will be like Fig. 3. The smoothness of the paper also makes a difference in the ink flow. A new pen should be wiped with a cloth dampened in water or alcohol, otherwise the smooth surface will let the ink run down too fast. Do not put lettering pens in ordinary ink. Clean the pen frequently with a cloth, while using.

EHMNWTZ

Fig. 3-.Too much ink.

ERRORS IN LETTER FORM. It is easy to depart from the correct form for any letter, and one does not notice his own departures without constantly comparing his work with the Sample Alphabet.

MARKING

There are two methods of lettering the backs of books, both of them having advantages, and in wide use, (a) lettering in black on white labels pasted to the book; (b) lettering in white ink directly on dark colored books, or in black ink on light colored books.

UNIFORM HEIGHT. In either case all the marking should be at a uniform distance from the bottom, preferably 1½ inch. The letterer needs a convenient marker for this; use a card, or double a 3 x 5 slip, or cut a ring around the handle of the pen holder, which is the least easily lost. A few labels or marking, out of line on the shelf will spoil the appearance of the whole lot.

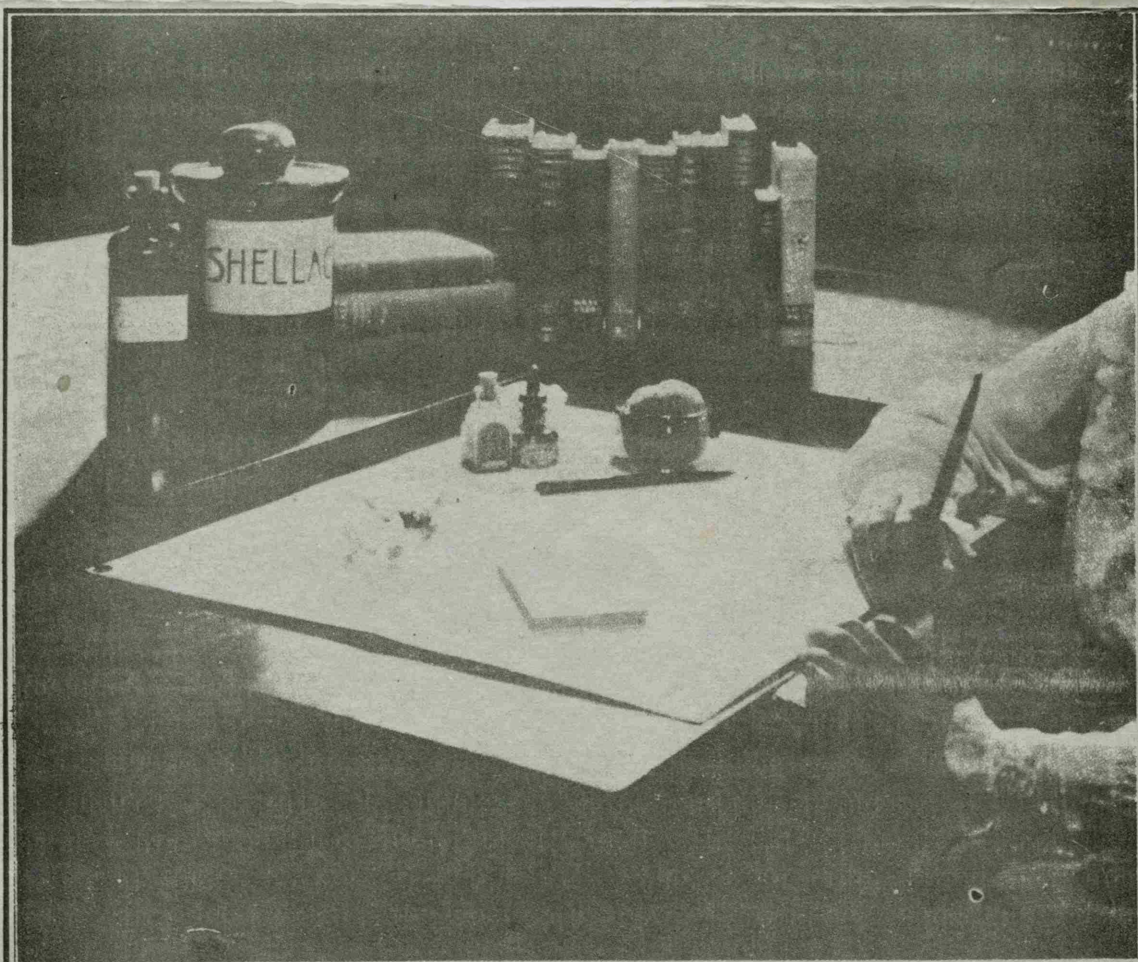


Fig. 4--Marking books. Equipment and position for average library.

LABELLING. Dennison gummed labels in suitable sizes may be used. Trim labels slightly narrower than the back of the book to prevent edges from rubbing loose. In applying labels, be sure that the gum is only moistened and not partly removed. Lightly wipe the spot where the label is to go with a cloth dampened in denatured alcohol, to remove the oil or gloss from the surface. Paste the label all over with very thin paste and rub it down tight with a clean cloth. After the labels are thoroughly dry, mark them, arranging the lettering neatly and in balance. Hold book on knee against the edge of the table, to steady the work.

LETTERING DIRECTLY ON BOOK. Remove gloss as directed above. Note correct height with marker and letter in white ink (if dark colored book) keeping the letters uniform in size and slant and in a straight line. If new at the work, better plan the spacing before using ink. Do not let the ink get dry or thick, or the pen will be hard to start and may then suddenly let the ink run and blot. If gilding or decoration occupies the space where the marking should go, it may be covered with a band of India Ink, and the white lettering can be done on this when dry. On books where the ink blurs, a thin coat of shellac before lettering will help.

SHELLACING. Both labelled and lettered marking should be shellaced, to preserve it. Some libraries take this occasion to shellac the whole back or the entire cover. In shellacing, consider the time spent. It is easy to use enough time on one book to do a dozen. If the whole book or whole back is to be shellaced, use a brush two inches wide and get over the space quickly. If only the lettering is to be shellaced, arrange the row of books with bottoms even, take a flat 3/4-inch brush and make a straight band of shellac across one back after another, lifting each to the right height. Keep the shellac brushes suspended in the jar, or else clean each time after using. Use best grade of white shellac.

A. L. A. Bookbinding Committee

JOSEPH L. WHEELER, Youngstown Public Library
GERTRUDE STILES, Cleveland Public Library
MARY E. WHEELOCK, St. Louis Public Library

Photographic Reprinting -
Latta Co. Montreal.

About $3 per page per 100 reprints.

200 15

40 41 42 43 44 45 46 47 48 49 50

0 1 2 3 4 5 6 7 8 9

10 11 12 13 14 15 16 17 18 19

20 21 22 23 24 25 26 27 28 29

30 31 32 33 34 35 36 37 38 39

40 41 42 43 44 45 46 47 48 49

50

I II III IV V VI VII VIII

IX X XI XII XIII XIV XV XVI

XVII XVIII XIX XX XXI XXII XXIII XXIV

I II III IV V VI VII VIII IX X

XI XII XIII XIV XV XVI XVII XVIII

XIX XX XXI XXII XXIII XXIV

I II III IV V VI VII VIII IX X XI

XII XIII XIV XV XVI XVII XVIII XIX XX

XXI XXII XXIII XXIV

Antapex Area Apex km/sec. km

sec. mm cm + — = ±

o ′ ″ h m s M Gal. Lat. Gal. Long.

R.A. Dec. Antapex Area Apex km/sec.

km sec. mm cm + — = ±

o ′ ″ h m s M Gal. Lat. Gal. Long. R.A. Dec.

Antapex Area Apex km/sec. km sec. mm cm

+ — = ± ° ′ ″ h m s M Gal. Lat.

Gal. Long. R.A. Dec.

Hα Hδ Hβ Hγ Hϵ Hζ H$_\alpha$ H$_\delta$ H$_\beta$ H$_\gamma$ H$_\epsilon$ H$_\zeta$

α β γ δ ϵ ζ η θ ι κ λ μ ν ξ o π ρ

σ τ υ ϕ χ ψ ω Δ Π Σ Ω

THE SCALE OF TIME

TIME CAN BE MEASURED, YET DEFIES DEFINITION. RECORDS OF ITS PASSAGE ARE TO BE FOUND IN ROCKS AND IN PRE-HISTORIC GARBAGE DUMPS, AS WELL AS IN THE WRITINGS OF HISTORY. SOME OF THESE - FROM THE DEAD SEA SCROLLS OF 2,000 YEARS AGO TO THE KENORAN MOUNTAINS FORMED ABOUT 2,500,000,000 YEARS BEFORE THE PRESENT - CAN BE DATED BY RADIOACTIVE-DECAY METHODS.

EVIDENCE FROM ASTRONOMY, METEORITES, AND ROCKS SUGGESTS AN AGE OF ABOUT 4,500,000,000 YEARS FOR THE EARTH. WHAT IS CALLED "GEOLOGICAL HISTORY" BEGAN WHEN THE EARTH HAD COOLED SUFFICIENTLY TO RETAIN AN ATMOSPHERE AND SEA. LIFE MUST HAVE STARTED IN THE REMOTE PAST BUT LEFT LITTLE FOSSIL RECORD UNTIL THE CAMBRIAN PERIOD, MORE THAN 500,000,000 YEARS AGO.

FOSSIL ASSEMBLAGES FOUND IN ROCKS FORMED SINCE THE CAMBRIAN CLEARLY INDICATE CHANGES IN THE FORMS OF LIFE THAT HAVE INHABITED THE EARTH FROM TIME TO TIME. SOME OF THESE CHANGES HAVE BEEN GRADUAL, OTHERS ABRUPT, AND THE OVERALL PATTERN IS BEST EXPLAINED BY DARWIN'S THEORY OF ORGANIC EVOLUTION.

THE LAST 70,000,000 YEARS OF GEOLOGICAL TIME CONSTITUTES THE ERA OF RECENT LIFE (CENOZOIC), WHICH IS LARGELY COVERED IN COLUMN 2. FOR PURPOSE OF SIMPLIFICATION, ONLY STAGES IN THE EVOLUTION OF PRIMATES (THAT BRANCH OF MAMMALS TO WHICH MAN BELONGS) ARE SHOWN, CULMINATING IN THE APPEARANCE OF "NEAR-MAN" IN EAST AFRICA SOME 1,750,000 YEARS AGO. TRUE MAN AROSE DURING THE PLEISTOCENE ICE-AGE, AS SHOWN IN COLUMN 3.

1. Geological Time

THE PRESENT

[PHANEROZOIC EON]
CENOZOIC ERA — ERA OF MAMMALS AND FLOWERING PLANTS
70,000,000
MESOZOIC ERA, ERA OF DINOSAURS — DINOSAURS EXTINCT, FIRST BIRDS, FIRST MAMMALS
225,000,000
PERMIAN ICE AGE — TRILOBITES EXTINCT, FIRST REPTILES, FIRST AMPHIBIANS
PALEOZOIC ERA, ERA OF INVERTEBRATE LIFE — FIRST LAND PLANTS, FIRST FISH
CAMBRIAN PERIOD — FIRST ABUNDANT FOSSILS
600,000,000

[PROTEROZOIC EON — UPPER, MIDDLE, LOWER]
950,000,000 — GRENVILLE OROGENY
1,700,000,000 — HUDSONIAN OROGENY
HURONIAN ICE AGE ?
2,500,000,000 — KENORAN OROGENY

[ARCHEAN EON]
ORIGIN OF LIFE
START OF GEOLOGIC TIME
FORMATION OF SEA AND ATMOSPHERE
4,500,000,000 — ORIGIN OF THE EARTH

6,000,000,000
YEARS BEFORE PRESENT

2. Primate Evolution

THE PRESENT
PLEISTOCENE — NEAR-MAN BECOMES MAN, FOUR GLACIAL EPOCHS
1,000,000
1,750,000 — EARLIEST NEAR-MAN -- ZINJANTHROPUS

[PLIOCENE]
OREOPITHECUS
11,000,000

[MIOCENE]
FORT TERNAN PRIMATE
PROCONSUL AND OTHER HOMINOIDS POSSIBLY ANCESTRAL TO BOTH MAN AND THE GREAT APES
25,000,000

[OLIGOCENE]
GIBBONS DIVERGE FROM OTHER PRIMATES
OLD-WORLD MONKEYS DIVERGE FROM OTHER PRIMATES
40,000,000

[EOCENE]
NEW-WORLD MONKEYS DIVERGE FROM OTHER PRIMATES
LEMURS DIVERGE FROM OTHER PRIMATES
PRIMITIVE PRIMATES
60,000,000
YEARS BEFORE PRESENT

3. The Rise of Man

THE PRESENT
HISTORIC (SEE COLUMN IV)
MESOLITHIC AND NEOLITHIC
13,000

[PALEOLITHIC — UPPER, MIDDLE, LOWER]
[FIRST TRUE MAN AROSE SOMETIME DURING THIS PERIOD]

MANKIND ABOUT 5 MILLION
MAN ENTERS NORTH AMERICA
WANING OF FOURTH GLACIATION
CRO-MAGNON MAN — FIRST ARTISTIC CREATIONS
NEANDERTHAL MAN BECOMES EXTINCT
50,000 — LOWER LIMIT C14 DATING
ONSET OF FOURTH GLACIATION
100,000 — NEANDERTHAL MAN
150,000 — FONTECHEVADE MAN
200,000 — WANING OF THIRD GLACIATION
250,000 — STEINHEIM MAN, SWANSCOMBE MAN
ONSET OF THIRD GLACIATION
300,000
350,000 — PEKIN MAN (USED FIRE)
400,000
450,000
500,000
550,000
WANING OF SECOND GLACIATION
FIRST HOMINIDS ENTER EUROPE
600,000
YEARS BEFORE PRESENT

4. Man's Written History

MANKIND INCREASING FROM 3 TO 6 BILLION
AD 1900
CURIE RUTHERFORD EINSTEIN
MENDELEJEFF GIBBS LE CHATELIER PLANCK
DARWIN MENDEL PASTEUR MAXWELL
DALTON AVOGADRO FARADAY HENRY
HUTTON WATT PRIESTLEY LAVOISIER GOETHE
HALLEY NEWCOMEN LINNAEUS KANT
BOYLE NEWTON DARBY
GALILEO HARVEY DESCARTES
BRAHE FRANCIS BACON KEPLER
BIRINGUCCIO COPERNICUS VESALIUS
AD 1500
MAGELLAN AGRICOLA — REFORMATION
COLUMBUS LEONARDO — RENAISSANCE
PAPER PRINTING COMPASS, IRON-CASTING GUNPOWDER — REACH EUROPE FROM CHINA
THE BLACK DEATH
MARCO POLO — ITALIAN RENAISSANCE
ROGER BACON AQUINAS NINTH CRUSADE
NECKHAM FIBONACCI GROSSETESTE
FIRST UNIVERSITIES: BOLOGNA PARIS
ARABIC NUMERALS INTRODUCED IN EUROPE
FIRST CRUSADE
NORMAN CONQUEST OF ENGLAND
AD 1000
AVICENNA
NORSEMEN REACH AMERICA
GUNPOWDER INVENTED IN CHINA
CHARLEMAGNE DANES RAID ENGLAND
BEDE
ALEXANDRIA MUSEUM DESTROYED
MOHAMMED
AD 500
AUGUSTINE ROME SACKED
HYPATIA ALEXANDRIA LIBRARY DESTROYED
GALEN MARCUS AURELIUS
PTOLEMY PAPER INVENTED IN CHINA
LAST OF NEW TESTAMENT WRITINGS
PLINY
JESUS — MANKIND ABOUT 250 MILLION
AD / BC
STRABO
LUCRETIUS
HIPPARCHUS — CARTHAGE DESTROYED
ERATOSTHENES
ARISTARCHUS ARCHIMEDES
THEOPHRASTUS STRATO EUCLID
ALEXANDER THE GREAT
PLATO ARISTOTLE — IRON AGE IN BRITAIN
SOCRATES HIPPOCRATES
EMPEDOCLES ANAXAGORAS
GREEK-PERSIAN WARS CONFUCIUS BUDDHA
500 BC
PYTHAGORAS ANAXIMENES HERACLITUS
THALES ANAXIMANDER JERUSALEM SACKED
ZOROASTER NECHO II LYDIAN COINAGE
LATIN ALPHABET DERIVED FROM GREEK
ASSYRIAN CONQUESTS SARGON II
IRON AGE STARTS IN CENTRAL EUROPE
COPPER-MINING IN EZION-GEBER
OLD TESTAMENT WRITINGS START
GREEK AND HEBREW ALPHABETS DERIVED FROM PHOENICIAN
1000 BC
TROJAN WAR
RAMSES II — EXODUS?
OLDEST TRUE ALPHABET - PHOENICIAN
IKHNATON (MONOTHEIST) TUTANKHAMEN
DESTRUCTION OF MINOAN CULTURE
BRONZE AGE REACHES NORTHERN EUROPE
DISCOVERY OF IRON SMELTING: ASIA MINOR
1500 BC
RISE OF ASSYRIA
STONEHENGE
COPPER MINING ON LAKE SUPERIOR
HITTITE CIVILIZATION APPEARS
HEIGHT OF INDUS CIVILIZATION
2000 BC
PAINTED POTTERY IN CHINA
HAMMURABI KING OF BABYLON
CONCEPT OF FIVE ELEMENTS IN CHINA
UR CAPTURED BY ELAMITES
AGRICULTURE REACHES NORTH CHINA
2500 BC
CRETE - EARLY MINOAN CULTURE STARTS
SARGON I UNITES SUMER AND AKKAD
COINAGE IN MOHENJO-DARO INDUS R.
AGRICULTURE REACHES EUROPE
3000 BC
BUILDING OF THE PYRAMIDS
MENES UNITES EGYPT
OLDEST SURVIVING POTTER'S WHEEL
OLD KINGDOM BEGINS IN EGYPT
OLDEST POTTERY IN RUSSELL CAVE ALABAMA
3500 BC
SUSA, ELAMITE CAPITAL, 40000 INHABITANTS
FIRST TRUE CITIES RISE ALONG NILE, TIGRIS-EUPHRATES, AND INDUS RIVERS
FIRST BRONZE SMELTING - ASIA MINOR
HEIROGLYPHIC WRITING
WHEELED VEHICLES
AGRICULTURE AND ANIMAL DOMESTICATION
6,000
YEARS BEFORE PRESENT

MAN IS STILL PRONE TO MEASURE TIME BY HIS PULSE-BEAT OR LIFE-SPAN - POOR CLOCKS FOR THE TENS OF THOUSANDS OF YEARS DEMANDED BY ARCHEOLOGY AND, STILL POORER, FOR THE MILLIONS OR BILLIONS OF YEARS THAT ARE THE CONCERN OF ANTHROPOLOGY, GEOLOGY, AND ASTRONOMY. YET MAN IS A PART AND PRODUCT OF ALL TIME, AND CANNOT HOPE TO UNDERSTAND HIMSELF WITHOUT SOME APPRECIATION OF HIS PLACE IN IT. THE COLUMNS ABOVE ARE DESIGNED TO AID IN THIS.

THE TOP OF EACH COLUMN REPRESENTS THE PRESENT. THE LAST ONE-PERCENT OF THE TIME INCLUDED IN A COLUMN IS ENLARGED 100-FOLD TO GIVE THE COLUMN ON ITS RIGHT. ACCORDINGLY, THE 6,000 YEARS OF MAN'S WRITTEN HISTORY THAT ARE COVERED BY COLUMN 4 AMOUNT TO ONLY THE LAST ONE-MILLIONTH PART OF THE TIME INCLUDED IN COLUMN 1.

Graham George

Canada's Music - 1955

(Reprinted from CULTURE XVI [1955] 51-65)

CULTURE
33, de l'Alverne Street
QUEBEC

Canada's Music—1955

An attempt to assess the quality of contemporary Canadian composition

GRAHAM GEORGE
Queen's University

METHOD — For the preparation of this survey each living composer listed in the CBC *Catalogue of Canadian Composers* (1952) (editor, Helmut Kallmann) has been asked to submit one or two short compositions representative of his or her style. These scores have been used as the basis for (1) assembling certain statistical information and combining it with material from Mr. Kallmann's invaluable book and other sources; (2) giving consideration to the character of contemporary music in terms of technical standards, influences, and, briefly, the question of national character; (3) giving individual attention to certain composers who, either by the intrinsic value of their works or by reason of their reputation appear to require it. The last classification divides itself into the consideration of two categories of composers: those whose talent is limited in expression by the use of relatively easy technical devices, and those whose technical equipment is potentially adequate for the expression of serious musical thought.

The discussion of individual composers is presented without naming them. The immediate purpose of the survey is to lay before the reader a carefully considered impression of the present state of Canadian musical composition. For this the names of composers are not necessary, and it would be unjust, on the memory of a few works heard and one or two read, to attempt an appraisal of the composer's standing in terms of his or her whole output.

It will be understood that to assemble musical scores from all over Canada and some parts of the United States has required much care, and the writer is grateful to Miss Martha Jamieson of the Queen's University Department of Music for her efficient and patient handling of the mechanics of this task; to Mr. H. P. Gundy of the Queen's University Library for taking charge of the scores on their arrival; and above all to the composers themselves for their most generous cooperation. A survey of this sort can too readily become either a mere assembly of the writer's subjective impressions or a re-working of existing surveys, themselves inadequately documented. That this article can attempt to be something more is due chiefly to the interest shown by the composers and their willingness to submit scores for scrutiny; its limitations will be those inherent in the abilities of the writer and those resulting from the impossibility, in the short time available, of getting into touch with some composers. At least three composers important to the development of Canada's music are not referred to in the following pages, and no doubt that estimate is in fact too small.

STATISTICS

THE SURVEY — In the CBC *Catalogue of Canadian Composers* published in 1952, 290 composers are listed as living. All these were approached by letter and asked to send a score or scores to be scrutinized for the purpose of the survey. Sixty-eight sent one or more scores, twenty-five letters were returned by the Post Office as undeliverable, and four wrote disclaiming any real standing as composers. Of the remaining 193 it is to be presumed that many were deterred by similar considerations of modesty, and no doubt some were disinclined to associate themselves with the survey.

STUDIES ABROAD — According to the most complete information now available, twenty composers now living have studied in France or with French composers — chiefly with Nadia Boulanger (six), Milhaud (five) and Honegger (three); three have studied with Hindemith; four with English composers; eight with American composers; and one (who is also one of the Hindemith students) with Bartok. In addition, Canadian composition is influenced by eleven living composers who came to this country with their style already formed; their backgrounds include such names as Kodaly, Vaughan Williams, Johan Wagenaar, Weigl, and Boulanger.

TECHNIQUE (in terms of idiom and competence)

Idiom	*Technique*	*Number of Composers*
Twentieth-century	Adequate	13
Attempted modernism	Inadequate	7
Intermediate style	Adequate	4
Traditional	Adequate	41
Traditional	Inadequate	3

PERFORMANCES ABROAD (excluding film music) since 1947

	CAPAC *list*[1]	BMI *list*[2]	*Total*
Britain	21	11	32
Europe	76	19	95
USA	33	40	73
Commonwealth (outside Britain)	18	1	19

WORKS

GENERAL — It was to be expected that a large proportion of the material submitted for the survey would be, both in content and technique, " remembered music ". The number of people living at any one time who would, entirely of themselves and without previous example, instinctively employ themselves in the arrangement of musical sounds must be very small. They would constitute the group of people having the greatest natural talent for music in their time; but, since the production of works of art demands much besides pure talent, not necessarily the group which would make the greatest eventual contribution to the art of composition. Apart from this small and special group, all who work with the materials of art are to some extent set in motion by the effect on them of previously existing works.

The question is then, not whether the composer is using *materials* which have not been used before, but how original a mind is being applied to the common stock of materials. This in turn requires definition, for by " originality of mind " we mean, not a determination to do something which has not been done before, but rather that unconscious and therefore unmanageable quality which gives distinction to the utterance when a man is expressing, with the utmost intensity and craftsmanship at his command, what is in him to express. The man of original mind, seeking

1 — Composers, Authors and Publishers Association of Canada.

2 — Broadcast Music Incorporated (Canada) Limited. The tally of performances in Europe is incomplete because BMI has only recently entered into agreement with European performing-right organizations for the interchange of this information. Even apart from this factor the lists certainly do not include every performance abroad since 1947. They are given because it will surprise most readers to find so many Canadian works being heard outside this country. As far as can be determined through the mists of international courtesy these performance have been well received; we need not be disturbed that neither the Thames nor any other river has been set on fire.

simply to say what he has to say, will sooner or later be forced by his very originality out of the traditional path, but we need not suppose that he will be forced to the spearhead of the *avant-garde*.

Since originality of mind is relatively rare, most of those who feel even a real urge to create will either choose materials in which a large amount of artistic work has already been done or will arbitrarily and wilfully use materials foreign to the needs of their ideas merely to avoid being considered " unoriginal " by others.

To classify most creative endeavour as unoriginal is by no means to suggest that it ought to stop. A great artist may be regarded as the flowering of a more general growth, and just as we cannot have a flower without soil, roots, greenery, and certain proportions of light and dark, so we cannot have a great artist without a comparable environment of humbler creative workers. In music more than any other art, because it must be performed before the listener can assess it, we tend to think chiefly in terms of " the very great ", " the great ", " the slightly less great "— and then nothing. We do not cherish minor composers with the same affection that we accord to a Lovelace or a Richard Baxter.[3] Yet a garden made up of nothing but flowers, even if attainable, would be aesthetically undesirable; and it suggests a state of mind lacking in subtlety that we want always to be on the mountain peaks of music. Furthermore we are unlikely to appreciate the peaks fully unless we are in a position to compare them with the more domestic valleys — as anyone knows who has attempted, on internal evidence alone, to assess the values in a work of doubtful authenticity attributed to a great master.

Even for expediency's sake we ought to recognize that the artists who are destined for immortality have no need of us; our only responsibility is to keep them alive in conditions under which they can do their work. It is the lesser men, not so destined, yet having a real part to play in the spiritual life of their time, who need sympathetic criticism and discriminating support. Indeed it may well be that such artists can speak to the majority of their contemporaries more clearly than the very great. The history of the response even of fine musicians to the work of their greatest contemporaries plainly shows that the very great may for the expression

3 — One would have to allow some qualification of this statement in respect of minor contemporaries — as in the case of Cecil Gray's entertaining and bigoted championship of Peter Warlock — but there are in such cases extra-musical factors which affect the judgment.

of their profundities require an idiom which leaves their immediate hearers at a loss.

It is with this secondary group of composers, characterized by solid craftsmanship and good if not great intellect, that a survey such as this must be primarily concerned. It is not given to us to know which of our contemporary artists will prove to have produced "immortal" works: the process that will sift them out includes conundrums to which we have no key; yet to avoid the accusation of evading the issue we may allow ourselves the hazard of supposing that Canada has not yet produced a composer of this calibre; and, bearing in mind the biological analogy which we have drawn, the statement would be in accordance with the probabilities. (There is, however, among the foreignbred composers who have recently adopted Canada as their home, at least one who from the small amount of his music known to the writer appears to have an intellectual power and a technical competence which place him in the ranks of important contemporary composers).

NATIONAL STYLE — On the same analogy there is and can be no distinctive "Canadian" musical style. What after all do we mean by "style"? In the context in which the word is now being used, is not the "style" of a group of compositions the particular flavour which all have in common? When we say that certain music is "very German", do we not mean that the thousands of German works produced since Germany, in the late seventeenth century, began to supersede Italy as the leader of the musical world (to say nothing of the thousands before that time) associate themselves in our minds with certain qualities of seriousness and weight, type of humour and complexity of thought? If this is true, it means that "style" in this sense can be only retrospectively recognized, when many composers have been working for common ends over an extended period of time, and when discriminating listeners have absorbed enough of the product for the common flavour to become apparent.[4] Neither of these conditions is fulfilled in Canadian music of the middle twentieth century: there is no

4 — It may be argued that in the art of painting Canada *has* produced a distinctive style in the work of the Group of Seven. But the "Canadian" flavour of the works by the Group of Seven lies solely in the fact that all its members were captivated by the power of the Canadian countryside. Apart from the subject matter there is no distinctive "Canadianism" in their works and the individual members of the group, having gone their several ways, have since clearly demonstrated this truth.

large body of serious Canadian music, and what there is has remained largely unpublished and to all too great an extent unheard.[5]

INDIVIDUAL COMPOSERS — In considering the characteristics of individual composers, we may start with the generalization that the scale of twelve autonomous notes has now fully established itself as the basis of twentieth-century music. No doubt some readers will in all sincerity resist this statement, but a proper understanding of the nature of artistic materials will inevitably show it to be true.

In any period the direction of men's minds will lead them to fashion materials to suit their purposes, and in the course of each period the greatest artistic intellects will take this material and wring out of it everything that it contains. It follows that the artist of the following period is subject to two pressures both forcing him to become a prospector of new materials: first (and far the more vigorous), the direction of mind which is inherent in the time in which he lives; and second, the practical fact that there is nothing left to say by the means which his predecessors employed.

It may be complained that art is getting more complicated all the time and " Where are the old simplicities? " Where are they, indeed? — but we cannot lure the atomic djinn back into the bottle, and in fact it is just as possible to express some aspect of the infinite in complexity as in simplicity. We cannot re-order the conditions into which we were born, but we can ensure that they are applied to true ends.

Some fifteen Canadian composers have recognized the validity and potentialities of the twelve-tone scale and use it as the basis of their works.[6] Of these, a proportion are taking the easy way — which is also the ineffective way — of using various technical devices which will cause the music to avoid the sensations of the traditional styles; but such composers do this either without a clear mental realization of how the music will sound or (more often) without a clear intention behind the musical con-

5 — The reader may feel that most of it probably deserves to be unheard; but let him ponder the fact that Verdi — a very great composer — wrote ten bad operas and four unsatisfactory ones before he started writing good ones, and that after the first three good ones he wrote six more imperfect ones before achieving the superb *Aida*, *Otello*, and *Falstaff*. All these, good and bad alike, were performed in music-mad nineteenth century Italy, and we may make a fair guess that, had they not been, we should not have had the six masterpieces.

6 — The phrase " twelve-tone scale " throughout the discussion refers not to the particular method of composing devised by Schoenberg and now generally referred to as the " serial " method, but to the whole area of music based on the scale of twelve notes.

ception itself. In any period of adventure such as we are now experiencing this condition will be found, and in some cases may be temporary. An artist whose background lacks a sufficiently bracing intellectual atmosphere may have to pass through such a phase, but those who have an urgent need to express somthing *specific,* and therefore cannot be content with mere manipulation of materials, will sooner or later by dint of whatever exertions find the means of doing so. It is true that a work of art, considered dispassionately, can be regarded as resulting from a deep understanding of the nature of the materials involved and their masterful manipulation; but the true artist's manipulation of materials is, however recondite and with however much labour achieved, only the outcome of his determination to express accurately the representation of an aspect of reality which his mind has conceived and already clearly perceives.[7]

COMPOSERS USING EASY TECHNICAL DEVICES — Of the composers who are evading the issue — not *all* the issues, but the fundamental one — by taking refuge in relatively easy technical devices, Composers Nos. 1 and 2 use a mixture of idioms:[8] partly successive consonances based on the notes of the twelve-tone scale, and partly major-minor tonality. The use of consonances based on the twelve-tone scale, if consistent, is a limited but satisfactory means of expression. (Its limitations arise from the tendency to too much uniformity of harmonic tension and the debilitating effect whichharmonic requirements exert on the melodic line: the melodies tending either to excessive half-tone movement or to excessive use of broken-chord formations.) But the combination of this technique with a reversion to major-minor tonality results in an idiom which teeters between past and present and has not enough muscle in its " present " element to overcome its self-imposed limitations. Composer No. 1 adds to this idiom the " trick " of making the third of the same common chord alternately major and minor, and Composer No. 2 adds movement by

7 — There will be differences of opinion as to exactly what it is that an artist expresses, but the argument here does not depend on unanimity about it. Presumably all would agree that the conception (whatever philosophically it may be regarded as a conception *of*) must be clear in the mind of the artist. Those who would like to come to grips with a powerful, gritty, and not entirely conclusive discussion of the nature of artistic conception as stated by a contemporary artist of unmistakeably first rank will find it in Hindemith's *A Composer's World.* For an extended and close-knit treatment of the same problem, see also GEORGE WHATTEY'S *Poetic Process.*

8 — The numbers are haphazard, having no reference to the alphabet or order of merit, but they do refer to actual composers, not hypothetical cases.

parallel dissonances — a device which can still be expressive ornamentally but is in 1955 far too well-worn to sustain the main load of thought.

Composer No. 3 gives the impression that he has been affected by what Sir Donald Tovey calls " the lean, athletic style of Hindemith ". There are superficial melodic resemblances, and an effect of harmonic spareness — which Hindemith uses when he wants to, but by no means all the time — is attempted by the frequent use of open fifths. Alas — it is not such trivia that make Hindemith sound like Hindemith, but a tightly woven harmonic texture, melodically based and paying insistent attention to questions of harmonic tension and density; and above all a tonal scheme accurately planned to produce the required result. One feels that Composer No. 3 has both talent and intellect, but that he is frustrating the one and not using the other. If he recognizes himself in these comments, will he not confer on all of us a benefit by wrestling, first with his intentions and then with his materials?

Composer No. 4 superimposes one consonance on another and treats each with some device — such as broken-chord formations — calculated to delay the listener's recognition of the simplicity of the material. This method has the advantage that the chords can be chosen in such a way as to avoid the sensation of the traditional use of tonality, but it contains the danger that traditional tonality is always lurking just below the surface and occasionally " blows " in a very disturbing manner.[9] Music of this type, especially when played without too much deliberation, undoubtedly achieves a certain effect, but composers who use devices of this sort forget that the nature of artistic materials is such that it is almost impossible to stir in them at all without achieving some effect. The parent who thinks his four-year-old draws " just like Picasso " has not progressed very far in appreciation of the manipulation of artistic materials; yet four-year-olds, being uninhibited and still trailing at least wisps of glory, do from time to time achieve by the sheer clarity of their natures a pictorial design which, however naively, contains the element of truth for which all artists seek expression — just as children speak sometimes in phrases of moving poetic quality. But the process of producing a work of art in any considerable sense is neither accident, nor the casual largesse of pure talent, nor the adventitious assembly, however ingenious, of means to titillate

9 — This is not to assert that traditional tonality is undesirable in itself, but it is incongruous in this context.

the senses — but insight, intellect, and grinding labour. Composer No. 4 has a reputation, and a talent that deserves it; but is already at the end of the road unless talent is brought in subjection to intellect, and both to a clear conception.

Composers Nos. 5 and 6 also use this device of superimposing conflicting triads in differing degrees of tonal opposition and breaking them up into various kinds of figuration. Composer No. 5 makes use of successive parallel dissonances as did Composer No. 2, sometimes in conjunction with an ostinato figure (that is, a brief, repetitive one) based on an opposing or indeterminate tonality. Bitonality or polytonality will usually produce a rather agreeable sensation of tension, but the intellectual weakness of such a procedure has been patent for a good many years. Composer No. 5 creates a series of musical sections founded on such devices and uses them in a juxtaposition which produces an impression of formal organization though it makes no effort to distinguish between the characteristics of biology and carpentry. He also reiterates rhythmic snatches in different accentual relationships as do Stravinsky and Bartok. But whereas Stravinsky and Bartok make such rhythmic intricacies an integral part of their thought Composer No. 5 uses them as casual " effects ". Composer No. 6, besides the superimposition of conflicting triads, attempts to achieve a certain sensation of unity by the reiteration of fragmentary melodic materials chiefly based on recherché scales — or perhaps on the notes of the twelve-tone scale used in a deliberately esoteric fashion. In the work on which this discussion of his style is mainly based the structure is A B A, in which A, has two elements, neither sufficiently well-defined to avert the sensation of an introduction to an introduction. Section B is the most distinct musical entity in the movement but it is too short-breathed and suffers too much repetition to achieve much definition of purpose. In a word, manipulation — not unskilful — of materials; and the effect of this without a sufficiently clear conception of purpose has already been discussed.

Composer No. 7, in the work to be considered, takes an expanding series of intervals, from the minor second to the augmented fourth, and in a rapid tempo lets them achieve a brilliant and ingenious effect over a sonorous bass striding in vigorous intervals. The effect at a first hearing is likely to be stunning — and let us be grateful that we have composers capable of stunning their listeners with an impression of virtuosity — but if we resolutely concentrate on content we find that, desite all this activity, very little is really happening; and the validity of that appraisal is borne out by the effect of a slower movement of similar procedure, in which the slightness of content is more readily realized. Nevertheless here is a composer of imagination and promise. A hundred years ago Liszt satiated our appetite for vacuous virtuosity for a long time to come; but if Composer No. 7 finds out what it is he wants to say, and makes more vigorous demands on himself in saying it, we may reap a handsome harvest. Talent is undoubtedly there.

Let it be emphasized that these composers, who have been rather ruthlessly exposed as depending too much on relatively easy technical devices, all have talent and deserve to be heard. But they will not fulfill themselves as long as they are so easily satisfied. To the seeker who knocks a few times, the householder of art will " hand out " a measure of satisfaction; but he who is content with a hand-out will never go in and become an intimate of the household; for that he must importune and struggle and if necessary grovel. To the artist, " I will not let thee go except thou bless me " takes on a special meaning.

COMPOSERS WHOSE TECHNIQUE IS POTENTIALLY ADEQUATE FOR THE EXPRESSION OF SERIOUS MUSICAL THOUGHT — The " serial " styles of musical composition, initiated by Schoenberg at the beginning of the century and since widely developed, are subject to two inherent dangers: first, they are likely to result in too much uniformity of harmonic tension,[10] and second, since they have no intrinsic structural basis which is at the same time apprehensible to the ear, their structural organization tends to be forced into too much reliance on details of melody, harmony, rhythm and above all the disposition of melodic or rhythmic phrases. It is true that all music depends to a degree on such details; but the degeneration which occurs in the nineteenth century as a result of the domination of music by details as opposed to design is brought forcibly to our attention when we remember that the two greatest composers of the Romantic period used special, and differing, means to overcome it. Wagner, as a result of the area of music in which he worked, had extra-musical factors available as a substitute for abstract large-scale structural coherence; and Brahms deliberately turned the clock back *structurally* (though not idiomatically) in an instinctive recognition of the dangers.

---

10 — We have seen (page 59) that this also results, at the opposite end of the harmonic spectrum, from the use of consonances based on the notes of the twelve-tone scale.

In the evolution of musical style it is presumably no accident that the appearance of major-minor tonality, with its strong potentialities for the clear definition of structure by means other than details, coincides with the first considerable development of instrumental music as an independent medium for larger-scale works of art. Music sung to words can be comprehensible with much less intrinsic structural definition than " abstract " music and for this reason serial music is of a type which from that point of view ought chiefly to be sung; but the extreme difficulty of singing it, by reason of the melodic and harmonic complication inherent in it, causes the proportion of vocal music written in it to be very small, and the amount of choral music infinitesimal: for a gifted solo singer can with determination conquer almost any difficulty whereas a chorus, however capable, requires more straightforward melodic and harmonic characteristics in the music if it is to keep its intonation steady. In this connexion the structural contrast between Wagner's music-dramas and his instrumental music based on the same material is of interest. The *Siegfried Idyll* is almost naïvely clear in its tonal organization, whereas, although Alfred Lorenz and others have demonstrated the microcosmic structural articulation of the music-dramas, the disparity in size between the structural units and the whole makes it impossible for the listener to receive his main structural impression from them. Thus it is left to the text and the dramatic situation to provide the chief aesthetic basis for the *comprehension* of the structure, even though from the composer's point of view the result is achieved by other means as well. Since the whole development of twentieth century music stems from Wagner's apotheosis of the best tendencies of his time, the view is tenable that some areas of contemporary music have been developed with insufficient recognition that what produces a clear impression when accompanied by words or other external aids to the identification of purpose does not necessarily do so without them. The validity of the serial method of composition in principle has by this time been established. But unless handled with care and imagination music so composed is apt to be static (because of the tendency to uniformity of harmonic tension) and structurally indeterminate (for the reasons just elaborated); leaving the hearer with the impression that nothing has happened except the creation of some intricately organized and often enjoyable sounds.

On the other hand considerable numbers of contemporary composers — including some Canadians — have shown that it is possible to organise the materials of serial music in such a fashion that the details — of melody, harmony, rhythm and the disposition of phrases, together with the now re-admitted tonality — will in fact tolerate the load put upon them, as they did in the best Romantic works. Even when achieved, this still leaves twentieth-century music some distance short of the liquid-architecture glories of the pre-Romantic era, unless the tonal organization of Hindemith can be conceded to provide their equivalent. The answer to this depends on whether thematic symmetry (in its loose musical sense) is to be regarded as essential to the classical structural conception, or whether tonality itself is not only the dominant but the conclusive factor.

Composer No. 8, who uses the serial method of composition, has a very agreeable sense of melodic, harmonic and rhythmic values. This music, though it does not always avoid the dangers of the idiom, contains many attractive and expressive ideas and is technically worthy of them. Among other things we should be grateful to the composer for being able to express good humour and amusement — and for having those qualities to express.

Composer No. 9 — also using the serial method, though loosely — has expressive melodic and rhythmic qualities and is capable of devising agreeable individual harmonies; but all this is marred, and the music rendered shapeless to the ear, by lack of logic in the sequence of harmonic tension. When, for example, a composer sets up a pendulum-swing of moderate but distinct harmonic tension, the moment at which he alters the material and thereby breaks the swing is clearly going to be important. It will probably require either a distinct increase or a distinct decrease in harmonic tension. Composer No. 9 however, in the work under discussion, moves away on a mere repetition of the previous chord, which itself was one of the milder and therefore less arresting elements of the pendulum-swing. When this is followed by a tonally confused cadence the ear finds it impossible to grasp the logic of the process. If this were an isolated example it could charitably be dismissed as a momentary lapse, but such apparent insensitiveness to the relationship of harmonies is a consistent characteristic of the work. This is a pity, and not only because the composer undoubtedly has talent, together with technical ability in other directions. In the construction of a work of art, the solution of problems such as these requires no genius — though genius, when present, obviously irradiates every part of the process — but simply hard work, based on a ruthless determination to get it " right ". There are artists who have the misfortune to acquire reputation before their battle is truly won, and who succumb to the temptation merely to consolidate what they have already gained. Composer No. 9 appears to be of this company. For his sake and ours it is to be hoped that he cannot be content to stay in it.

Composer No. 10 uses a conservative harmonic basis and melodies of no great force, but he puts his harmonies into juxtaposition and superimposition with piquancy and over all spreads a lustre of sophisticated, arresting instrumentation. As a result this music has one of the most distinct " personalities " of any now being produced by Canadians; it is vital and debonair, and deserves the attention it receives. Its limitations derive from the fact that it is more concerned with manner than with matter, but there is room in music for the " man-of-the-world ": he does not often attain immortality, unless he has other qualities as well, but he is likely to be very good company.

Composer No. 11 is an exponent of what by this time may be termed the American " school " of composition, and this is scarcely surprising since he has spent most of his life in the United States.

In content, the strongest impression is of a deep sincerity and disinclination either to manipulate the material for its own sake or to use devices as a demonstration of skill. This is refreshing. The music has a clear tonal organization and the harmonies, though by no means conventional, often group themselves round the progressions of the late Romantic style. (It is a curious fact — though probably not surprising to thoughtful Europeans — that American compositions, though they may be constructed in a relatively advanced style, tend to have a strong spiritual affinity with the music of the Romantic era.) The strongest element in the music of Composer No. 11 — and this also is characteristic of the American style — is that of rhythm, which has a robust, open-air quality that reconciles the listener to the lack of true melodic interest. For the melodies divide themselves into two types: they are either dominated by harmonic considerations, tending to a type of disjunct motion which from the purely melodic point of view does not contain its own logic (but for which logic is provided by the harmonies), or they follow the conventional patterns of modal music or music of major-minor tonality.

Sincerity — clear tonal organization — vigorous rhythm — and a true talent: these are surely good enough reasons to listen to his music when ever we can, and trust that in time the melodic line will tighten and the "direction of mind" — carrying the harmonic organization with it — will become more truly contemporary.

The strong sense of structure characteristic of Composer No. 12 expresses itself in the work under consideration — inevitably, since it is a passa caglia — chiefly in the disposition and relative importance of climaxes. In a period such as ours an emphasis on structure is itself an admirable trait, but it is a pity that the detailed means of applying it are in this composer's work not yet very refined. There is too much use of parallel dissonances — a "relatively easy technical device" which we have already discussed — and what may appear at a first hearing to be a vigorously dissonant texture turns out on further enquiry to have been created by the rather commonplace method of running parallel sixths (for example) and parallel fourths in opposite directions. Out of fifteen treatments of the passacaglia theme, seven (and the coda) are constructed by means involving some sort of parallelism. Since these seven treatments are more often than not in alternation with contrapuntal developments of the theme it may be that the composer planned it in this way. If so it was a miscalculation, for the ear still wearies of the parallels. Composer No. 12 is by no means lazy, but one gets the impression that he is depending too much on talent. The men of greatest talent do not.

Composer No. 13 is capable of clear, forceful conception, a strong melodic line — sometimes a little more angular perhaps than the purpose requires — clear tonal organization and a style consistently based on the functions of the twelve-tone scale. On the study of one work, and that not the composer's latest, one would suggest that the sequence of harmonic tension does not always appear to be logically worked out. At times it seems unduly thick and at other times it breaks with no apparent reason into consonance.

Yet the catalogue of virtues which precedes and outweighs this complaint indicates a composer of high merit whose works ought to be heard even more often than they are, and whose place in Canadian music ought to be recognized even more generally than it is.

CONCLUSION

The writer may be forgiven if finally he addresses himself directly to the composers who have made this survey possible.

Canada's composers will not gain by adopting " attitudes ", either of mutual admiration or of jealousy; but they can help each other if, when circumstances warrant it, they speak their minds plainly. The invitation of CULTURE to write an article on the present state of musical composition in Canada seemed to the writer to be such a circumstance; and in acquitting himself of it he has tried to write as objectively and honestly as he hopes any of his colleagues would do in the same situation.

In the art of musical composition Canada has much talent, some technique, not yet rigorous enough standards. In total it is well worth the attention — sympathetic, discriminating, patient, honest — of Canadians.

CULTURE —

a source of study material on the Canada of today—Each issue contains :

- Classified lists of books and articles, many in digest form ;
- Notes on learned societies and cultural organizations ;
- Chronicle of intellectual events in the nine provinces ;
- Surveys of religious and educational trends ;
- Articles discussing Canadian problems.

CULTURE —

un instrument de travail sur le Canada d'aujourd'hui — Chaque numéro contient :

- un répertoire bibliographique qui classe et résume articles et livres ;
- des mélanges sur les sociétés savantes et associations culturelles ;
- une chronique des principaux événements intellectuels ;
- un bulletin qui dégage les courants de pensée sur un sujet donné ;

des Articles sur les problèmes canadiens.

L'abonnement est de $2.00 par année.
Chaque numéro se vend séparément 60s

CULTURE
33, rue de l'Alverne,
QUÉBEC

A. W. Douglas

WITH THE AUTHOR'S COMPLIMENTS

SOLIPSISM AND RELATED MATTERS

[*Off-printed from* MIND : *a Quarterly Review of Psychology and Philosophy. Vol. LXIV., N.S., No.* 256, October, 1955.]

HERBERT DINGLE

SOLIPSISM AND RELATED MATTERS

By Herbert Dingle

The problem of solipsism in various forms has arisen throughout the history of philosophy, but has become specially prominent with the rise of the logical positivist school. It is not difficult to see why this is so. When the question was simply, " Can I prove that other people exist? ", no restriction was placed on the method of proof ; it could be quite different from that which guaranteed one's own existence. But the interest of the logical positivists is concentrated in meaning rather than existence, and since they claim that the meaning of a proposition lies in the means by which it can be verified (or falsified), it becomes difficult for them to assert that " you " exist in the sense in which " I " exist unless the evidence for " you " is identical in character with the evidence for " I ". That it most certainly is not. Hence, if " existence " is the name given to what is established by the evidence for " I ", then existence cannot be postulated of " you " ; in other words, I alone exist. In view of this menace, it is not surprising that much attention has been given to this question in recent years.

When we examine the discussions of the question, however, and this applies to old as well as recent discussions, we are struck by one remarkable thing. If a philosopher wishes to disprove the claims of realism, say, he brings forward a realist philosopher—it may be Locke—and shows where he has blundered. If the target is subjectivism, then Kant may be invoked. If idealism is to be refuted, then Berkeley is there to take the count. And so on. But when solipsism is to be discountenanced, and it always is, no champion is called upon to represent and defend it ; it is always " the solipsist " who is confounded. The disinterested spectator who wishes to be fair to the combatants is therefore at a loss. He cannot refer to the works of this universal enemy to see what he has to say for himself, for no reference to them is ever given. If he attempts to deduce from the refutation what it is that is being refuted, he finds himself arriving at different doctrines according to the particular hero who undertakes to rid philosophy of this pest. Each deals effectively with his own dragon, but invariably another dragon, bearing the same name, arises to confront the next hero. *Plus c'est la même chose, plus ça change.* Consequently, " the solipsist", anonymous and protean, looks like being immortal.

Now why is it that, throughout the ages, philosophers have repeatedly felt themselves forced to repel an attack that has never been made? I can think of only one explanation, namely, that they are half-conscious of an unresolved difficulty underlying the foundations of their systems of thought. They are convinced of the stability of those foundations, but they feel that they could not justify their conviction if it were assailed by arguments of a kind that, directed against the superstructure, they would have to treat seriously. They feel obliged to deal as fundamentally as possible with the philosophical problem, and they therefore embody their uneasiness in a form of words that enables them to reason it away without impairing the validity of the rest of the system. The form of words chosen is given the name " solipsism, " and it varies with the nature of the system whose foundation it threatens. Some philosophers are satisfied if they can exhibit " solipsism " as something clearly absurd, though they are prone tacitly to identify absurdity with that which is strongly repugnant to commonsense rather than with that which is irrational, which is the meaning they would insist on in a more superficial problem. Others admit that " solipsism " cannot be refuted, but claim that they are justified in rejecting it because no one could seriously believe it. In one way or another it is disposed of to the philosopher's satisfaction, and it is rarely, if ever, that one such philosopher challenges the divergent refutation of another, since his desire is simply to get the horrid thing out of the way, and not to protect it from invalid criticism.

Let us try to express the essence of the solipsistic incubus as simply as possible. Every philosopher wishes his system to be rational; that is to say, he wishes to be able to show that we can deduce every statement contained in it from something else until we arrive at some basic facts or propositions that are self-evident. (There are, of course, those who do not aim at being rational, but are completely satisfied with their experiences, whether or not the words in which they express them convey any intelligible meaning to others. I have the highest respect for such persons, but we do not call them philosophers ; we call them mystics. They have no interest in the solipsistic problem.) Now there are only two kinds of such basic facts or propositions. They must be either statements which the philosopher has voluntarily made, as in an abstract mathematical system for instance, or experiences of the philosopher himself. In Euclid's geometry, the justification for any sentence in the proof of any proposition can be traced back to the definitions, axioms and postulates which are accepted without question ; if not, the " proof " is invalid. In matters of fact, the ultimate evidence is an experience of the philosopher himself. My reason for believing that the atomic weight of oxygen is about 16 may be that I have measured it and so proved it directly by experience. In fact it is not ; it is that I have seen marks on paper which other experiences of a similar kind, together with some of different kinds, lead me to interpret as a statement to this effect, and yet other of my experiences lead me to infer that this interpretation is to be trusted. Indirect as this route is, it ends always in my experience, which I cannot question. And what is true of the atomic weight of oxygen is true of every matter of fact that I can assert. The logical foundation of everything that I believe is in myself. I may question everything that I build on it, but I cannot question it. It is therefore unique ; or, in other words, I am unique. I may or may not be able to prove what I call the " existence " of other people, but in any case I have a kind of " existence " which does not belong to them, because mine does not need to be proved ; it is self-evident. Others abide my question, I am free.

Now this is distasteful. I am therefore faced with the problem: how can I reconcile the two views, one which regards me as the *fons et origo* of the whole universe, past, present and such future as there may be, and the other which makes me out to be a negligible speck in immeasurable space, persisting for a brief moment in infinitely extended time? The general answer has been that they are irreconcilable ; the first view has been called " solipsism " and rejected. But it has been rejected only because it is irreconcilable with the second, not because of any intrinsic fallacy that has been found in it. This seems to me unsatisfactory. If the evidence for the first view is inescapable, then we must accept it and the conclusion to which it leads. The second view also, if properly expressed, can be made inescapable. Hence we must accept both, and the problem is to do this without becoming involved in a contradiction.

I called the evidence for the first view inescapable. The general admission has been that that view is "irrefutable", but that is a question-begging term. It is irrefutable that there is a planet revolving round a star in a stellar system too far away to have yet been observed, on which a course of events is taking place exactly similar to that now occurring on the Earth. No one, I suppose, feels any compulsion to assert this, but no one could refute it. The argument for the so-called "solipsism", however, is not of this character. We are not merely unable to refute it, we are bound to acknowledge that it is valid. If we do not accept the conclusion, it is incumbent on us to give some reason for not doing so, and that reason has not been given. A hypothetical person who accepts the conclusion has been called mad or frivolous or something of that kind, but that is not a reason. In fact, such a reaction is itself frivolous. If we are to take philosophy seriously we must refrain from abuse of those whose arguments we cannot answer and be ready to follow wherever reason leads. I therefore ask you to accept what I may call "the egocentric axiom", and see what follows. I do not, let me say, ask you to accept solipsism. Despite the variety of meanings which the word has been given, they all agree in representing the solipsist as one who not only accepts the egocentric axiom but also denies the equivalence of himself and other people. But the evidence for that equivalence also is inescapable. I will not pause to consider why and in what sense this must be acknowledged because it is unlikely that any one will dispute it and in any case it will become clear at a later stage. What I want to maintain is that both the egocentric axiom and the essential equivalence of all human beings must be accepted, and solipsism is supposed to admit only the first. There is no name, so far as I know, for one who accepts both, nor am I concerned to make or to find one. All that I wish to assert, for the sake of clarity and not to avoid unpopularity, is that "solipsist" is not the word.

The problem with which we are faced may be expressed thus : How can I consistently hold that I contain and am more comprehensive than the whole universe, and also that the universe contains me as an infinitesimal part of itself? I might perhaps for a moment anticipate the result of the discussion by pointing out that the verbal form of the question itself suggests an answer. A sufficiently unsophisticated person would exclaim : "But why should you think these statements contradictory? It is 'I' that contains the universe, and the universe contains 'me'. How can it be contradictory to say that x contains y and y contains z?"

Our language is not always so helpful, but here I believe that its suggestion goes to the root of the matter. We have different words for "I" as subject and "me" as object, but we instinctively suppose that these two words represent what is logically one entity. I shall maintain that this is a mistake, and that "I" and "me" are essentially distinct. I do not say that they are unrelated, but that the relation between them, whatever it may be, is not that of identity.

Perhaps we may best approach the problem by considering what we mean by "the universe", which is to stand in such different relations to "I" and "me". There will be no misunderstanding, I think, with regard to the ostensive definition of this term, *i.e.* the picture which it evokes in our minds when it is uttered. It is what we may describe as the world about us, containing stars and houses and people and so on, and to avoid irrelevant subsidiary questions we may, at this stage at least, agree to limit it to what we ordinarily call the *physical* universe, disregarding any immaterial constituents that may conceivably inhabit living creatures or the world at large. We say that this universe "exists", and our evidence for this is that we perceive it, *i.e.* we have certain experiences on the basis of which we feel justified in making this assertion. (In accordance with the egocentric axiom I should of course have said something of the following kind. I perceive certain phenomena, which include some which I describe as related to "other persons", and associated with these other persons I have certain visual and auditory experiences which I interpret as concurring with still other perceptions, describable as "direct observation", in the conclusion that something which I call "the universe" can conveniently be postulated. But if I began to write like this I am sure that no one would read further. I shall therefore take the liberty whenever it seems desirable of speaking in the ordinary way, notwithstanding that what I say may be literally inconsistent with what I am maintaining. It must be remembered that our language was mainly constructed to accord with a mode of thinking that rejected the egocentric axiom, and can only be adapted to the acceptance of that axiom and its implications with great circumlocution. I shall therefore not hesitate freely to use sentences in which a captious critic will have no difficulty in finding anomalies, trusting my more intelligent readers to interpret them in accordance with the general point of view which I am taking up.) The question I want to ask is : How do we proceed from the sensations, which are the original data, to the conclusion, "the universe exists"?

There are two possible answers to this question, which are usually expressed as " by inference " and " by construction ". When I say, " I infer that the universe exists ", I presuppose that the existence of the universe is something which is prior (logically prior, I mean, though temporally prior would usually be implied also) to my perception of it, and that my sensations are merely the means by which I become aware of this prior truth. If there were no sensations, either mine or anyone else's, the meaning and the truth or otherwise of the statement, " the universe exists", would be quite unaffected. That is the ordinary commonsense view which until this century was accepted unquestioningly by most ordinary people and by scientists in particular.

When, on the other hand, I say, " I construct the universe ", what I mean is that I form a concept of something to which I assign certain properties, including that of giving rise in me to the sensations that lead me to form it. To take a very simple example, when I say, " there is a billiard-ball in front of me ", what I mean is that I see a round, red colour, feel a resistance to the touch, and so on, and I then construct a concept of a hard, extended, enduring object, able to reflect light selectively and to roll in a certain manner and to do a variety of other things such that, by some mysterious but describable route, its behaviour results in my having the sensations I have mentioned. Some of the properties I include in the concept are given it not to account for sensations directly associated with it but because of other sensations ; for instance, I assign to it a solid interior although I have no direct experience at all that may be said to come from its interior. This is done in order to make the construction of the whole universe, corresponding to the whole field of experience, as economical of concepts as is possible. For this reason we ought, strictly speaking, always to discuss this question in terms of the universe and not of a single object in it, but if we bear the possible limitations in mind we can allow ourselves the simplicity of concentrating our attention on as small a field as we wish. The question we are considering is then which is the proper thing to say, " I infer the billiard-ball from my sensations " or " I mentally construct the billiard-ball so as to relate my sensations together " ?

I am going to maintain that, in the present state of knowledge, the former has ceased to be permissible and the latter is inevitable. For this there are several reasons. In the first place, as a matter of simple description, we do construct, whether we infer or not. This can be seen best by considering the scientific rather than the commonsense view of the billiard-ball, although it is equally

true for both. The conception of a host of electrified mass-points interacting according to quantum laws is clearly something that needs imagination of a high order to bring it into being. There is no possibility of inferring it from the simple sensations of sight, touch, etc., for which it is made to account. We are not *led* to it ; we have to conceive it *ab initio*, and then test it to see if it does in fact correspond with what we experience. If then, " to infer " means something different from " to construct ", the difference can consist only in the addition to this simple description, of the postulate that what we construct has some independent property of " existence " : we have inferred that there exists a billiard-ball of which we have constructed the description. But there is no necessity for this addition. The constructed description serves *all* the purposes for which we need to do anything at all beyond experiencing independent sensations. In so far, then, as inferring differs from constructing, it is without any justification.

Another reason for speaking in terms of construction rather than inference is that it is generally acknowledged that we cannot infer any sensation directly from others ; for instance, I cannot infer from my sensations of a billiard-ball that after experiencing the sensation of striking it I shall have the sensation of seeing it move. This is brought out nowhere more clearly than in Bertrand Russell's book, *Human Knowledge: Its Scope and Limits*. Russell, however, wishes to maintain that, in both commonsense and scientific reasoning, we do infer, and he therefore claims that " among the premisses of our knowledge, there are some general propositions, or there is at least one general proposition, which is not analytically necessary, *i.e.* the hypothesis of its falsehood is not self-contradictory ". If these general propositions are known, then they, together with our sensations, suffice to enable us to infer the existence and character of the universe. He proceeds to seek for these propositions, and ultimately arrives at five, which he grants may, by further thought, be reduced to a smaller number.

Now I am not here concerned to discuss these propositions ; I wish only to point out that since it takes the greater part of a large book to bring them to light, and they are even then not final, they are not self-evident. Also, by hypothesis, they are not inferred, they belong to our " stock of uninferred knowledge ". The only remaining possibility is that they are constructed : we have to frame them and then try them to see if they work. Hence, even if all that Russell maintains is granted, and the universe is allowed to be inferred, it cannot be inferred without what is previously constructed. There seems little point in constructing in order to avoid construction.

A third reason for preferring construction to inference is that you can construct a number of independent descriptions of the universe without contradicting yourself, but you cannot infer from the same data that the one independently existing universe is two or more different things without at least one of the inferences being wrong. Now we have at least two independent descriptions of the universe—the commonsense description and the scientific description—and they do not agree. Hence, if the universe is inferred, we must decide which description is wrong, whereas if it is constructed we may use whichever suits our purpose on any particular occasion. That is, in fact, what we do.

The view taken by the advocates of inference is that the scientific and the commonsense descriptions are not different but that the former is simply a more precise and detailed version of the latter. This, however, is certainly wrong.

This is not difficult to see now that physics has reached a stage where its departure from commonsense is obvious. The constituents of a scientific table, for instance, obey a different kind of statistics from those of commonsense objects ; if you interchange two of them you must suppose not merely that you have obtained an exactly similar table—that would be wrong—but that you have actually the *same* table. That is nonsense when applied to commonsense material objects. But in fact the scientific universe has been essentially different from the commonsense universe right from the beginning of modern science, though until now they have been so nearly parallel that the divergence has not been realised. Newton's law of gravitation, for example, which dates from the seventeenth century, has been thought to describe the way in which planets move. It does not ; it has nothing to do with planets. What it describes is the way in which mass-points move. Now a mass-point is a constructed concept so little evident to commonsense that no one even imagined it before the seventeenth century. The path of a mass-point has been so close to that of a planet that the two have been identified in thought and the one assumed to be a more precise description of the other. But suppose that, through internal stresses, a planet exploded and burst into fragments. In all probability not one of those fragments would pursue the path prescribed by the law of gravitation, but the mass-point would do so. We call it the " centre of gravity " of the planet, and the explosion would make not the slightest difference to it.

This is not, of course, a new discovery—it is a part of classical physics—but since planets have not been in the habit of exploding there has been no confusion in supposing that the law of gravitation described their paths. But actually that law is part of a fundamentally different world from that which contains material objects.

We describe our experiences in terms of the commonsense world or the scientific world according to our needs. For ordinary practical affairs it is the commonsense world that we live in, but for understanding the relations of things we must turn to the scientific world. Playing cricket, for instance, is a commonsense activity, and the rules are framed in accordance with the commonsense conception of the world. If a batsman struck the ball so as to break it into pieces, the game would automatically cease, for the rules would become inapplicable ; they presuppose the integrity of the ball as a material object. Scientifically, the game could proceed without interruption, but it would be impracticable to require umpires, at the existing rates of pay, to determine whether a fieldsman had caught the centre of gravity of the ball before it reached the boundary. In the commonsense world we live and play games, but we do not understand it. In the scientific world we can understand what happens, but we cannot conduct our ordinary practical affairs. In civilised life we make the best of both worlds by translating, as far as we can, the scientific results into commonsense terms, and so apply them to our comfort or otherwise, but this is only partially possible. As the game of cricket shows, the fundamental difference between the two worlds remains.

I do not see how this can be properly understood unless we recognise that each world is constructed in order to serve its own particular purpose. If there is simply one independent external world whose character we are trying to infer from our experiences, we have to choose between them. Even that exaggerates our power : we have no choice, but must accept the one to which the rules of inference compel us. I do not know which that is, and I leave it to those who in this matter believe in inference to decide. I would simply point out that in fact very few, if any, accept the decision or are interested in it ; we all live in either world as occasion demands.

A final reason for preferring construction to inference is that we are thereby enabled to lay the foundations of philosophy in that which we cannot doubt, thus realising the Cartesian ideal. As we have seen, we can infer nothing about the world—*i.e.* nothing that enables us to predict future experience—from past experience alone. If we insist on inferring, we must add some "principles of inference"—call them what you will—for which we cannot account, which might very well have been quite different and which are chosen on *ad hoc* grounds because they do in fact lead to the results we want. It is like choosing the rules of a game so that we shall be sure to win. All the consequences which we reach then rest on a grand assumption which, by hypothesis, may be wrong.

Let us see what it is that we cannot doubt. There are two kinds of such things, which we may for brevity call *experiences* and *principles of reasoning*. Experiences include all our sensations, emotions, passions, feelings of various kinds which cannot be included in a formal definition for the very reason that they are fundamental data ; we can only mentally point to them and say, "those are experiences". I can only actually experience, of course, at the present moment, but what for brevity I have here called experiences are what in ordinary language would be more properly termed *memories* of experiences. Every experience of which I can take account is a memory, for by what we call the passage of time it is immediately thrown into the past before I can begin to reflect on it. Memories of experiences in this sense are indubitable. I may doubt any interpretation I give to them ; I may even doubt whether in fact I had such an experience, but I cannot doubt that I have the consciousness now of having had it. Memories of this kind constitute indubitable data of the first kind.

The other kind is concerned with reasoning. When we read, for example, a mathematical theorem—say a proposition of Euclid—we feel compelled to proceed from one step to the next until we reach the conclusion. What I cannot doubt is the validity of such a passage. I cannot state in words what this indubitable thing is because again it is too fundamental for that. I can put in as many intermediate steps as I like, but always there remains a finite leap or leaps which I feel compelled to take. The indubitable "principles of reasoning" that enforce this leap are always between the lines. Like the elementary memories of experiences, they cannot be described in words without implying some particular interpretation of them that is open to question, but they themselves are not open to question.

This, of course, does not imply that any particular logical conclusion is indubitable. We cannot begin to apply the principles of reasoning until we have some premisses, some postulates from which deductions can be drawn, and all that we can hope to say with certainty about the deductions is that they follow from the premisses. We can therefore never be certain, in an absolute sense, of the conclusion of any piece of reasoning, for we can have no indubitable premisses. The only indubitable things available are memories of experiences, and, as we have seen, these are not possible premisses because no inferences can be drawn from them ; an experience does not imply anything at all. Our equipment for philosophising in a manner conformable to the Cartesian ideal consists only of principles of reasoning which cannot be applied without premisses, and memories of experiences which cannot act as premisses and can lead to nothing beyond themselves. What, then, are we to do?

There is only one thing that I can see : we can *invent* premisses —*i.e.* adopt arbitrarily certain postulates to which we give strict definitions—and then draw conclusions from them. The concepts in our postulates can then be paired off with our experiences (memories) in such a way that to each kind of experience there corresponds a particular concept ; *e.g.* we may say that we will regard concept A as corresponding to experience α. If, then, in our deductions from the premisses the concept A appears in a certain context, we shall expect an experience α to appear in the corresponding context of experiences. In this way we can, in effect, use some experiences to predict others in spite of their barrenness. We cannot directly deduce anything from an experience, but we can translate it into rational terms from which we can deduce something, and then translate back again. This is, in fact, what we do in science. We do the same thing though more intuitively, in forming our conception of the common-sense world, but science affords the more convenient example for exposition.

This very abstract description can be made clearer by a specific example. I choose what I may call the geometrical theory of physics, *i.e.* the application of geometry to the correlation of our experiences of the physical world. In former days, when the inference view of science was accepted almost unquestioningly, it was supposed that the physical world was an externally existing entity submitted for our inspection, and that its constituents showed the same relations as those of the figures dealt with in euclidean geometry. The fact that we could determine the geometrical relations of things in advance of experience was regarded as mysterious, and, as is well known, Kant ascribed this to the *a priori* equipment of the mind ; but, whatever the explanation might be, the necessity for natural objects to obey the euclidean theorems was not questioned.

This, as is now realised, was a mistake, but the precise relation between euclidean geometry and experience is not so widely understood, and it is worth while to examine it. Euclid's geometry is, in itself, a system of pure thought, starting from arbitrary postulates and definitions and then developing through their logical consequences. It nowhere makes contact with experience. For example, "a straight line is that which lies evenly between its extreme points". But how can we determine that a candidate for this honour does lie evenly between its extreme points? We are not told. Instead we are given a postulate: "let it be granted that a straight line may be drawn from any one point to any other point". Again, much use is made of the concept of equality: an isosceles triangle, for instance, is "a triangle two of whose sides are equal". There is much about equal things, such as, "things which are equal to the same thing are equal to one another", but there is nothing to tell us how to determine whether the sides of a triangle are equal or not. In the whole system of reasoning there is nothing that enables you to bring the concepts employed into relation with experience in any definite way. You are left to choose your own criterion of "lying evenly between two points", "equality", and the rest.

Let us, then, make a choice. It must necessarily be an arbitrary one, but let us suppose that we lay down a prescription for the construction of what we call a "straight rigid rod" and establish a correspondence between that and the geometrical straight line. Similarly we can define—again arbitrarily—what we call a "measuring rod" which, when used in a certain way, will give us a criterion of equality of straight lines. We can then construct a figure which corresponds to the euclidean isosceles triangle. We then look through Euclid's calculations and we see that the angles at the base of *his* isosceles triangle have been proved equal: is this true of ours also? We cannot say, for our measuring rod will not determine the equality of angles but only that of straight lines. We must therefore arbitrarily construct an instrument, called a "protractor", which will tell us whether two angles are equal or not. It turns out that we can do this, and we then find that, subject to the unavoidable errors of measurement, the angles at the base of our isosceles triangle also are equal.

But can we therefore say that we have proved in advance that the angles at the base of our isosceles triangle are equal? Clearly we cannot. There is nothing inevitable in the choice of our material analogues of the geometrical conceptions. Instead of a straight rigid rod and a protractor we could have chosen what we call the path of a ray of light and an optical goniometer, or we could have chosen a piece of elastic and a loose fan. In the former case we would—again within the limits of errors of measurement—have confirmed Euclid, and in the latter case, in all probability, not. And there is no compulsion whatever lying on us to make one choice rather than another. What makes such an apparently futile proceeding important is the fact that, having once made the few arbitrary identifications involved in the premisses, the whole of the conclusions reached by the geometry become applicable to the world of experience. For instance, we can predict that the area of the square field of which one side is the hypotenuse of a right-angled triangular enclosure will be equal to the sum of the areas of the square fields lying against the other two sides. It would, I think, be humanly impossible to foresee this without the aid of geometry. And this is a type of all science. Every scientific hypothesis rests on arbitrary premisses arbitrarily coupled to experiences, and it remains valid so long as the consequences it entails allow the coupling to be maintained consistently.

One point in this requires comment. In giving this illustration I have been professing to show how we can, in effect, use some indubitable memories of experience to predict others by the device of linking them to the postulates of a logical system. But what I have linked to those postulates are material objects, which are not indubitable experiences at all but conceptions belonging to the commonsense world. This needs some explanation. I have done so because we are so accustomed to the commonsense world that by far the simplest way to explain a process is to do so in commonsense terms where that is possible. But I must qualify the description by saying that when I spoke of linking the euclidean straight line with a straight rigid rod, the linkage I was actually referring to was between the euclidean straight line and certain experiences which are included with others in the group represented in commonsense terms by the concept of a straight rigid rod. The commonsense object is a concept of something occupying a certain region of space for an indefinitely extended time and possessing a colour, a temperature, a weight, an elasticity, a density, an electrical resistance and a number of other properties which, in appropriate circumstances, can arouse in me experiences of sight, feeling and so on. That is not what I link with the euclidean straight line. I am indifferent to its colour, its taste and smell if it has any, its weight and what not; they can be anything you like so long as I obtain the experiences that enable me to say, this is straight and rigid according to my definitions of those qualities. The linkage in question is therefore between these experiences and the euclidean conception, and when the euclidean conception turns up in a conclusion, all that I am entitled to expect are those experiences again.

Our procedure in science, then, is to construct a purely logical system of thought standing in an unambiguous relation to indubitable experiences. That logical system, on the largest scale, we call the universe. For commonsense purposes we do the same thing, but the logical system is quite different, for its purpose is not to relate together the largest possible number of experiences but to enable those of the most practical importance to be anticipated in the most convenient way. The concepts of the scientific universe are such things as mass-points, electro-magnetic fields, thermodynamic equilibrium, genes, the unconscious, while those of the commonsense universe are planets, £5 notes, legs of mutton and policemen. For the purpose of elucidating our solipsistic problem we could choose either, but to confuse them would be fatal. Since, in the present state of knowledge, " myself " and " another person " are concepts that occur in both, it does not matter which we choose, and therefore, in spite of the fact that I could probably make my point more forcefully in terms of scientific conceptions, I choose those of commonsense because of their greater familiarity and also because most discussions of solipsism have been conducted in terms of them. I would only pause to point out the difference between the commonsense and the scientific " person " before proceeding.

The commonsense person we know well enough ; whether myself or another, he is an individual who preserves his identity throughout a finite stretch of time, and during that time lives a sort of private life of his own but can communicate in some measure his thoughts and feelings to others. Each person is recognisable by the continuity of his bodily form, he is unique and, as a personality, indivisible. If he commits a crime he can be charged with it later as the same person, and he is held to be responsible for his former actions. The scientific person is not nearly so definitely conceived. A large part of him is said to be " unconscious ", and he is usually largely unaware of the motives that prompt his actions. The same body may be associated with two different personalities and, on the other hand, it is possible that, through the merging together of the unconscious elements, the same fundamental " person " may be manifested through different bodies. It is indeed conceivable that with the further progress of psychology it may be found necessary to abandon the idea of discrete personalities altogether, in somewhat the same way as physics has abandoned the idea of discrete identifiable electrons. That, however, is important for us now only because of its conceivability ; we are not concerned with its probability. It serves to assure us that the scientific " person " is a construct which we can shape and re-shape as freely as we find necessary for the purpose of meeting the needs of psychology, and altogether without regard to any prejudices we may entertain concerning the necessary existence and obviousness and inferability or whatever you will of Mr. John Brown who lives next door.

Let us, however, return to John Brown, the commonsense John Brown, of whose identity and individuality we have no doubt. If I am asked why I assert that John Brown exists, I can only reply that I have seen and heard him and can bring witnesses who have done the same, that I have seen his name in the Directory, and so on—a mass of observations of my own. I can relate these observations together, and make sense of them in such a way as to enable me to make predictions that are realised, by postulating the " existence " of the said John Brown and giving that postulate the ordinary properties that we associate with a twentieth-century Englishman. It is true that this does not account for all my experiences of John Brown. I might, for instance, see him in Indian war-paint, leading his followers against a horde of cowboys while I, as a small boy, look on admiringly. This is hardly consistent with my postulate of him as a respectable suburban Civil Servant of my own age, but since we are now in the commonsense world, which is constructed for practical purposes only, I give that a special name, a *dream*, and dismiss it. This is perfectly legitimate, of course, in the commonsense world, because that world is not constructed in order to be " true " in the scientific sense, but in order to make everyday life go on as smoothly as possible. That can be done by ignoring awkward experiences like " dreams ", and I am therefore fully justified in ignoring them.

Now the point I wish to make is that precisely the same reasons that led me to postulate John Brown lead me to postulate myself. All that I am aware of by actual experience is what, in ordinary language, I say is happening to me at the present moment. The conception of a continuously existing being of fairly advanced age, bearing my name and having a more or less disreputable past, is a conception which I form in order to relate together memories of experiences which I have now. The direct part which those memories take in the whole conception of myself is very small. For instance, I postulate that this being, myself, attended a certain school continuously for several years, whereas all that I remember of my experiences at that school is contained in a few isolated incidents. I can, and in fact do, repeatedly modify my description of myself as I take new experiences into account. Thus, whereas, on grounds of memory alone, I say that a certain event A happened before another event B, I do not hesitate to change the order of these events as the result of seeing certain documents. In this and in other ways I am constantly changing my description of the being which I call myself, exactly as I might change my description of the being which I call John Brown.

The description of a commonsense person, then, as a postulate formed to make sense of my present experience (*i.e.* to fit into a logical scheme which can be consistently linked to experience as previously outlined) is applicable equally to John Brown and to me. I do not know of any other way of describing the commonsense world (or the scientific world for that matter) that permits this absolute equivalence of John Brown and me to be acknowledged. What makes it possible is the recognition that the data on which I have to work are all memories of experiences, that every concept I construct has its definition determined by my desire to include it consistently in a logical scheme which can be linked to those memories of experiences in the manner described, and that I freely take the liberty of creating, modifying and destroying such concepts in order to maintain the linkage as fresh memories of experience are taken into account. The complete logical system—*i.e.* the commonsense world—at which I arrive in this way includes *everything* that is ordinarily called the universe—matter, time and space. I exercise the same liberty of changing my conceptions of time and space as I do of changing my conceptions of matter and persons. The whole world, in all its aspects, is unceasingly being renewed in order to satisfy our desire to live in a commonsense way or, in science, to include all experiences in a single system.

But this result has not been attained without a cost (if cost is the proper word for what turns out to be an enormous advantage). " I " has been left out of the world. Both Mr. Brown and "me" are postulates formed to correlate memories of experiences, but those experiences before they become memories belonged to " I ". That is the egocentric axiom. We can hardly help asking the question : what can we say about " I "? The answer is, nothing, except in a negative way. " I " is

that which experiences, but before an experience becomes data for philosophising it is no longer an experience but a memory of experience, made such by what we call " the passage of time ", though the phrase is extremely misleading because it tends to identify this fundamental fact of consciousness itself with the concept of an extension which we call " time " in physics and in ordinary life and in which we arrange and measure the intervals between events. This is one of the greatest difficulties presented to us by our traditional language, which was formed to accord with a way of thinking in which " I " and " me " were regarded as identical. But that there is a fundamental difference between the passage of time which is the basic fact of consciousness, and the concept which we call time in describing the order of the universe, can perhaps be seen best by considering what we mean by the *reversal* of time. What usually goes by that name is a magical state of affairs in which events occur in the opposite to the natural order ; apples leap from the ground to join themselves to trees ; they gradually shrink until they become blossoms, and so on. The reversal of the time of consciousness, however, would be a state of affairs in which I would know much of what was going to happen, be conscious of it approaching, and then, as soon as I had experienced it, lose knowledge of it completely except in so far as I might be able to calculate it from my knowledge of what was still in the future, as we now become aware of coming eclipses from past experience. These two completely different things we call by the same name, and it is therefore perhaps scarcely surprising that we find ourselves faced by apparently insoluble problems. I will call the time of consciousness—that which enables me to call a particular datum of consciousness a " memory of experience " in contrast to a simultaneous datum which I call a " present experience "—*subjective* time, and the extended time of physics or of commonsense (ignoring, as relatively unimportant in this connection, the difference between them), *physical* time. The latter is a voluntarily formed concept, but the former is inviolable : it pertains to " I " and not to " me ", and as such is not available for modification.

We often say that it is a fundamental fact of consciousness that I am always at the present moment. This looks like a positive assertion about " I ", but in fact it is not ; it is simply the negative statement that " I " does not conform to the physical time order. If we try to make it conform, all that we can do is to use some such nonsensical phrase as this, for clearly it is nonsensical to speak of anything being always at the present moment. The present moment—indeed, any moment—in physical time is simply a point having no magnitude, while "always" is another name for the whole, possibly infinite, stretch of time. "Always at the present moment" is therefore a contradiction. At the present moment, both what I say I am "actually now experiencing" and what I say "I am remembering occurred last year" are equally present. At my leisure I sort them out and associate with each memory a postulated event or range of events which I then arrange in sequence in physical time. I am always "at the present moment" while I am doing it, but me is getting older as I proceed, and each event recedes further into the physical past as it remains fixed at the point of physical time at which I have placed it.

What are the consequences of accepting this view? They are probably the opposite of what would be expected. It has been the constant fear of philosophers that acceptance of the egocentric axiom would subordinate the whole world to "I", and so must be avoided at all costs. In fact it does something quite different; it removes "I" from the world as something about which we cannot philosophise, and so leaves the philosopher free to give full scope to his imagination and reason without the dread of having had to put something surreptitiously behind his back because, although he cannot deny it, it appears so absurd that he is ashamed to acknowledge it. Released from that nightmare, he need fear no danger of straying into forbidden paths. "I" consists of that which cannot go into the past as memory; and therefore cannot—not should not, but *cannot*—become an object of thought, data for philosophical consideration. Whatever can be so treated is a part, not of "I" but of "me" or the rest of the world.

The fundamental problem with which we are faced then, is that of purifying our statements of legitimate philosophical problems, *i.e.* ridding them of all that presupposes that "me" includes what properly belongs to "I". All that remains is left untouched by these considerations. What is removed is perhaps slight in bulk—this is no sovereign prescription for solving all philosophical problems, it solves none of them—but I think it includes most, if not all, of the traditional intractable questions. I will try in conclusion to indicate one or two of them.

Our leading clue is that whatever in experience refuses to go over into the past and become a memory belongs to "I", and nothing can be said about it. It includes the whole of what I may call "living experience" (I must do the best I can with an inappropriate language), all that distinguishes my present view from my window with my memory of the same view this time yesterday. Both the present view and the memory are experienced now in subjective time, and in so far as I can describe them they are identical, yet I have not the slightest doubt that one is distinguished from the other. That quality of one which enables me to say that it is *not* a memory belongs to "I". It has gone before I can write the words down so far as it pertains to the describable view then spoken of, but it is still with me, attached to another replica of the same scene. The "presentness" that refuses to go into the past of physical time, and yet does not vanish but is always experienced, is what characterises "I". Philosophy can say nothing about it. Let us see what this removes from philosophical consideration.

In the first place, it is clear that we can say nothing at all about the possibility or otherwise of death in the sense of annihilation of consciousness. Death is a familiar feature of both the scientific and the commonsense worlds, and I can say with practical certainty that both John Brown and "me" will die; *i.e.* there will be a moment in the future of physical time at which many of the phenomena which I describe as the behaviour of John Brown or of me will come to an abrupt end; or, in other words, when the postulate of a living John Brown or me will fail to afford a rational correlation of memories of experiences allotted to later moments in physical time. The question is still open whether further experiences of the kind studied by the Society for Psychical Research, for instance, may lead to a modification of this belief. But, however that may be, no considerations of this or of any other similar kind have any bearing on "I". Since the concept of physical time has no relevance to "I", it is simply meaningless to ask whether a time will come when "I" will cease to exist. This is not, of course, a proof of survival of death. That question can go on being discussed as before; it has nothing to do with living experience.

Another such question is that of freedom of the will. At any moment I am faced with an indefinitely large number of courses of action. I choose one of them. It is ambiguous to ask whether my action was "determined". It is determined if I determine it. When it is performed it becomes a memory, and is then subject to correlation with other memories, and it is perfectly possible for me then to be able to say, "I see now that what made me do so and so was such and such". The action is then truly determined. But *now*, in identical circumstances (so far as they can be identical) I may choose a different action. When it is done I can, as before, say that it was determined and that it differed from the first action because a new determining factor—my knowledge of what determined the previous one—was operating. Clearly this can go on indefinitely. Every action, having once been performed, takes its place among the memories that constitute the data of philosophy, and there is no reason to doubt that it can be related to other memories in the manner which we are accustomed to call *causation* or *determination*, although, in the present state of knowledge, I do not think we are entitled to assume that it will necessarily be deducible wholly from events occurring *earlier* in physical time. But what travels along, so to speak, and refuses to be left stranded in the bed of the time-stream, is the freedom to choose a different action from the one performed last time or the one required by any scheme of determination that I may have discovered or constructed. " I " is free, but " me " is determined—or may become so with fuller knowledge. Note that this is not a positive statement about " I ". To be free is simply not to be determined. Being determined is the positive thing, for one has to do the determining; that is the whole business of philosophy. What more fundamental freedom can there be than freedom from being philosophised about?

I will conclude with a reference to the logical positivists' criterion of meaning, namely, that the meaning of a statement lies in the means which must be taken to verify it. This is not so directly concerned with the distinction between " I " and " me " as the matter just discussed, but it is closely related to our general theme.

I think the defect of the criterion is that it fails to respect the fundamental distinction between experience and reason—or, more precisely, between memories of experiences and the concepts occurring in the logical system which constitutes the world. If the word " meaning " is to have any significance at all justifiable in view of its ordinary use, it must remain a logical term, pertaining to reason, and therefore it should be definable quite independently of experience. But the logical positivists' criterion denies it a significance within a logical system, and relates it to the connection between the logical system and experience. Hence it cannot be acceptable.

All the sentences we commonly use, whether in science or in commonsense conversation, are intended to relate to the logical system which is the description of the universe. Consequently they are properly called meaningful if they do in fact signify something intelligible within the concepts of that system. The logical positivists' criterion, however, defines meaning in terms

of the linkage of the system with experience, and therefore they must regard anything within any logical system which cannot be so linked as meaningless, notwithstanding that its purport within the system is perfectly clear. This is at best an unfortunate use of a well established word.

The point can be illustrated in terms of either the scientific or the commonsense world : let us begin with science. Consider the statement : the two points in which two parallel straight lines meet are at a maximum distance apart in space. In terms of euclidean geometry this statement is meaningless; parallel straight lines in euclidean space do not meet and there is no maximum distance in that space. In terms of riemannian geometry, however, it has a clear meaning ; in the geometry of a spherical surface, for instance, it not only means something but happens also to be true. None of this has any reference to experience. Now suppose we define meaning in the logical positivists' way, in terms of the means by which we test the statement. Then it would seem that we do not know whether it has a meaning or not unless we know what happens when we extend straight rigid rods indefinitely in both directions. At present we certainly do not know this. We believe that space free from matter would be " spherical " in the riemannian sense, but that actual space is disturbed in an unspecifiable way by the presence of what matter there is, and whether the rods would ever meet in it we have no idea. We therefore do not know whether we can test the theorem about the distance apart of their intersections or not. It seems foolish to say that one does not know whether there is any meaning in something that he perfectly well understands.

I have chosen this type of example to follow naturally the geometrical example I chose earlier, but in fact any scientific hypothesis could be selected ; the meaning of a statement relating to it must be sought within the terms of the hypothesis and not in its external relations. It was meaningful of the older astronomers to say that the material of the celestial spheres was an incorruptible quintessence, or fifth element, notwithstanding that the statement bore no relation to any possible experience, because their universe, or logical system, included such spheres as necessary concepts, and the question of their composition was therefore a relevant one. It was meaningful of the nineteenth-century physicists to assign a value to the density of the luminiferous ether, although, as it turned out, the " ether " hadn't the properties which would have enabled that value to be determined. And so on, throughout the whole of physics.

Examples from the commonsense world are not so numerous, since the great stability of that world is one of the chief reasons for its practical efficacy, and the point under discussion is best illustrated when the logical system changes and the phenomena do not. But consider the statement: Mary Jones is a witch. The commonsense world of a few centuries ago included the Devil, and the meaning of the statement was that Mary Jones was able to do superhuman things by his aid. The " verification " of the assertion, however, might have been the fact that someone at whom she had looked later became ill, or that when thrown into the lake she did not drown. I am not sure whether the logical positivists would grant a meaning to the statement, or, if so, what it would be. All that I want to propose is that, in this as in other cases, the meaning should be defined within the logical system alone, and the applicability of that system to experience should be denoted by some other word.

University College, London

PRINTED IN GREAT BRITAIN AT
THE UNIVERSITY PRESS
ABERDEEN

R. Mar 25 /

JOURNAL
OF THE AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

JANUARY 1940

and possibly foolish in my admiration for Plato's *Republic*. I think there are certain books in this world which if we read we don't need any others, and Plato's *Republic* is one of them. It is the most ancient and the most modern of books. It is the wisest and the finest.

The lines in our reader were from the close of the ninth book, and I cite them now — something which to me sums up this tradition of taste and excellence in American education. Plato was read by the boys in Harvard. He was known by all the clergymen in Massachusetts Bay. He is part of our American heritage.

Many of you remember the close of the ninth book of Plato. Plato in the person of Socrates is talking to a young man named Glaucon. Socrates has been telling him of the city, the ideal city, the city of God, which he has told Glaucon is laid upon high and toward which all earthly cities must look as an ideal. It is the old story of the city beautiful, the city we remember, of course, in St. John's vision in the Book of Relevations.

And like the modern skeptic of today, Glaucon says, "Socrates, I do not believe that there is such a city of God on this earth."

And in Socrates' reply is all our American inheritance, all our American tradition, a lovely line of labor, of the inner vision and ideal of educated, thoughtful people. Socrates says to Glaucon:

> Perhaps there never has existed a heavenly city, and perhaps there never will exist a city of God on this earth; but whether such a one exists in heaven or ever will exist on earth, is no matter, for the wise man will live after the manner of that city and no other, and in looking upon that city, will set his own house in order.

PROBLEMS OF THE WOMAN SCHOLAR

By Cecilia Payne Gaposchkin

When I was invited to speak on the subject, "The Woman Scholar," I accepted the task gladly, although I knew it to be no easy one. And when I accepted it, I said that I was minded to speak especially on the problems of the woman scholar.

This is not an account of an armchair research. To me "The Woman Scholar" is not a theoretical subject. Research is the calling by which I earn my bread, and its problems are a living issue — a tree glowing with blossoms and bristling with thorns. I shall not evade the existence of the thorns. They must be examined, and their prick must be endured, before we can hope to pluck the Sempiternal Rose.

"The Woman Scholar" — how much I prefer to say, "The Scholar who is a Woman." That puts the emphasis where it belongs. The hardships, the drawbacks, of a woman scholar's life — who has not heard them lamented, wherever two or three doctors of philosophy are gathered together? Of course they are real; of course they are serious. But let us not forget that two thirds of them are not peculiar to woman; they are the problems of the scholar.

To many of us, the sharpest and most stubborn of the thorns is a very material one: the financial returns of scholarship are negligible. True. But everybody knows that in the beginning. Not even a man can expect to grow rich by scholarship. And personally I think it not quite inappropriate that the work that is most satisfying to the spirit should be done at some material cost. There is a famous principle in physics known as the Conservation of Energy, which, being translated into the idiom of ordinary life, reads: "One has to pay for what one gets."

Since I was very young, I have always wanted to do research. In those days I had a very real idea about what research involved — an idea for which I still have a nostalgic love. One would sit, I thought, preferably in a gloomy laboratory, contemplating the Universe and the Nature of Things, and wonderful new theories would spring fully armed from one's brain, as Pallas did from the brain of Jove. I have lived to learn that it is not like that at all.

No. The research that I have met and made consists of steps that seem childish as one takes them. The research worker's prayer should not be for a transcendental vision. I have formulated a little one for myself: "Lord, show us the obvious." The scientist's task is half done when he has correctly formulated the question that he is trying to answer. To find the right answer is usually not nearly so difficult as it is to formulate the right question. Not infrequently one makes one's best progress on the lines of: "To what question can this, that I have found, be the right answer?"

So I am approaching the problem of the woman scholar with the formulation of three simple, concrete questions: Who should be a scholar? How to be a scholar? And why be a scholar?

Who would and who should be a scholar? The first of those questions is without an answer. What is it that kindles the unquenchable flame, the burning desire to know and to understand, that nothing else will satisfy? This is one of the many unexplained forces that mould us. One who carries that fire must be a scholar; nothing else will serve.

Who should be a scholar, then? Many girls, and some boys too, have come to me for advice as to whether they should enter the lists and become astronomers. So many, that I have a stereotyped answer ready for them.

First, I say, you should only aim at a life of research if nothing else whatsoever will do. For "nothing else" is, approximately, what you will receive.

Secondly, you must be prepared to master every necessary tool. I do not mean only the theory and technique of the subject that you choose, for of course you will master those. You must, for example, make yourself a linguist. No language in which a line of your subject is printed should be a closed book to you. If you can't read it, learn it. Buy a dictionary and a grammar and sit down to it.

Thirdly, you must have good health, good eyesight, and great courage. If he or she has these, I say to the young scientist: "Go forward. There is a chance that you may become a scholar."

But how? It is not only after the college course is done, not only with the preparation for the higher degree, that the scholar's life begins. A Ph.D. who has done his duty well is perhaps ready to begin creative work. But at this point many a promising scholar has had to lay aside his newly-sharpened tools (and the chances are that he has not only sharpened them, but designed them and forged them as well) to begin to earn a living. At this point, where help is most vital, it is hardest to find. A newly-fledged Ph.D. is not ready or fit to step into a research institution. He must find himself, and must consolidate the work that he has only now learned how to do. In other words, he must land a fellowship. (You will notice that I am saying "he"— but that is really a neuter pronoun in the sense that I, like Humpty Dumpty, choose to give it.)

I was fortunate. The Rose Sidgwick Fellowship saw me through a year, and on its wings I took my first flight, in other words I wrote my first book. By that time one had learned a little, and published more, probably a great deal too much. One was ready for a post in a research institution, and luckily one got it.

I think that it is only by means of fellowships, wisely given to those who have shown their ability, not only by promise but by actual performance, that the gulf can be bridged and worthy scholars launched into the world.

I cannot leave the question of how to be a scholar without taking another look at the thorns. What is man's reaction (I mean, of course, the scholar man's reaction) to the woman scholar?

I am apt to classify men (solely from a professional standpoint, you understand) in three groups. First there are those who bully one. Happily these are rare; and they can be repaid in their own coin by the intrepid.

Secondly, there are those who do not take one seriously. Their attitude is: "Ah, when youth and beauty take the field, what can a mere man say?" (which, I beg to assure you, is no invention, but an actual quotation). These are a tedious group, difficult to rebuff.

Thirdly, there is the group of men who treat one as an equal, and in my profession they are the enormous majority. They are serious and fair, but even the best of them, in unguarded moments, will cast aspersions on feminine ability.

We all have to face the question: are women really the inferior sex when it comes to creative work? One has to admit that their performance, taken *en bloc*, may seem to warrant that conclusion, at least in point of quantity. And few of us are able to judge of quality excepting in a very limited field of interest.

I have considered this problem — it is one of the very longest and toughest of the thorns that grow around our rose — not less than many of you. For if women are really inferior in scholarly ability, I should hesitate to encourage them to be scholars, even though that would involve me in a very distasteful confession of failure. But I seem to see light ahead for the woman who wants, with all her mind, to be a scholar.

I do not believe that women, properly educated, trained, and supported, are intrinsically less able than men. As students they are apt to do as well. They are quick, patient, ingenious. Many of them are even original. (After all, there are not very many original men. True originality is pretty rare.) But they have, apparently, one drawback: they lack staying power. And the question that troubles us is, why?

It is not a matter of health. Women are strong; they have to be. And on the average, they tell me, women live longer than men; but I have seen enough of statistics in my own little field to hold back on the significance of that. I can only say that two of the best known women astronomers of the last century, Mary Somerville and Caroline Herschel, lived, respectively, to the ripe old ages of ninety-eight and ninety-nine. And the work of little Caroline, at least, was physically hard enough for a woman; it is told that she sat recording at the telescope through the night, until she could write no longer, for the ink had frozen.

The reason for the lack of staying power of the woman scientist is, I think, psychological. There seems to be an idea that it is a little unreasonable for a woman scholar to want a normal home life; and, of course, marriage for her is regarded as a most remote contingency. So she falls into line, and tries to be a scholar and nothing else — usually with disastrous results. Few people of any sex are suited to the life of a recluse. Woman, I think, can bear it least of all.

A young man, starting on a life of research, looks forward naturally to marriage and a home. Why should not the scholar who is a woman have the same prerogative? She is entitled to a real home, to marriage and children too, if her nature points that way, or to acquiring children by adoption if marriage does not make it possible for her to produce her own, and if, like most women, she has the instincts of a mother. I think that if she can take her place as a normal human being — if her life expands naturally — her abilities will expand too, and she has a chance to develop into a mature scholar.

There is no lack of examples. Madame Curie, who surely occurs to all of you, was wife and mother, and her home life was singularly unpretentious. That does not seem to have prejudiced her daughter against marrying a physicist and following her mother's footsteps, which, I should say, is a pretty good advertisement.

I could point to a dozen living examples, but I will pause only on one. She is Miss Annie Cannon, most famous of all women astronomers of any time, whose colleague I have the honor to be. Many of you have met her. Many of you know her well. But probably when she talked to you, it was not about her work. One would never know, people say, that she is a great scientist, to listen to her conversation. So I will say a word or two about it.

Miss Cannon's life work has consisted in the exacting and laborious job of classifying the spectra of a quarter of a million stars. There is probably no branch of astronomy, no astronomer anywhere, in any part of the world, who does not at some time use Miss Cannon's work. And when Miss Cannon says a thing is so, it is so. Skeptics have checked up on her before now, but they have not remained skeptics. That statement probably describes, better than any talking about the nature of her work, the extent of Miss Cannon's contribution to science.

But the remarkable and outstanding thing about Miss Cannon is not her scientific work, for that affects a very small number of people. There are not many astronomers in the whole world — there are about five times as many women attending this convention. Her greatest contribution is her life. She is that rare and beautiful thing, a truly happy woman, and that, I think, is an even greater achievement than being a great astronomer. Miss Cannon is the best example that I know of the balanced life — and the balanced life is, probably, the secret of her greatness as a scientist.

Something can be done by you, and especially by those of you who are responsible for the administration of fellowships, to promote the balanced life. It is not promoted, for instance, by systems of bringing a number of woman scholars to live together under the same roof. That, it seems to me, discourages and cramps the development I have in mind. And I have heard, somewhere, of a fellowship that had to be returned if the recipient subsequently married. I doubt whether such are encouragements to the balanced life.

I have spoken of the "who" and the "how" of research. Let me finish by a brief word as to the "why." For sometimes it seems to me — sometimes it must seem to all of us — that the scholar is a very ostrich, burying his head in the sands of speculation, while the human race commits suicide behind his back. What right have we, who seem to be the extreme luxuries of civilization, to be taking ourselves so seriously while civilization herself is tottering? What is the worth of knowledge, in comparison to human life?

I can only answer from my own catalogue of values. Without the fruits of knowledge, life would be barren. And knowledge can give to life a beauty and a rhythm that nothing else can confer.

A month ago, I stood on a mountain top in Texas where one of the greatest telescopes in the world, the eighty-two-inch telescope on Mount Locke, was being dedicated to the service of science. Astronomers from all over the world had come to the celebration. One of the greatest living physicists spoke, on the theme, "Science and Its Uses to Humanity." He spoke of the misuses of science; its abuse as a weapon of war. And then he spoke of its uses and the benefits it has conferred upon humanity; of the technical improvements that it has made possible, of the lives it has saved. But there was one thing of which he did not speak, the greatest contribution of all that science has made to humanity, in my opinion, —

the intense beauty of the universe which it has exposed to us.

I should like to close by saying a few words about that myself, for I have said something about the nature of the scientific career and the people who should embrace it and the way in which it can best be practised, but I have said nothing to explain why it is worth practising.

To me, science opens an unseen world that is unspeakably beautiful. It is as beautiful as a symphony and in very much the same way. In the last few months, I have been doing a very complicated piece of research which was concerned with the way in which atoms are behaving in the atmospheres of very distant stars. We were drawing pictures of those atoms and calculating what sort of light they would shine with. It sounds like an impossible job, but it can be done. And it seemed to me as I worked that every atom in the universe is like a tiny harp on which the light of the stars is playing a glorious tune.

The beauty of the universe has had few poets to sing it. Dante perhaps came nearest to it when he sang of the glories of Paradise. Shelley saw the vision, and he writes of it in the "Hymn to Intellectual Beauty,"—

> Sudden, thy shadow fell on me,
> I shrieked, and clasped my hands in ecstasy.

Science has it in her power to construct an intellectual symphony as beautiful as any music that was ever written; to sketch a picture as wonderful as any canvas that was ever painted. And these contributions of science to the loveliness of the world are immortal. They talk of the lives saved by science. But science has never succeeded in doing more than prolonging life. The vision that it constructs is eternal.

When I look at the world of physics with the unspeakable intricacy of the very tiny, and then at the world of astronomy with the tremendous majesty of stars and universes and systems of universes, I feel that I can quote the words of a poet who was writing of a very different sort of inspiration — and quote them not irreverently:

> Oh world invisible, we view thee
> Oh world intangible, we touch thee
> Oh world unknowable, we know thee
> Inapprehensible, we clutch thee.

FAITH WITHOUT ILLUSIONS

AN ADDRESS BEFORE THE POLISH ASSOCIATION OF UNIVERSITY WOMEN

By Stanislawa Adamowicz

> Wisdom is knowing what to do next, skill is knowing how to do it, and virtue is doing it.
>
> David Starr Jordan

The last two decades have been a time of historic importance for the pacifist movement. The longing for peace and for a reconstruction of international relationships, so generally felt after the upheavals of the Great War, contributed to make it such, and flattering hopes foresaw a near future in which the pacifist movement would sweep the whole world. That was an attitude based not on facts, but on faith and desire — how eloquently were we assured in many languages that peace had definitely triumphed over ignorance and war, that all the nations had definitely given up the use of arms for deciding their disputes, that they were uniting not for destruction but for creative work.

The spell of this new faith was so strong that for some years an impartial judgment of events was made very difficult. Optimism was considered a duty.

During this period the number of international organizations was multiplied almost to one thousand, for not only politicians, but also business, professional, social, and trade organizations felt a need for mutual contacts. The importance of such organizations varied to a considerable degree. Some of them can look back on years of work and noteworthy results, but there are many which merely vegetate.

In this state of things we lived to see a general political situation which grew ever more disquieting. The Treaty of Versailles, once justly described as "a middle way between the theology of Wilson and the practical needs of a distracted Europe," and never wholly carried out, was ultimately left in shreds. At the last masks were lifted, and faced by merciless reality men saw with dread that nothing was left but to oppose force to lawless might.

The most pessimistic expectations were fulfilled, but in this case one can scarce imagine anyone rejoicing at being proved

---

About the time that the German army was entering Poland, a copy of *La Femme Polonaise*, magazine of women's activities in Poland, reached A.A.U.W. Headquarters. This issue contained the text of an address on the peace movement by Dr. Stanislawa Adamowicz, given before the Polish Association of University Women in May — three months before Dr. Adamowicz was elected president of the International Federation of University Women. Simply as a matter of historical record, the suggestions of a Polish university woman as to methods of working for peace, voiced so short a time before her country's annihilation by military conquest, would be of interest. But Dr. Adamowicz's address is reprinted here, not because the thought of Poland's fate lends poignancy to her comments, but rather because of the practical wisdom she brings to bear on the problem which most vitally concerns us all today.

— Editor's Note

right. We should keep calm and remember that great results in great causes have often been attained only after many failures and trials. We should learn a lesson from defeat in order to avoid in future a repetition of old errors.

In speaking of this matter I have no intention of discussing the general political situation, only our own work and the demands which we should make upon ourselves in carrying it out.

THE present situation may be viewed as an ideological crisis, a break-down of the faith in positive results of international collaboration. Voices are raised, that since we have been defeated we will find more satisfaction personally and work more profitably by returning to narrower limits or even by giving up everything outside our personal interests.

Matters are further rendered difficult by the social stress which runs parallel with the political crisis and its agonizing uncertainty of the morrow. I do not hold that Europe is a mere cemetery of dead cultural values. New life arises from the old values and that is never a painless process. We must adapt ourselves to the hard reality and learn to work under changed conditions.

Before I begin to speak of methods of work I should like to make some preliminary observations. It is necessary to realize that in international relations, as in every other domain, the law should not be too much in advance of reality, for in that case it cannot be put into effect. The most wisely and nobly conceived law will bring more harm than good if it can be broken with impunity.

We must work by stages. Those who take part in the movement, its friends, and above all, its adversaries, should see that we achieve at least some tangible results, for otherwise it will be said: "All this is very fine and much to be desired, but it is an unattainable dream."

We should change our methods of propaganda. Let us not cherish the illusion that the world can be converted by public demonstrations and by even the blackest pictures of the horror of future wars. Solemn celebrations, marches, banquets, mass meetings — all these things may have a certain value, but we should consider them as being more for show, and bear in mind that among the crises of the time we have also a crisis of words.

Words are supposed to have power. Let us examine this assertion. Can we say that words incontestably have power in all circumstances? Have we not overestimated their power in post-war years? Soft words, announcing kind intentions that remain intentions only; fine words, giving promises that will not be kept; discreet words, implying that which may not be said openly; how often have men been satisfied with mere parables. They have not found the "magic word." They are tired of speeches and this crisis is added to the others.

OUR methods of work. I will review them under several headings:

1. The purpose of international cooperation in all periods of history remains always the same: the exchange of spiritual values between nations. The form of that exchange however must fit the epoch in which it takes place.

2. Under present circumstances only such international organizations can keep alive and retain some influence, as (*a*) really carry on some kind of work and (*b*) are at least in their inner workings truly international communities, based on principles of civilization, order, liberty, and justice.

3. There must be a plan of work, directed towards tangible results. Such a plan is necessary even under the present most unfavorable conditions and it must be carried out in spite of difficulties.

4. That plan must be suited to those who are to carry it out. As Marshal Pilsudski said, "You must not make thoughts and plans exceeding the strength of the instrument which is to execute them."

5. Whoever undertakes international work should be properly fitted for it. To know a country one must know its geography, its political, social, and economic history, its nation's own opinions on its historical development, its industries, morals, beliefs, endeavors, and aims, its educational ideals, its science and art. That is no small task, but without a thorough knowledge of facts on which alone can be based a just appraisement of symptoms, one cannot nowadays claim the right to discuss international problems.

6. More sincerity is needed. We should cease to applaud equally those who treat us to well-worn platitudes and those who are truly the spokesmen of life's needs. Every period of history produces its own specific types of men, whether admirable or worthless. The last two decades can undoubtedly point with pride to numbers of Knights of the Holy Grail, but they have also produced a type whose only stock in trade are fine phrases, one that lives and thrives by taking advantage of humanity's great longing for peace. Such people may seem great or small, they may gather applause, but their activities are barren and leave no trace, for their phrases serve only to cloak an utter emptiness.

7. Criticism is necessary, for a good critical analysis profits the critic and the criticized, their listeners and readers. Too much unanimity is often a sign of small interest and low vitality.

8. Let us create living examples and centers of tangible work, however modest. We can carry out such work by every well-conducted course of a foreign language, by our studies aiming at a thorough knowledge of international problems, by exchanging with foreign countries exact, complete and reliable information, by explaining to foreign visitors our achievements and our troubles, by international collaboration in scientific work, by finding money for international scholarships, and by turning to account all existing and potential possibilities, arising from our membership of the I.F.U.W., which has such a fine record in international collaboration after the Great War.

9. Words should take their proper place. A verbal assurance must be strictly in accord with the possibilities of action, and in order to regain its value speech must become sober, sincere and competent.

I SHOULD like to hope that what I have said here in our Association as in a Republic of Liberty of Thought, will become a nucleus which our common work and strivings will surround with new thoughts and sentiments, so that at last we may bring up such workers as we need in the field of international cooperation.

In moments of difficulty let us say with Biegański:

> Our work is like the work of the husbandman. And our soil has fields that have been tilled for centuries, and virgin fields, untouched as yet by the ploughshare of civilization. As for me, I prefer the hard work of the pioneer to that of turning up exhausted soil that will not yield a harvest greater than it has hitherto produced.

NOTES ON HIGHER EDUCATION

Fiftieth Anniversary of Barnard College

Another women's college has passed the half-century mark. On November 14 and 15 Barnard College celebrated its fifty years of existence with a large dinner at which the speakers were Lord Lothian, British Ambassador to the United States, President Nicholas Murray Butler, of Columbia University, Mayor F. H. La Guardia, of New York City, and Dean Virginia C. Gildersleeve, of Barnard College; and an all-day conference on higher education attended by many notables. Floral decorations, colorful academic costumes, and the sound of trumpets produced an atmosphere of picturesque dignity for the discussions of "Intellectual Adventures," and various phases of higher education, particularly for women, that constituted the program of the conference.

The "intellectual adventurers," who illustrated the satisfactions of research in their own fields, were Dr. Harlow Shapley, Harvard Astronomer; Dr. Marjorie Hope Nicolson, dean and professor of English at Smith College; and Dr. Michael I. Rostovzeff, archaeologist, of Yale. The speakers on problems of higher education were President Butler, of Columbia, Dr. William Allan Neilson, president emeritus of Smith, and Dean Gildersleeve. The *New York Times* reported Dean Gildersleeve as having made the following significant remarks regarding the status of college women today:

> Do I speak as if the battle had been completely won and all were well with women in education and the professions? That is very far from being the case. As a matter of fact we are celebrating our anniversary at a moment when the position of women, educationally and professionally, is at a much lower point than it was just a few years ago.
>
> This is a temporary setback. It is partly due to the appallingly difficult times in which we live, to the national and international tragedies that dislocate our best-laid plans. Perhaps it is due partly to the failure of women themselves to rise to the challenge of their opportunities. It is due, I think, to some revival of old prejudices and superstitions. It is due in some measure also to that unimaginative reluctance on the part of many men and women of wealth to give adequate support to the education of women.

The Presidency of Smith College

The announcement of the election of the new president of Smith College came as a complete surprise to the educational world, as there had been no indication beforehand that the matter had neared conclusion. With Mrs. Dwight Morrow acting as president since the retirement of President William Allan Neilson last June, the appearance was that a considerable amount of time might be consumed in the selection of the new president.

In electing Dr. Herbert John Davis, who is an Englishman, a graduate of St. John's College, Oxford, an English scholar and a professor of English at Cornell University, Smith College is apparently trying to carry on the Neilson tradition. This is a tribute to Dr. Neilson, but it might possibly be a handicap to the new president. However, the trustees could not have been unaware of this possibility, and have undoubtedly considered Dr. Davis' originality and creative ability to be of the highest caliber.

The 1939 commencement at Smith nat-

AMERICAN SCIENTIST

A QUARTERLY PUBLICATION OF THE SOCIETY OF THE SIGMA XI DEVOTED TO THE PROMOTION OF RESEARCH IN SCIENCE

VOL. 30 APRIL, 1942 NO. 2

THE PROBLEM OF THE EXPANDING UNIVERSE

By EDWIN HUBBLE
Mt. Wilson Observatory

I PROPOSE to discuss the problem of the expanding universe from the observational point of view. The fact that such a venture is permissible is emphatic evidence that empirical research has definitely entered the field of cosmology. The exploration of space has swept outward in successive waves, first, through the system of the planets, then, through the stellar system, and, finally, into the realm of the nebulae. Today we study a region of space so vast and so homogeneous that it may well be a fair sample of the universe. At any rate, we are justified in adopting the assumption as a working hypothesis and attempting to infer the nature of the universe from the observed characteristics of the sample. One phase of this ambitious project is the observational test of the current theory of the expanding universes of general relativity.

I shall briefly describe the observable region of space as revealed by preliminary reconnaissance with large telescopes, then sketch the theory in outline, and, finally, discuss the recent more accurate observations that were designed to clarify and to test the theory.

THE OBSERVABLE REGION

The sun, as you know, is a star, one of several thousand million stars which together form the stellar system. This system is a great swarm of stars isolated in space. It drifts through the universe as a swarm of bees moves through the summer air. From our position near the sun we look out through the swarm of stars, past the borders, and into the universe beyond.

Until recently those outer regions lay in the realm of speculation. Today we explore them with confidence. They are empty for the most part, vast stretches of empty space. But here and there, separated by immense intervals, other stellar systems are found, comparable with our own. We find them thinly scattered through space out as far as telescopes can reach. They are so distant that, in general, they appear as small faint clouds mingled among the stars, and many of them have long been known by the name "nebulae." Their identification as great stellar systems, the true inhabitants of the universe, was a recent achievement of great telescopes.

On photographs made with such instruments, these nebulae, these stellar systems, appear in many forms. Nevertheless they fall naturally into an ordered sequence ranging from compact globular masses through flattening ellipsoids into a line of unwinding spirals. The array exhibits the progressive development of a single basic pattern, and is known as the sequence of classification. It may represent the life history of stellar systems. At any rate, it emphasizes the common features of bodies that belong to a single family.

Consistent with this interpretation is the fact that these stellar systems, regardless of their structural forms, are all of the same general order of intrinsic luminosity; that is, of candlepower. They average about 100 million suns and most of them fall within the narrow range from one-half to twice this average value. Giants and dwarfs are known, 10 to 20 times brighter or fainter than the average, but their numbers appear to be relatively small. This conclusion is definitely established in the case of giants, which can be readily observed throughout an immense volume of space, but is still speculative in the case of dwarfs which can be studied only in our immediate vicinity.

The limited range in luminosity is important because it offers a convenient measure of distance. As a first approximation, we may assume that the nebulae are all equally luminous, and, consequently, that their apparent faintness indicates their distances. The procedure is not reliable in the

case of a single object because the particular nebula might happen to be a giant or a dwarf rather than a normal stellar system. But for statistical purposes, where large numbers of nebulae are involved, the relatively few giants and dwarfs should average out, and the mean distances of large groups may be accurately determined. It is by this method that the more remote regions of space, near the limits of the telescope, may be explored with confidence.

Throughout the observable region the nebulae are found scattered singly, in pairs, and in groups up to great compact clusters or even clouds. The small scale distribution is irregular, and is dominated by a tendency towards clustering. Yet when larger and larger volumes of space are compared, the minor irregularities tend to average out, and the samples grow more and more uniform. If the observable region were divided into a hundred or even a thousand equal parts, the contents would probably be nearly identical. Therefore, the large scale distribution of nebulae is said to be uniform; the observable region is homogeneous, very much the same everywhere and in all directions.

We may now present a rough sketch of our sample of the universe. The faintest nebulae that can be detected with the largest telescope in operation (the 100-inch reflector on Mount Wilson) are about two million times fainter than the faintest star that can be seen with the naked eye. Since we know the average candle power of these nebulae, we can estimate their average distance—500 million light years. A sphere with this radius defines the observable region of space. Throughout the sphere are scattered about 100 million nebulae, at various stages of their evolutional development. These nebulae average about 100 million times brighter than the sun and several thousand million times more massive. Our own stellar system is a giant nebula, and is presumably a well-developed, open spiral. The nebulae are found, as has been said, singly, in groups and in clusters but, on the grand scale, these local irregularities average out and the observable region as a whole is approximately homogeneous. The average interval between neighboring nebulae is about two million light years, and the internebular space is sensibly transparent.

THE LAW OF RED SHIFTS

Another general characteristic of the observable region has been found in the law of red shifts, sometimes called the velocity-distance relation. This feature introduces the subject of spectrum analysis. It is well known that, in general, light from any source is a composite of many individual colors or wavelengths. When the composite beam passes through a glass prism or other suitable device, the individual colors are separated out in an ordered rainbow sequence, known as a spectrum. The prism bends the light waves according to the wavelength. The deflections are least for the long waves of the red and are greatest for the short waves of the violet. Hence position in the spectrum indicates the wavelength of the light falling at any particular place in the sequence.

Incandescent solids, and certain other sources, radiate light of all possible wavelengths, and their spectra are continuous. Incandescent gases, however, radiate only certain particular wavelengths, and their spectra, called emission spectra, consist of various isolated colors separated by blank spaces. The patterns are well known, hence gases in a distant light source can be identified by their spectra.

The sun presents a third kind of spectrum, known as an absorption spectrum. The main body of the sun furnishes a continuous spectrum. The heavy atmosphere surrounding the main body is gaseous and would normally exhibit an emission spectrum. Actually, the atmosphere, because it is cooler than the main body, absorbs from the continuous background those colors it would otherwise emit. Therefore the solar spectrum is a continuous spectrum on which is superposed a pattern of dark gaps or lines. These dark lines identify the gases in the solar atmosphere and indicate the physical conditions under which they exist.

The nebulae are stellar systems, and their spectra resemble that of the sun. Dark lines due to calcium, hydrogen, iron, and other elements in the atmospheres of the component stars are identified with complete confidence. In the case of the nearer nebulae, these lines are close to their normal positions as determined in the laboratory or in the sun. In general, however, accurate measures disclose slight displacements, either to the red or to the violet side of the exact normal positions.

Such small displacements are familiar features in the spectra of stars and are known to be introduced by rapid motion in the line of sight. If a star is rapidly approaching the observer, the light waves are crowded together and shortened, and all the spectral lines appear slightly to the violet side of the normal positions. Conversely, rapid recession of a star drags out and lengthens the light waves, and the spectral lines are seen to the red of their normal positions.

The amounts of these displacements (they are called Doppler shifts) indicate the velocities of the stars in the line of sight. If the wavelengths are altered by a certain fraction of the normal wavelengths, the star is moving at a velocity which is that same fraction of the velocity of light. In this way it has been found that the stars are drifting about at average speeds of 10 to 30 miles per second, and, indeed, that the stellar system, our own nebula, is rotating about its center at the majestic rate of one revolution in perhaps 200 million years.

Similarly, the nebulae are found to be drifting about in space at average speeds of the order of 150 miles per second. Such speeds, of course, are minute fractions of the velocity of light, and the corresponding Doppler shifts, which may be either to the violet or to the red, are barely perceptible.

But the spectra of distant nebulae show another effect as conspicuous as it is remarkable. The dark absorption lines are found far to the red of their normal positions. Superposed on the small red or violet shifts representing individual motions, is a systematic shift to the red which increases directly with the distances of the nebulae observed. If one nebula is twice as far away as another, the red shift will be twice as large; if n times as far away, the red shift will be n times as large. This relation is known as the law of red shifts; it appears to be a quite general feature of the observable region of space.

If these systematic red shifts are interpreted as the familiar Doppler shifts, it follows that the nebulae are receding from us in all directions at velocities that increase directly with the momentary distances. The rate of increase is about 100 miles per second per million light years of distance, and the observations have been carried out to nearly 250 million light years where the red shifts correspond to velocities of recession of nearly 25,000 miles per second or 1/7 the velocity of light.

On this interpretation the present distribution of nebulae could be accounted for by the assumption that all the nebulae were once jammed together in a very small volume of space. Then, at a certain instant, some 1800 million years ago, the jam exploded, the nebulae rushed outward in all directions with all possible velocities, and they have maintained these velocities to the present day. Thus the nebulae have now receded to various distances, depending upon their initial velocities, and our observations necessarily uncover the law of red shifts.

This pattern of history seems so remarkable that some observers view it with pardonable reserve, and try to imagine alternative explanations for the law of red shifts. Up to the present, they have failed. Other ways are known by which red shifts might be produced, but all of them introduce additional effects that should be conspicuous and actually are not found. Red shifts represent Doppler effects, physical recession of the nebulae, or the action of some hitherto unrecognized principle in nature.

COSMOLOGICAL THEORY

The preliminary sketch of the observable region was completed about ten years ago. It was not necessarily a finished picture, but it furnished a rough framework within which precise, detailed investigations could be planned with a proper understanding of their relation to the general scheme. Such new investigations, of course, were guided when practical by current theory. Let me explain the significance of this procedure.

Mathematicians deal with possible worlds, with an infinite number of logically consistent systems. Observers explore the one particular world we inhabit. Between the two stands the theorist. He studies possible worlds but only those which are compatible with the information furnished by observers. In other words, theory attempts to segregate the minimum number of possible worlds which must include the actual world we inhabit. Then the observer, with new factual information, attempts to reduce the list still further. And so it goes, observation and theory advancing together toward the common goal of science, knowledge of the structure and behavior of the physical universe.

The relation is evident in the history of cosmology. The study at first was pure speculation. But the exploration of space moved outward until finally a vast region, possibly a fair sample of the universe, was opened for inspection. Then theory was revitalized; it now had a sure base from which to venture forth.

Current theory starts with two fundamental principles: general relativity and the cosmological principle. General relativity states that the geometry of space is determined by the contents of space, and formulates the nature of the relation. Crudely put, the principle states that space is curved in the vicinity of matter, and that the amount of curvature depends upon the amount of matter. Because of the irregular distribution of matter in our world, the small scale structure of space is highly complex. However, if the universe is sufficiently homogeneous on the large scale, we may adopt a general curvature for the universe, or for the observable region as a whole, just as we speak of the general curvature of the earth's surface, disregarding the mountains and ocean basins. The nature of the spatial curvature, whether it is positive or negative, and the numerical value, is a subject for empirical investigation.

The second, or cosmological principle is a pure assumption—the very simple postulate that, on the grand scale, the universe will appear much the same from whatever position it may be explored. In other words, there is no favored position in the universe, no center, no boundaries. If we, on the earth, see the universe expanding in all directions, then any other observer, no matter where he is located, will also see the universe expanding in the same manner. The postulate, it may be added, implies that, on the grand scale, the universe is homogeneous and isotropic—very much the same everywhere and in all directions.

Modern cosmological theory attempts to describe the types of universes that are compatible with the two principles, general relativity and the cosmological principle. Profound analysis of the problem leads to the following conclusions. Such universes are unstable. They might be momentarily in equilibrium, but the slightest internal disturbance would destroy the balance, and disturbances must occur. Therefore, these possible worlds are not stationary. They are, in general, either contracting or expanding, although theory in its present form does not indicate either the direction of change or the rate of change. At this point, the theorist turned to the reports of the observers. The empirical law of red shifts was accepted as visible evidence that the universe is expanding in a particular manner and at a known rate. Thus arose the conception of homogeneous expanding universe of general relativity.

In such universes, the spatial curvature is steadily diminishing as the expansion progresses. Furthermore, the nature of the expansion is such that gravitational assemblages maintain their identities. In other words, material bodies or groups and clusters of nebulae do not themselves expand but maintain their permanent dimensions as their neighbors recede from them in all directions.

Several types of expanding universes are possible, and some of them can be further specified by the nature of the curvature, whether it is positive or negative. In fact, the particular universe we inhabit could be identified if we had sufficiently precise information on three measurable quantities, namely, the rate of expansion, the mean density of matter in space, and the spatial curvature at the present epoch. Recent empirical investigations have been directed toward these problems, and the results will be briefly described in the remaining section of this discussion.

COMPARISON OF THEORY AND OBSERVATIONS

We may begin with two results which are thoroughly consistent with the theory. The first result concerns the assumption of homogeneity; the second, the conclusion that groups maintain their dimensions as the universe expands.

The distribution of nebulae has been studied in two ways. The first information came from sampling surveys at Mount Wilson and at the Lick Observatory. Small areas, systematically scattered over the sky, were studied with large telescopes. Thus the nebulae that were counted lay in narrow cones penetrating to vast distances. These surveys established large scale homogeneity over the three-quarters of the sky that could be studied from the northern latitudes of the observatories involved.

Cones.

Later, the Harvard College Observatory, with the help of its southern station, has furnished counts of nebulae extending over large areas but made with moderate size telescopes. In other words, these nebulae are scattered through wide cones penetrating to moderate distances. Shapley, in his reports, has stressed or perhaps over-stressed, the familiar, small scale irregularities of distribution, but analysis of such published data as are adequately calibrated agrees with the earlier conclusion. In fact, the mean results from the two quite different methods of study are sensibly the same. This fact re-emphasizes the large scale homogeneity of the observable region.

The second result is derived from a study of the Local Group. Our own stellar system is one of a dozen nebulae that forms a loose group, more or less isolated in the general field. These neighboring systems furnished the first clues to the nature of the nebulae and the scale of internebular distances. They are so near that their brightest stars could be recognized and compared with similar stars in our own system. Radial velocities of the members of the Local Group, listed in Table I, suggest that the law of red shifts probably does not operate within the group. This conclusion is positive evidence supporting the validity of the theory. If the universe is expanding, the group maintains its dimensions as the theory requires.

The remainder of the recently accumulated information is not favorable to the theory. It is so damaging, in fact, that the theory, in its present form, can be saved only by assuming that the observational results include hidden systematic errors. The latter possibility will naturally persist until the investigations can be repeated and improved. Nevertheless, a careful re-examination of the data now available suggests no adequate explanation of the discrepancies.

TABLE I—RADIAL VELOCITIES IN THE LOCAL GROUP

The observed velocities (second column) represent a more reasonable distribution than the velocities corrected for red shifts (fifth column). The latter are all large and negative with the exception of the first two, for which the red shifts are insignificant. This fact suggests that the law of red shifts does not operate within the Local Group.

LOCAL GROUP

Known Members	*Observed Velocity*	*Distance in Million Light Years*	*Expected Red Shift*	*Velocity with Red Shift Removed*
L M C	+ 45	0.085	+ 13	+ 32
S M C	+ 13	0.095	+ 16	— 3
M 31	—130	0.7	+110	—240
NGC 6822	+ 20	0.5	+ 85	— 60
IC 1613*	....	1.3	+210	....
Fornax	— 40	0.6	+100	—140
Probable Members				
NGC 6946	+ 90	1.6	+265	—175
NGC 1569	+ 60	2.3	+370	—310
IC 342	+ 30	2.3	+370	—340

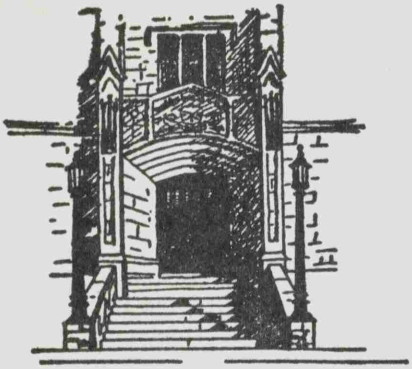
* A spectrum of an object in IC 1613, obtained by Baade, shows a definitely negative velocity. The numerical value of the velocity is rather uncertain, and, for this reason is not included in the table. However, the negative sign indicates that IC 1613 is consistent with the other members of the Local Group.

THE INTERPRETATION OF RED SHIFTS

The investigations were designed to determine whether or not red shifts represent actual recession. In principle, the problem can be solved; a rapidly receding light source appears fainter than a similar but stationary source at the same momentary distance. The explanation of this well-known effect is quite simple when the beam of light is pictured as a stream of discrete quanta. Rapid recession thins out the stream of quanta, hence fewer quanta reach the eye per second, and the intensity, or rate of impact, is necessarily reduced. Quantitatively, the normal brightness is reduced by a fraction that is merely the velocity of recession divided by the velocity of light—in other words, the red shift expressed

$d\lambda/\lambda = v/c$

Ref to Eddington MSS
+ letters from Einstein
Bertrand Russell
O Lodge



DOUGLAS LIBRARY NOTES

QUEEN'S UNIVERSITY AT KINGSTON, ONTARIO
SUMMER 1965, *volume XIV, number 3*

WALLACE R. BERRY

BUILDING FOR A NEW ERA

The New Library: The Evolution of a Plan

THREE years ago I stood in the Principal's office, looking across at the library with Principal Corry and Vice-Principal Deutsch, pondering the kind of extension to the building that would serve Queen's for at least the next two decades. It seemed like a formidable problem. At the expected rate of growth, the addition would need to be more than twice as large as the old library. Was there enough space north of the library for such an annex? And, if so, what sort of addition could be made to the carefully proportioned Collegiate Gothic design of the Douglas Library without producing an architectural monstrosity?

Our first thought was to erect on the corner lot a separate building of contemporary design with connecting stacks below ground and a passageway at ground level linking the two libraries. Such a plan has been proposed by Neal Harlow, Dean of the Graduate School of Library Service at Rutgers University, who had made a preliminary survey of the problem. Much work remained to be done, however, on the problem of integrating the two buildings. Both Toronto and McGill had added modern wings to old libraries, but in neither case, I felt, was there a happy union of old and new. I was apprehensive about this hybrid solution, nor did the architect's first sketch provide an incentive to proceed. What ruled out this plan, however, was a municipal by-law regulating the offset of the proposed building from University Avenue on the west and Union Street on the north. Indeed, so restricted was the permitted building site that a separate library was no longer a practicable possibility; any addition would have to be a direct extension of the old building to achieve the required space.

At first we envisaged an annex that would rise no higher than the second storey of the old building in order to retain unobscured the large tracery window on the north wall of the third floor reading room. The restricted building site, however, had created a critical space problem. Dr. Deutsch made two proposals: dig the foundations deep enough for four stack levels (as against two in the old wing) and extend the height of the annex to that of the original library. The architects agreed that both these suggestions could be carried out. I then recalled that Dr. Mackintosh once suggested the possibility of lateral extension of the stack area below ground. This would provide additional space without contravening any municipal by-law. I further suggested that the new wing be extended along Union Street beyond the east wall of the old library so that it would, in effect, wrap around the north-east corner of the building. This would accomplish two things: it would obviously provide more space, and it would yield sufficient length for a hipped roof at right angles to that of the old building. This would make possible an impressive third floor reading room with adequate space for mezzanine floors on the north and south sides.

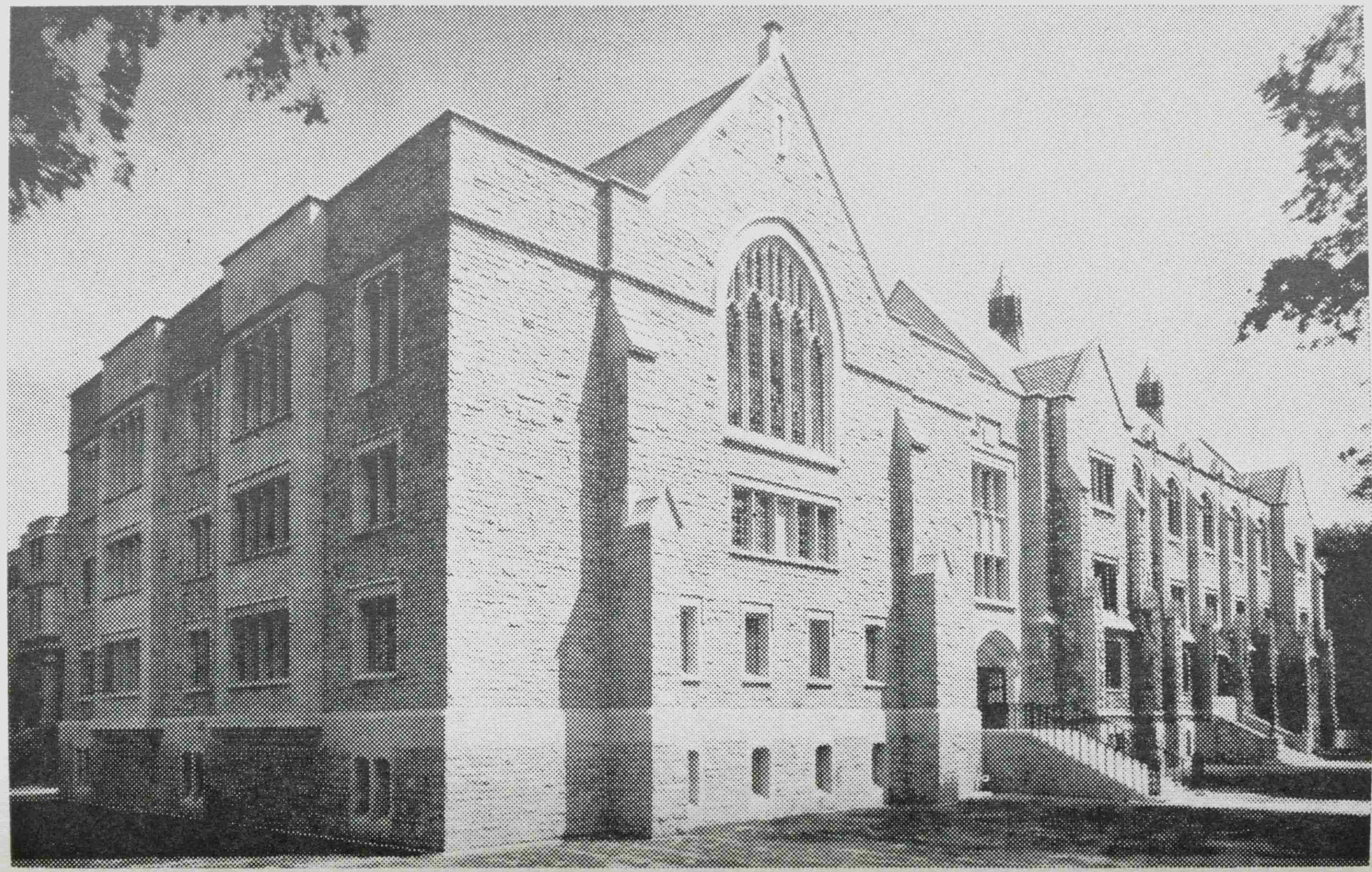
All of these ideas were discussed with architects who added their strong recommendation that the extension be designed in modified Collegiate Gothic style to harmonize with the original structure. Their subsequent sketch won the immediate approval of the Board of Trustees. Detailed planning then began in earnest.

A faculty advisory committee spent long and arduous hours with the Librarian and Mr. Andrew Mathers of Mathers & Haldenby, the architects. Two changes were made in the exterior plan. The first was to add a new built-up stairway and entrance to the main floor of the new wing from University Avenue. The second proposal was a large terrace along the east facade of the old library from which there would be an impressive entrance to the new wing and a new door to the old wing. Looking to the future, the committee pointed out that the terrace would also provide access to a south wing, if and when this further extension is made to the library. At my request, the architects agreed to have the space beneath the terrace excavated for a large storage area. As a whim, they proposed to make the terrace balustrade an exact replica of that of Stirling Castle.

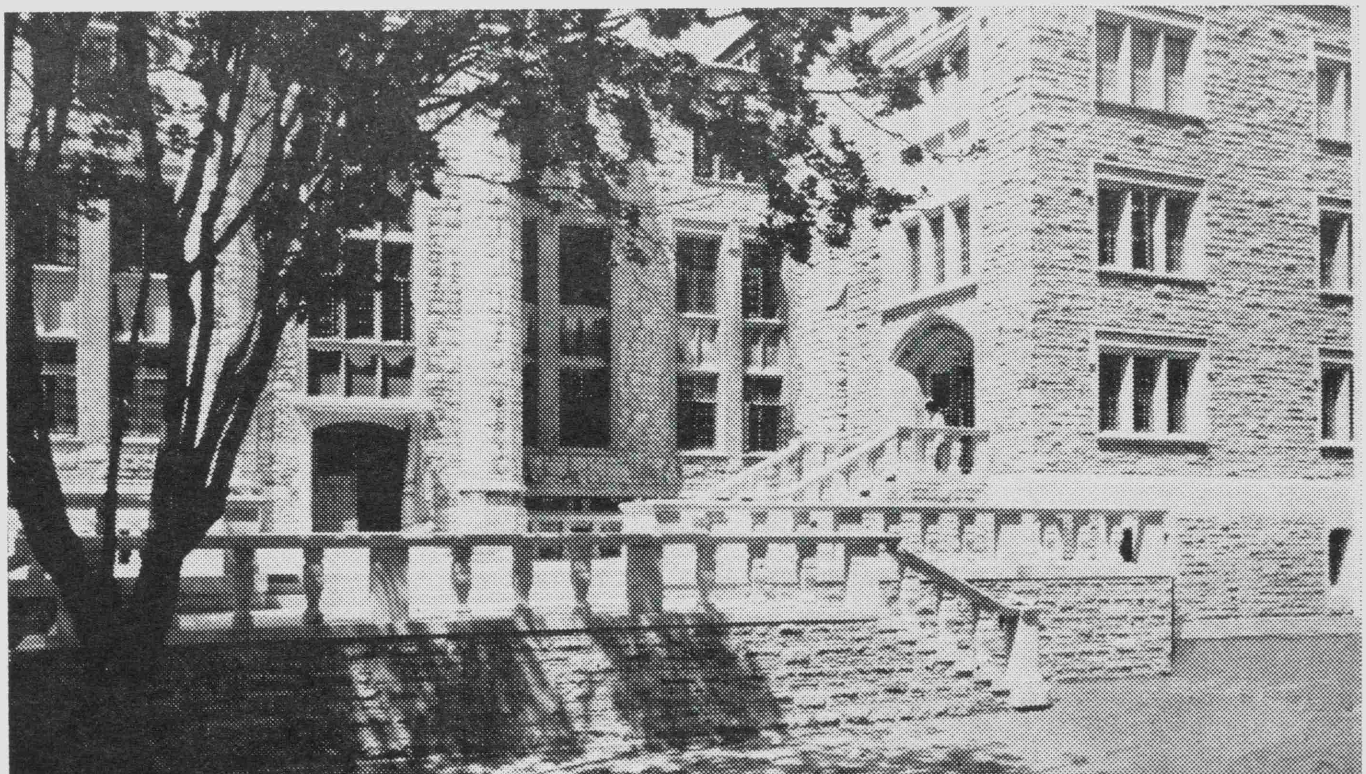
To solve a university planning problem, the Principal now asked that the new top stack level be given over to accommodate the Industrial Relations Centre until such time as this department obtains a permanent home.

One final problem in integrating the old and new libraries was solved by Principal Corry. In order to open out space on the first and second floors of the old building, it was agreed that the two tower stacks running through the centre of the library on either side of the Memorial Hall be eliminated, but the two-storey Hall itself was to remain. This made it impossible to produce a workable floor plan for the technical service divisions on the first floor, and on the second it formed a central barrier to providing adequate space for the archives and Canadiana sections. This impasse was overcome when Dr. Corry sanctioned removal of the Memorial Hall, the bronze plaque and the stained glass windows to be re-erected in the Students Memorial Union. Once this decision had been made, it became possible at once to proceed with plans for the functional integration of the old and new wings. A library is not simply enclosed space; all library areas are inter-related and if their physical relationship is ill-considered or non-functional the whole library operation suffers.

We had early decided that the entire book stock would be moved to the new stack area and that the two stack levels remaining in the old library would house the government documents collection, to be transferred from the basement of Sir John A. Macdonald Hall. Thus, as soon as spring examinations were over, a team of students under supervision of the Circulation Department began shifting books while workmen were still putting the finishing touches on the new stack area. Once the books were in the new wing, the public and technical service departments quickly followed.



West front: the old library (right) and the new wing



WALLACE R. BERRY

East front: the terrace and entrances to the old and new wings

At the time of writing, the old Douglas Library has been almost completely vacated, and a major reconversion project is about to begin. Until this work of reconstruction is completed we shall still have to cope with make-shift arrangements. The new main floor reading room, for example, now houses the cataloguing and acquisition divisions while the Chief Librarian occupies what was designed to be a student typing room.

Half a million dollars and ten months later, the new, integrated and fully modernized university library will, we hope, be officially declared open and a new era will begin.

H.P.G.

A Leavening of Leacock

AMONG the papers of Canadian writers in the Douglas Library archives, there are about thirty letters, a single essay and a poem from the pen of Stephen Leacock. It is a small garner compared with the riches of Old Brewery Bay and the Redpath Library but not without interest for lovers of Leacock and light verse. The author may be a short-distance man in the Literary Correspondence Stakes yet even a hurried note (see illustration) bears the imprint of his vigorous personality.

Some of the letters touch on Leacock's appearances on the Queen's campus. On University Day, Oct. 16, 1919, the Senate conferred upon him the honorary degree of Doctor of Laws; after the event, he wrote to Principal Bruce Taylor (Oct. 25): "May I take occasion to tell you how very deeply gratified I was—and am (and will be)—at the honour you did to me. I was glad that it fell to my share to speak in a foolish vein for I think that if I had started out to express in seriousness what I felt, I might have got maudlin about it."

His remarks were only briefly reported, although the *Queen's Journal* gives us a glimpse of "Dr. Stephen Leacock hunched up over his plate" at the Convocation dinner, then rising to address the gathering "with his cigarette in his hand and 'give-'em-what-they-expect-no-matter-what-it-costs' written all over his face."

The *Kingston Standard* noted Leacock's reference to one of the other LL.D.s, the new Leader of the Opposition in the House of Commons:

> Professor Stephen Leacock of McGill University spoke briefly but long enough to convulse his hearers with laughter. He had been waiting all day to speak but couldn't get a chance. That did not mean there was nothing to interest him. Even Mackenzie King made a good speech for a Liberal*.

Leacock was no stranger to Queen's in 1919, although on previous visits he had usually spoken in a serious vein. Ten years earlier, he had addressed the Political Science and Debating Club on "Asiatic Labor in the British Colonies." On Feb. 15, 1911, the *Journal* published the full text of "What the Universities Can Do For Canada", a discourse delivered at an open meeting of the Arts Society in Convocation Hall. (Attacking "the virus of the yellow dollar", he said he wanted to see the time when the universities would "turn out some of those great people who cannot earn their own living.") And in a letter of Nov. 14, 1913, to Mrs. O. D. Skelton (one of four letters from Leacock to the Skeltons in the Douglas Library), he proposes to speak at Queen's on "Women, Children and the State".

In later years Leacock was an occasional contributor to *Queen's Quarterly*, thereby becoming a benefactor of this Library. On Dec. 28, 1938, he writes apropos of his valedictory piece on Sir Andrew Macphail: "I have endorsed the cheque in favour of the College Library and would like them to buy with it two or three of Andrew's books and have them suitably bound for the library, and to allow me to inscribe them." Another *Quarterly* article, D. D. Calvin's recollections of Prof. John Macnaughton, struck a responsive chord. Writing on Oct. 3, 1933, Leacock congratulates the author on "your delightful picture of 'John' . . . You certainly managed to 'put across' the Rabelaisianism of that great man up to the breaking strain of Presbyterian print."

There is evidence in the Lorne Pierce Papers that Leacock took a casual view of business correspondence. The replies he scrawled in the margins of letters from The Ryerson Press give the impression of a man dealing with a swarm of midges. But Peter McArthur's study of Leacock in *The Makers of Canadian Literature* series was welcomed in a letter of Jan. 11, 1923 to "Dear Mr. Ryerson" *(sic)*: "I am pleased and flattered to be included in your Series, and especially delighted to think that I am to be dealt with by Peter McArthur. I owe him a great deal of kindness and encouragement when I was first starting to write, which I can never forget. I may say that it was Peter McArthur who helped me to bring out my first book. Up to the time of meeting him I had really only done short, casual stuff."

McArthur's letters to Pierce indicate that Leacock was an elusive subject. "His silence continues to be abysmal," McArthur writes midway through his task. Later, however, he reports that "Stephen has come out of his silence" and has pronounced the completed manuscript "First rate. Fine. Excellent. Of course it is too flattering but I don't object to that at all. You have really made me seem quite an interesting character and I am correspondingly grateful to you."

More intimate are the letters to his friend and former McGill colleague, B. K. Sandwell, in the Sandwell Papers at Queen's. In 1925,

*The *Queen's Journal*'s compliment was also nicely-turned: "It is rarely that Queen's listens to as fine a speaker as the leader of the opposition. It was such a pleasure to listen to his easy oratory, his fine choice of words and phrases, and the fluent smoothness of his speech, that one almost forgot at times to grasp the meaning of what he was saying." (Oct. 21, 1919).

when Sandwell was hovering between journalism and an academic career, Leacock wrote prophetically (June 2): "I think that it would be your best plan to join the staff of *Saturday Night*: this would, I am sure, be very congenial work. I remember General Currie repeating with great gusto to a whole supper party at his house (last winter) some of your bright things about the standardiz^{n} of social life and I am sure that you have a wide public . . . If you can get a pretty good job with *Saturday Night* as a basis of operation for literary and journalistic work, take it."

The advice and the job were ultimately taken and on Oct. 7, 1932, Leacock sends the new editor congratulations on his appointment to *Saturday Night*—"and to them too." A veteran contributor to the magazine, he writes (Oct. 13, 1942) of "the long outstanding account of gratitude that I owe to *Saturday Night*. I remember as if it were yesterday instead of being 48 years ago when they first published my "Pathology of Clothes" and gave me a standing with the Medical World I have never lost . . . What kind of standing I am not saying."

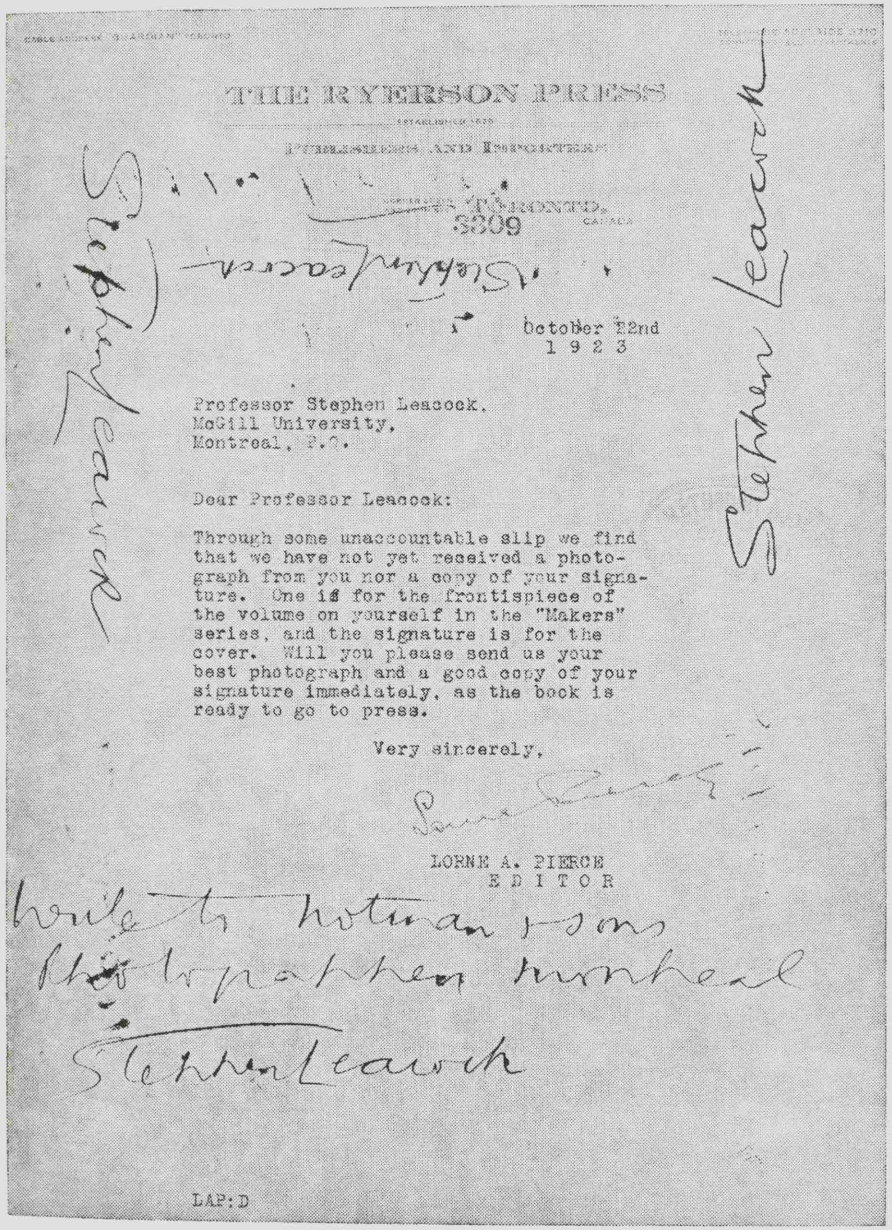
A year before his death, he thanks Sandwell (March 28, 1943) "for your letter and for your praise . . . as one gets old praise gets sweeter . . . especially from old friends . . . I read, with appreciation, all your stuff on the social outlook . . . things are pretty tangled, aren't they! You recall the American Patriot who was willing to 'sacrifice a part of the Constitution, and if need be the whole of it, to save the remainder'. That's where the moneyed interests of Canada ought to be now."

Two letters to E. C. Kyte, former Queen's University Librarian, and the curt letter of resignation from the Royal Society of Canada ("as a matter of personal economy") complete the Leacock correspondence in the Douglas Library archives. There is also the manuscript of a published essay, "Life's Minor Contradictions", and the piscatorial verses reproduced in this issue. The Rabelaisianism of the great man is evident here but hardly up to the breaking strain of contemporary print.

Salmagundi

RECENT additions to the Douglas Library's manuscript collection have had little in common but the unexpectedness of their arrival. They may be considered as the ingredients of a mixed dish such as the one that supplies our title (chopped meat, anchovies, eggs, onions and seasoning, according to the *Concise Oxford Dictionary*); or in another light, as windfalls. A few of them are briefly noted here, with the names of those who generously contributed to the stew or shook the tree.

Correspondence and other papers (originals and photocopies) of the astronomer Sir Arthur Eddington, containing material of historic interest in the development of astrophysics; the gift of his biographer,



THE RYERSON PRESS

PUBLISHERS AND IMPORTERS

TORONTO, CANADA

October 22nd
1 9 2 3

Professor Stephen Leacock,
McGill University,
Montreal, P.Q.

Dear Professor Leacock:

Through some unaccountable slip we find that we have not yet received a photograph from you nor a copy of your signature. One is for the frontispiece of the volume on yourself in the "Makers" series, and the signature is for the cover. Will you please send us your best photograph and a good copy of your signature immediately, as the book is ready to go to press.

Very sincerely,

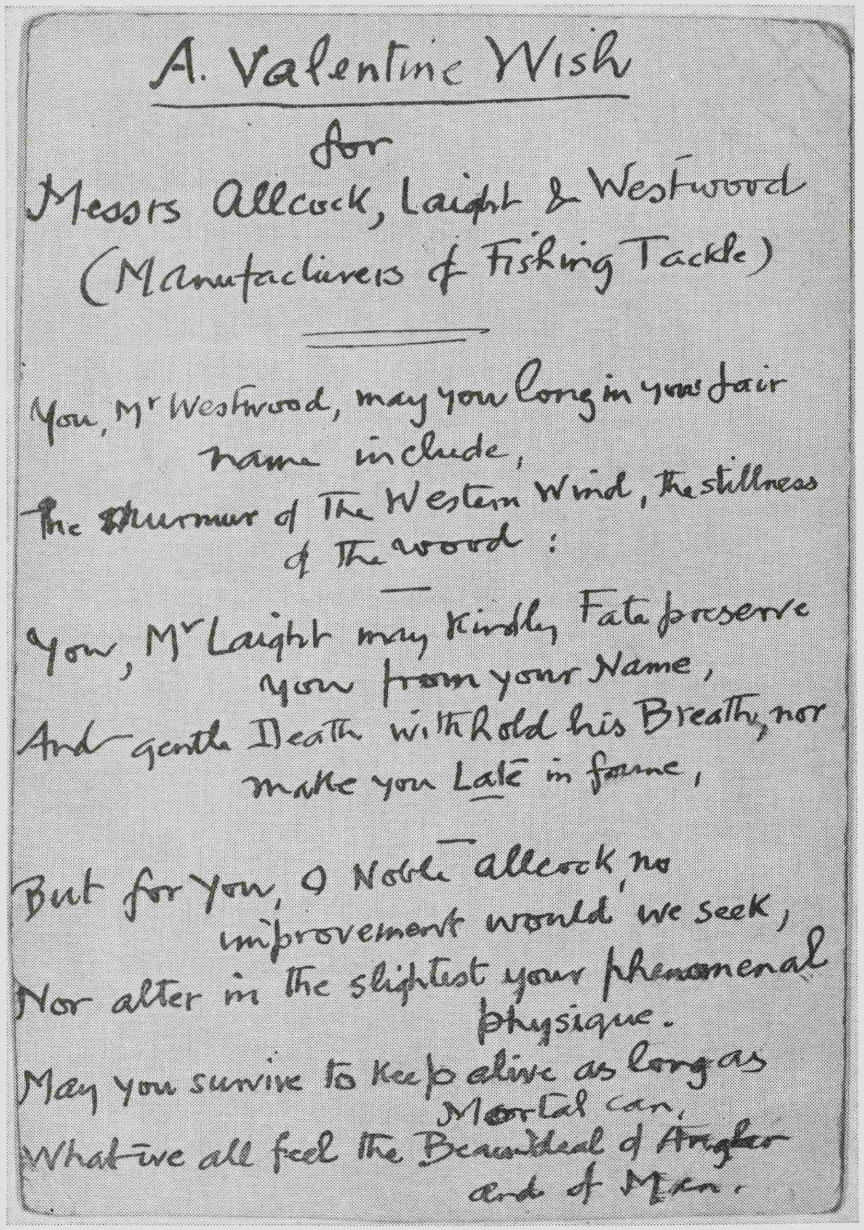
LORNE A. PIERCE
EDITOR

Write to Notman & Sons Photographers Montreal

Stephen Leacock

LAP:D

Professor Stephen Leacock supplies an autograph . . .



A. Valentine Wish
for
Messrs Allcock, Laight & Westwood
(Manufacturers of Fishing Tackle)

You, Mr Westwood, may you long in your fair
name include,
The murmur of The Western Wind, the stillness
of The wood:

You, Mr Laight may kindly Fate preserve
you from your Name,
And gentle Death withhold his Breath, nor
make you Late in fame,

But for you, O Noble Allcock, no
improvement would we seek,
Nor alter in the slightest your phenomenal
physique.
May you survive to keep alive as long as
Mortal can,
What we all feel the Beau-ideal of Angler
and of Man.

. . . and salutes the angler's friend (*Leacock MSS., Douglas Library*).

Dr. A. Vibert Douglas, Emeritus Professor of Astronomy, Queen's University, who has also deposited letters she has received from Albert Einstein, Bertrand Russell, Sir Oliver Lodge *et al.*

Letterbook (1830-49) of Benjamin Tett, pioneer merchant on the Rideau Waterway; a record of transactions in lumber, wheat and potash interrupted by alarums on the Rideau during the Rebellion of 1837-38; the gift of Mr. Edmund Tett of Newboro, Ontario (an addition to the Tett Papers).

Catalogue of the library of Rev. William Bell, first Presbyterian minister of Perth, Upper Canada; compiled in August 1817 on his arrival from Scotland and diversified by a series of recipes for grape, gooseberry, currant and alder wine, and "Porter for private use"; the gift of Mrs. C. C. Inderwick of Perth (an addition to the Bell Papers). Several volumes then catalogued were presented to Queen's College Library by the owner's son, Rev. George Bell, College Librarian 1883-88, and are now in the Douglas Library.

Letters from England of William Macaulay, later Anglican rector at Picton, to his family in Kingston, Upper Canada, 1816-18; a lively, independent-minded commentary on his experiences as an Oxford student and traveller in England, France and the Low Countries; deposited by Mr. A. R. Garrett of Oshawa, Ontario (an addition to the Macaulay papers).

The William Macaulay letters contain an early account—possibly the earliest extant by a Canadian—of a visit to the field of Waterloo. It reached us on the eve of the 150th anniversary of the battle (June 18) and we publish it here to mark the occasion. There is perhaps more of the 23-year-old Macaulay than of Waterloo in this exuberant narrative but as the writer disarmingly points out, on this occasion he himself was "the hero of the field". (With the possible exception of the Marquess of Anglesey and his illustrious leg.)

Letter from William Macaulay to his brother John, Oxford, Mar. 25, 1818†

I paused in the narration of my adventures I think at Waterloo. The morning after we arrived at Brussels, after having a simple but excellent breakfast, the first good one I had gotten among the ten thousand that I had passed through on the continent, we prepared to take advantage of the sunshine and devote the first day to a visit to the field of battle. My three comrades, whom I have already informed you I met at Paris, and overtook at Mons, and I hiring a cabriolet, or vehicle on four wheels with leather covering which may be removed at pleasure, and velvet cushions, set off at a round trot to Waterloo. In seeing a country good weather is everything—on that day we seemed to pass through a very good country, tho' wooded. Our route lay through the forest of Soigne[s] on a broad and excellent pavement covered as our guide told us on the days of action with

†The letter describes a journey of the preceding autumn.

every variety of bustle and distress. You may imagine with what ears and eyes of expectation we opened at the distance of half a mile ahead the church and little village of Waterloo. A few children, running up, received us before we were well out of the cabriolet with offers of bullets, buttons and other relics, real or pretended, of that battle—but as we were proceeding to the church our attention was drawn to an inscription which we saw on a stone tablet in a garden on the right and a willow which seemed planted over some departed hero in melancholy testimony of an early tho' glorious fate. It is the first memorial of death that rises on the stranger's sight at Waterloo—with admiration and reverence we approached it. I found on perusing a very indifferent epitaph that no gallant soul was slumbering there—it was only one of the legs of the Marquis of Anglesea. You may think as you sit in cold blood in Canada that we were shocked at such misapplied consecration— & that to our respect and veneration contempt and laughter succeeded. But we had caught the spirit of the place, and country, and no midnight monk ever visited the shrine of his tutelary saint with more reverence than we did this illustrious leg—nay more, we fairly went into the adjoining house and were there shewn the identical boot that was on the leg at the battle of Waterloo—but here was the ne plus ultra of our admiration. For about one quarter of an hour, I think, we experienced this deliquium [eclipse] of reason.

We hastened in the next place to the village church—a little plain building hung round with commemorative tablets of the officers of several regiments—but seeing nothing in the writing particular I did not note down any of the inscriptions. Passed the little tavern at which Wellington fixed his headquarters about as good a one as Jock Miller's at Cornwall. Bespoke dinner at what seemed a better one— & hastened on a mile and a half to the busy scene of action. The field, where the actual manoeuvres were made, is one finely diversified with easy hills intersecting each other at various angles—a noble place for a battle. After looking at a variety of things we stationed ourselves at the Wellington tree and there took a range of the whole. I can describe that better by words than writing so I refer you to myself on my return. At present I shall myself be the hero of the field. Kept on the main road till we got to Bonaparte's several stations—called in at the house La belle alliance and dispatched a few bottles of Rhenish wine, and some bread and cheese—ploughed [? slept] a little—went to the Chateau de Gomont [Hougoumont] and returned round by a different route— & when we had got into a snug hollow, where there was no probability of any one seeing or hearing us, we valiantly gave three grand cheers and after this feat made the best of our way to the dinner awaiting us, which by this time we had appetite to dispatch with as much alacrity as if we had ourselves been at the four days fight.

If the peasantry about Waterloo suffered by the battle, they have been amply remunerated since by the number of visitors who go daily there.

To Prof A Vibert Douglas
McGill University
Montreal
from O.L.

(*Reprinted from* NATURE, *August* 30, 1924.)

A Philosopher on Relativity.

By Sir Oliver Lodge, F.R.S.

At the twenty-third annual meeting of the Eastern Division of the American Philosophical Association, held at Brown University, Providence, R.I., in December 1923, a presidential address on "The Einstein Theory and a Possible Alternative" was delivered by Prof. William Pepperell Montague, professor of philosophy in the Columbia University of New York. In this address Prof. Montague shows himself to be a philosopher rather especially interested in physics; and he claims the advantage of having discussed certain aspects of the subject with Prof. Bergen Davis and other members of the physics department at Columbia. He reviews and criticises parts of the Einstein theory in a lively manner, thereby arousing interest among philosophers; and his contentions are deserving of notice.

Apparently Prof. Montague raises no objection to Einstein's General Theory, so far as it deals with matter and gravitation, and so far as it replaces the idea of force by the idea of space-curvature. He seems to consider these apparently diverse ideas as only different methods of expressing the same thing; much as you might say that it does not matter whether you represent an ellipse by drawing it, or by writing $x^2/a^2+y^2/b^2=1$. Both modes of expression represent the same thing. Some might hold that a picture is a nearer approach to reality than a formula, but both call up relevant ideas in the mind. Moreover, a picture,—which regarded from a strict point of view is millions of molecules of one substance superposed upon billions of another,—must depend helplessly on the human mind for recognising in it any of the properties of an ellipse!—must, in fact, depend just as much on mind for its interpretation as does the algebraic convention. After all, as regards precision of measurement, the mathematical rather than the pictorial presentation is the more explicit and accurate of the two.

I must make it clear that Prof. Montague expresses appreciation of pure mathematics and feels no philosophical objection to those more striking and revolutionary ideas of Einstein which were borrowed from the pure mathematicians. In the geometrical way of regarding matter and force, the infinite finiteness of the universe, the representation of impenetrable specks of matter as impassable distortions of space,—in all this Prof. Montague rather rejoices; as the following extracts will show:

". . . bodies moving with accelerated velocities are subject to forces, hence the later Einstein theory consists, first, of a new though Cliffordian conception of the nature of *force*; and, second (growing out of that), of a new though Riemannian conception of the *universe itself*, as a domain at once boundless and finite. . . .

"Some will undoubtedly feel stifled and penned in at the thought that if they were to travel in a 'straight' line for only a few septillions of miles they would find themselves on the way home without ever having turned around. Others will find the new Riemannian hyper-sphere large enough for all practical purposes; and they will delight in the possibility of relating in some curious way the curvature or size of the universe as a whole to the dimensions of its minimum elements."

Prof. Montague does not think that the hypergeometrical conceptions of reality need be upset by what he urges as failure in the simpler basis on which the original doctrines of relativity were founded—doctrines admittedly not so well established by actual *ad hoc* observation of predicted results as those of the more general theory have been.

"It is not, I think, too inaccurate to say that while the Special Theory reduces geometry to physics and is offensively destructive and phenomenalistic in its conception of the world, the General Theory reduces physics to geometry and its tone and temper are rationalistic and constructive. The muddy prose of Hume and Mach gives place to the clear poetry of Riemann and Clifford."

Prof. Montague goes on to pay a tribute to the late Prof. Clifford, with which, as an old student and junior friend of that remarkable genius, I cannot but sympathise:

"It was Clifford, working under the inspiration of the new geometry of Riemann, who, I think, first suggested that matter could be conceived as a non-Euclidian wrinkle in space. . . . It is pleasant to think that Clifford, whose mind was of such rare beauty and who in his appreciation of spiritual values possessed what the musicians call a sense for absolute pitch, should have been the first to hold a conception which now seems destined to have most far-reaching consequences."

So it turns out that Prof. Montague's criticisms are directed, not at the more recondite parts of the subject so finely developed and expounded by Eddington, but at its foundations as ordinarily expressed. His main objection seems to be to the Larmor-Lorentzian law for the composition of velocities, and to the absolute constancy of the velocity of light as supposed to be measured by different observers. He objects also to this velocity being regarded as a maximum velocity which cannot be exceeded. His view is that light is not really emitted and abandoned to a stationary ether, as a water splash is abandoned by a ship, but that light is continually associated with the lines or field of force belonging to and moving with the source,—somewhat after Faraday's idea of ray vibrations; an idea which, in modified form, has obtained weighty support of late, and about which it is best not to be dogmatic.

There has been a conspicuous tendency, of late, to revolt against the simplicity of the undulatory theory. Something more than that is evidently wanted. And incidentally I may mention that Prof. Benedicks, of the Metallographic Institute of Stockholm, has written an immediately forthcoming small book called "Space and Time," in which he supports some modification of the emission theory. With a corpuscular theory in empty space, the Michelson-Morley experiment would raise no difficulty at all, and probably would never have been performed; for the velocity of light would depend on the motion of the source, and everything would be simple. A similar simplicity is aimed at by Prof. Montague. He does not indeed propose a corpuscular theory—he sees difficulties in that,—but he is well aware that what he does suggest is quite alien, and indeed contrary, to the early parts of the Einstein theory. He adduces therefore simple imaginary experiments, akin to those so often appealed to by philosophic relativists, by which he thinks the Einstein view might be disproved. He realises the difficulty of doing anything effective with only two signalling observers, who must be dependent on inconclusive to-and-fro journeys, so he arranges a triangular duel, with a third observer, or rather signaller, equidistant from the other two.

Let there be two observers on the same parallel of latitude, with perfect signalling appliances and stop-watches, which, however they are affected by the rotation of the earth, must at least go at the same rate; and let there be a third signaller at the north pole, who by symmetry is able to establish simultaneity between the other two. At the word "Go!" from the pole, the two on the equator signal to each other, and time the interval between sending and receiving. Prof. Montague claims that, on the ordinary wave theory, and as he mistakenly seems to think on the Einstein theory, the one travelling to meet the signal should get it sooner than the one whom it has to overtake. For, as he says, even waves take less time to travel less distance,—. . . "even Einsteinian light travels a shorter distance in less time than it does a longer distance."

On the other hand, on a corpuscular theory there would be no observable difference, because the increased speed of the corpuscles from an advancing source would compensate for the recession of their recipient. So both Prof. Montague and Prof. Eddington would, I presume, expect a negative result; and the experiment would not discriminate between them. Unless, indeed, it gave a positive result, to the chagrin of both, and the triumph of a common-sense view based on the behaviour of ordinary waves.[1]

It will be observed, however, that Prof. Montague has abandoned translation, as hopeless for his purpose, and has utilised rotation; and about rotation there has always been something with a tinge of the absolute about it, even in relativity doctrine. But whether it is necessary to make this admission, in order to safeguard a positive result from Prof. Montague's imaginary experiment, is very doubtful. His own attitude is hostile to waves in a stationary ether, as well as to the less intelligible doctrine that every observer, at all times, must measure the same velocity for light; he does not actually sustain or mention a corpuscular theory, as Prof. Benedicks does,—and as apparently the Swiss genius Ritz did,—but his postulated entanglement of the waves with the field of the source comes to somewhat the same thing.

Prof. Montague goes on to attack the composition of velocities in a more direct manner, and likewise ridicules several curiosities of time measurement, including queer tales by rapid travellers with return tickets, cited from Eddington and Weyl; but concerning the hypothetical slowing down of physiological processes by motion, and other humorous interpretations of certain equations, I am not myself seriously sympathetic enough to justify my trying to sustain them against criticism.

Incidentally I note that he has a long footnote in which, by means of to-and-fro north and south signalling compared with the result of similar east and west signalling, he claims that we might distinguish between Einstein and Lorentz,—whatever that may mean. It looks as if he thought that Einstein discarded the β factor representing the FitzGerald-Lorentz Contraction (introduced by Larmor in 1900, "Æther and Matter," p. 173 *et seq.*, and vigorously used by Einstein), while Lorentz admitted it. Either I misunderstand him here, or he makes a mistake.

The alternative which Prof. Montague seriously proposes to the relativity treatment of light is not the corpuscular theory,—for, as he says, "light is in almost all respects wave-like rather than corpuscular"—but it is this,

". . . that the medium or carrier of light waves is not a doubtfully existent ether-substance, but the certainly existent field of force which each electron and proton carries with it."

He thus desires to abolish a stationary ether, as Einstein does not, and claims that because an electric field is centred on its charged particle, it follows that when a charged particle moves, its field must move with it.

"The velocity *in* the field will be constant and absolute, but the velocity *of* the field has to be added to it."

Thus he tries to combine the advantages of the wave and emission theories in this respect. But the full treatment is not so simple; a great deal is known about the way in which a field moves, and he would find himself immersed in plenty of complexities, unless he discarded electromagnetic theory altogether.

Finally Prof. Montague proposes an experiment to test his crucial assumption, namely, that the velocity of light is affected by the motion of the source, and is not independent of it as it would be in a stationary ether and as it is in Einstein's theory. His proposed experiment depends on rotation, again; and, to summarise it briefly, it employs the idea that light from the sun's advancing limb ought to come to us quicker than from the receding limb. His proposed rotator is not the sun, however, but a mechanical cylinder, sphere, or disk, projecting light from opposite points of its circumference, through a couple of narrow slits or tunnels, on to a moving sheet of sensitive paper. The slits or narrow tunnels are carried by a pair of drums, which are separated by a considerable distance and are revolving about an axis at right angles to the main axis and parallel to the path of the two beams of light. (He makes these drums revolve in opposite senses, but that is surely a mistake or a needless complication.) It follows that if they are revolving quickly enough, the light may be unable to get through both slits, because of the time taken in the journey between them, and he claims that with increasing speed the fading of the spot from one beam should precede the fading of the other. His experiment therefore is really a Fizeau-like experiment to measure the velocity of light, or rather to compare the velocities from two oppositely moving sources without the use of a mirror or any return journey: the fading and disappearance of the traces on the photographic film at a certain speed of rotation being looked for, and the times of fading compared. But presumably any mode of determining the velocity of light would serve: the essence of the experiment is not the mechanical details, which are crude, but the suggestion that it is possible to find a difference in the velocity of light according as it comes from the approaching part of a rotating wheel or from the receding part.

[1] May I direct attention to a clear pre-relativity description of all this class of problem, in an old volume of NATURE for 1892 (vol. 46, pp. 497-502, and also on pp. 164 and 165; the latter with a misprint of θ for ϵ in two places).

Well, that is a definite suggestion for experiment, if any one really thinks it likely (as I do not) that the velocity of light depends on the motion of the source: though it would seem as if measuring the velocity of light from an approaching and receding star would be more likely to decide the question. At any rate, the difficulties encountered by employing a non-terrestrial source would be of another order. Prof. Montague fears, however, that a final entanglement of the light in the fields of atmospheric matter might interfere with a correct determination of velocity from an astronomical source. It might also be argued that the known Doppler effect, depending on stellar advance and recession, gives a relative frequency accurately calculable on the basis of a constant velocity for light, and that to supplement this by the peculiarities of a projectile kind of light would be merely perturbing. To this he would doubtless reply that a fair and square initial consideration of light as projected from its source will give the Doppler effect and explain the M.M. result with perfect ease. He might also claim, perhaps, that his variety of ray-wave would evade the usual Foucault objection to emission theories, and might give the Fizeau result in dense substances as well. These things are not elaborated in his paper.

But now—seeking what can be politely said in support of any of his contentions—it must be admitted, I think, that the relativity explanation of the Doppler effect can be made to look as if it had a weak point. Algebraically it comes out right, of course, but it has too much the air of the ordinary explanation, which attributes an obvious meaning to $c \pm v$. The ordinary explanation, for an observer approaching a source, is simply that the observed frequency increases in the ratio

$$\frac{n}{n_0} = \frac{c+v}{c}$$

by simple composition of velocities: which is still Professor Montague's, and used to be everybody's, argument. But, with the relativity law for compounding velocities, deduced from Larmor's transformation, this so described ratio would be unity, and there would be no Doppler effect at all if it had to depend on an apparently changed speed of arrival of the waves. Relativity, however, does not attempt to proceed by compounding velocities for the purpose of explaining the Doppler effect: it knows that c cannot be added to or subtracted from, by anything a source or an observer can do; so it simply applies the Larmor-Lorentz transformation to the space and time periodicities of wave motion, and deduces algebraically

$$\frac{n}{n_0} = \sqrt{\left(\frac{c+v}{c-v}\right)}.$$

Neglecting v^2/c^2 this has the same value as the ordinary expression above, and no experiment yet made can discriminate between them. But am I wrong in imagining that a relativist would dislike writing it in that form and would prefer the expression

$$\sqrt{\left(\frac{1+v/c}{1-v/c}\right)}?$$

For this, though identical, conveys no inappropriate suggestion of compounded velocities.

In conclusion, it is always satisfactory when controversialists can get up against a question of fact. Stripping it to bare bones, we may put these two questions:

(1) Does the velocity of light really depend on the speed of its source?

Wave theory, Einstein theory, ether theory, all say "no." Corpuscular theory answers "yes": and Prof. Montague's adopted conception of a ray vibration also, in his opinion (but as I think doubtfully), answers "yes."

(2) Does the measured or apparent velocity of light depend on the motion of an observer?

Corpuscular theory, and Prof. Montague's theory, reply, "Yes if the source is stationary," "No if the source is moving with the observer." Ordinary wave theory would say "Yes in any case," for what the source is doing does not matter; that can only affect wave-length, not speed. Einstein's theory would loudly say "No in any case": for if one could discriminate between motion of observer and motion of source, relativity as commonly stated would be upset, and attention to a stationary ether would be made inevitable. Experiment so far has declined to answer: for a to-and-fro journey involves squares and can be dodged. So then at present we have no discriminating reply, unless an answer in favour of Einstein is to be taken as implied by the general consistency and sufficiency of his theoretical results both old and new.

One who is impressed with the mysterious way in which the Larmor-Lorentz transformation thoroughly formulates all known results without any trouble or hesitation, and yet who is not helped thereby to form a clear physical conception of the process, might urge that to clinch matters an experiment is desirable which should aim at determining $c \pm v$; when v is the speed, not of source, but of observer. That is, an experiment is wanted which would measure the speed of an observer relatively to light, and therefore relatively to a stationary luminiferous medium. Direct determination of the velocity of light at different seasons of the year, by any method, would at first sight seem able to settle this question, provided an accuracy greater than one in ten thousand could be attained.

But consider this further. A fixed space-interval and a time-keeper constitute the real observer: the FitzGerald contraction does not depend on whether motion is positive or negative, nor does direction of motion affect the rate of a clock. Hence if the experiment is made now and six months hence, x/t will equal x'/t', and no difference in the speed c will be perceived.[2] That seems right from one point of view; and yet, physically, waves *ought* to travel down an ether stream quicker than up, unless group velocity has something objectionable to say.

To sum up the position, still in an interrogative

[2] Because $\frac{x'}{t'} = \frac{x/t - u}{1 - ux/c^2t}$, which equals c if $x/t = c$, and not otherwise.

manner without dogmatism:—change of frequency depends solely on relative motion of source and observer: combined motion of both through a medium does not affect frequency on any theory, so long as the motion is steady. Ordinary aberration is wholly and solely caused by motion of observer relative to path of ray. Is observed velocity of light dependent on motion of observer, too? The strength of the relativity position is that no way of performing the experiment is likely to give a positive result, unless truly relative motion is introduced, as by mounting the whole receiver on the end of a revolving arm; and questionably even then. The strength of the ether position is that a relative ether stream past fixed "stations," though undemonstrated, is at least not negatived by this or any other experiment, and may therefore nevertheless be a reality. A philosopher may be able to explain what "reality" means.

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*