



CLASSIC LIVING BOOK

THIS WONDERFUL
UNIVERSE

Agnes Giberne

COMPLETE AND UNABRIDGED

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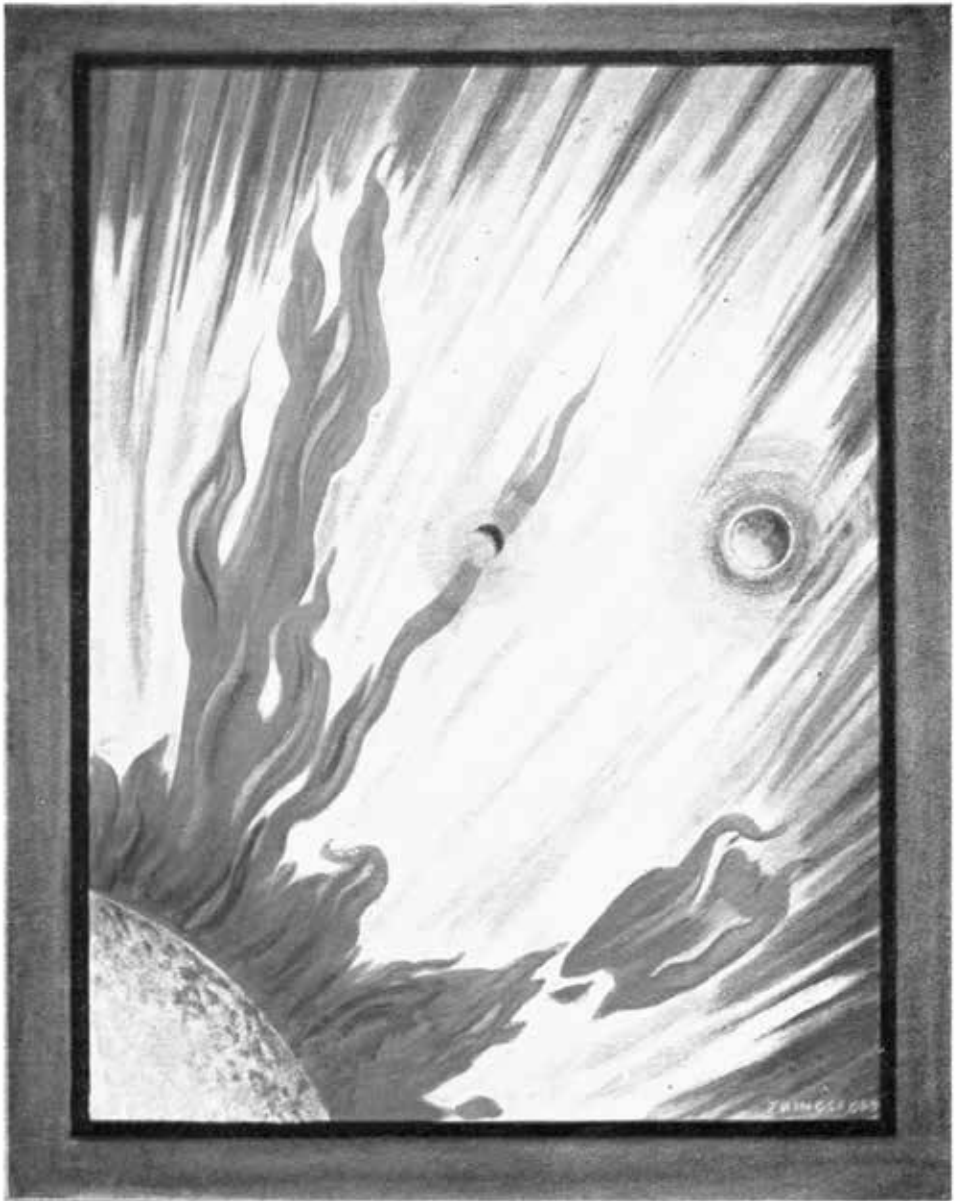
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This Wonderful Universe

by

AGNES GIBERNE





COULD THE SUN APPROACH TO WHERE THE MOON IS, THEN AT ANY INSTANT GREAT CRIMSON "FLAMES" OF HYDROGEN GAS MIGHT LEAP FORTH AND ENWRAP OUR LITTLE EARTH IN THEIR FERVID EMBRACE.

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FOREWORD TO NEW EDITION

MANY years ago, a small volume under this title was published by the S.P.C.K. When a letter came, asking me to revise it for re-issue in an illustrated form, I speedily found that to “revise” meant to “re-write.” And re-written it has been during the past few months, with abundant omissions and still more abundant additions. Except possibly here or there in the first few pages, I doubt if a single sentence has kept its old form unaltered. And though, in the main, I have roughly followed the outlines of my former plan, it has been largely reconstructed, and very many of the chapters are entirely new.

I have to express my grateful thanks to Mr. W. H. Wesley, Assistant Secretary of the Royal Astronomical society; Mr. E. Walter Maunder, F.R.A.S.; Professor H. H. Turner, F.R.S., Director of the University Observatory of Oxford; Professor E. B. Frost, Director of Yerkes Observatory, Wisconsin; Mr. Harlow Shapley, of Mount Wilson Observatory, California; and others, for most kind help given in the work of re-writing, by their ready response to inquiries on my part about difficult questions and new developments.

My thanks also are due to several poets of the present day, whose names will be found here and there, as well as to their publishers, for leave kindly granted for the use of their poems both in this and in a companion volume on the subject of Plant-life, which is to appear a little later. So, while the latter will be about flowers on our Earth,

this one is about more flaming blossoms in the Garden of the Skies.
As wrote Erasmus Wilson, long ago -

“Flowers of the sky; ye too to age must yield,
Frail as your silken sisters of the field.”

In both books, I have given quotations not only from modern poets but from many of bygone generations. It is always interesting to note the manner in which great scientific truths are received by widely differing minds, gifted with poetic insight. Perhaps not least so with writers of a past age, when that which was known, alike of life on our small world and of conditions in the great Universe, could hardly be compared with what is known to us now.

AGNES GIBERNE.

PART I

**OUR OUTLOOK
FROM EARTH**

I. - A RAPID WHIRL

ONCE upon a time, a man is reported to have said: “Don’t tell *me* that the world goes round. I know better. ‘Cause why? When I get up in the morning, I see the very same view all round as when I went to bed.”

That man, at all events, thought for himself, which is better than not thinking at all, even though his thinking led to a mistaken conclusion. And the reasoning was not out of place. Nay, he had hold of an important truth; only he used that truth wrongly.

He grasped the fact that a man, going from one spot to another, must from time to time have different things about him. If he walks, the changes come slowly; if he travels by train, they arrive more quickly. In any case, he cannot pass onward, hour after hour, moving among objects which do not move, and still see the same houses, the same trees, the same fields, the same hills. As he advances, he leaves the old surroundings behind and finds himself amid new surroundings.

The man, of course, knew this. Though not learned in scientific matters, he had his share of common sense. When somebody told him that our solid old world was not, as he supposed, quietly at rest, but was incessantly twirling like a teetotum, he began to use his common sense.

He knew that when he went to bed at night, he could see certain objects in the country around; and he knew that when he woke up in the morning, he would find those same objects, each in exactly the

same position. Then he put two and two together and decided that the notion of the Earth spinning must be a mistake.

“Don’t tell *me*,” he said. “I know better!”

And all the time, he was himself making a curious mistake. Up to a certain point, his reasoning was not incorrect; but he looked in the wrong direction for the changes of scene which he rightly considered ought to come about. And rather oddly, while taking it for granted that *he* would move with the moving Earth, he does not seem to have faced the probability that other objects on Earth’s surface would do the same.

It never occurred to him that not only his own little house and garden and everything in them, but other houses with all that they contained, and trees and fields, hedges and ponds, hills and valleys — one and all must be carried onward just as fast as the surface of the Earth was moving. Otherwise, if everything were left behind by that rushing surface, it would mean a complete and terrific jumble of destruction.

Naturally, therefore, the view before his eyes each morning had to be the same as his view of the evening before.

When a man in a railway carriage is borne along at the rate of fifty miles an hour, all that is inside that carriage travels at the same pace. The cushions, the seats, the people, the luggage, the fly on a windowpane, the air which fills the compartment — all are journeying at fifty miles an hour. And when a traveller wishes to find a changing scene, he must not fix his gaze on the floor, or the seats, or on a fellow traveller. He must look *outside* at the fields, the trees, the houses, the villages seen through the windows.

This is just what one on Earth must do if he would discover the movements of our globe from changes in the scenery. He must look right outside, away from Earth altogether; not at the things on our world, which move with the Earth as he does himself. And that is exactly what the man did not do. He looked only at the things around, all journeying with himself, and he forgot to gaze away *outside*, away from the hurrying surface of the solid globe on which he stood.

“Ah, yes,” perhaps you may say. “He ought to have looked right off

from everything on the ground. He ought to have watched the clouds. Then he would have understood.”

No; not even then. That would have meant a second mistake on his part.

It is true that he would not usually find precisely the same clouds as the evening before, because clouds are perpetually altering their shapes, melting away, reforming, taking new outlines. But these changes in them would be real. They would not be *seeming* changes brought about by his own movements.

The clouds would have travelled onward, as he did himself, with the Earth's surface. They might be blown hither and thither by currents of air; but *as a whole*, they would have been carried from west to east by the steady whirl of the entire atmosphere, which moves with the surface of the Earth.

So if the man wished to get a really outside view, he would have to look beyond the clouds, beyond the great deep ocean of air, which really is a part of our Earth. He would have to lift his gaze into the sky, where float the Moon and Sun, the planets, and the stars. Then, at last, he would find scenery which seems to change, like the objects noticed out of a rushing train — objects which often cannot but seem to move, if this world really does move, because they are not a part of the Earth, as air and clouds, hills and towns, fields, rivers, and oceans are.

“Now glowed the firmament
With living sapphires; Hesperus, that led
The starry host, rode brightest, till the Moon,
Rising in clouded majesty, at length
Apparent queen unveiled her peerless light,
And o'er the dark her silver mantle threw.”

MILTON: *Paradise Lost*.

II. - HEAVENLY BODIES.

The first and simplest idea which a child generally has of Earth and sky is of a wide, flat plain, and of a fixed sky above, with clouds and a sun in it by day, and a moon and stars in it by night. Stars always at night, when the sky is clear; and a sun always by day, unless hidden by clouds; but a moon not always after dark.

So much as this, an intelligent child might be expected to find out for himself, even if not told. And the first men who inhabited this Earth must have seen such things very much as an untaught child now would see them. Probably this was the idea in the mind of the man who could not believe that the Earth revolved.

But suppose that, instead of making up his mind in such a hurry, he had taken time to watch and to think. Suppose he had glanced away from Earth to the heavens, far beyond cloudland; had looked, not once or twice only, and not carelessly, but day after day with attentive and earnest eyes. Suppose he had kept this up week after week, month after month, even year after year, trying to find out what changes in that heavenly scenery might mean.

He would see what already he knew — that the Sun, each morning, comes up from below the easterly horizon, crosses the sky — higher up or lower down at different seasons — and goes down below the westerly horizon. He would notice that the Moon, by night, when visible, does much the same; rising somewhere in the east, crossing part of the sky, and setting somewhere in the west.

He would find the stars also to be on the move, many of them, like the Sun and Moon, rising in an easterly direction, crossing the sky, and setting in a westerly direction. A certain number, toward the north, are never seen from our part of the Earth to set but keep circling round and round a certain point.

Then, if left to himself, with no books or teachers and no help from the thousands of years during which other men before him have watched, waited, studied, and found explanations, he would doubtless fall into the same mistakes that men of ancient days fell into long ago.

He would feel sure that this flat Earth, on which he had a footing, which feels so firm and solid, must certainly be at rest. Therefore, he would feel no less sure that the whole sky, with Sun, Moon, and hosts of stars, must be whirling round and round our Earth, once in every twenty-four hours.

That would indeed be a tremendous feat for the heavens to perform! Wonderful things are done in the sky, but nothing quite so utterly and hopelessly beyond all human imagination as this!

Only, in far-back days, it was not beyond imagination, because men then knew so very little of the real size of our marvellous universe or of the enormous numbers of stars contained in it, or of the stupendous distances which divide its stars one from another. To the mind of a man in those times, it was much more difficult to imagine that our world could spin day and night like a huge top than that the entire heavens should perpetually whirl round and round us.

Of the two explanations, one had to be true; and it was just a question of which was the easier to accept. Men believed that which seemed to them the simpler.

Now that we know better what would be meant by such a whirl, we realise how much simpler and easier the explanation is, founded on the idea of our small Earth's daily turning on her own axis.

Astronomers gradually discovered that many other bodies in the sky — the Sun, for instance, and the planets — are steadily spinning or revolving, each on its own axis, some more quickly, some more slowly. Examined through a telescope, they are clearly seen to do so. And

if other bodies, many of them far larger than this world, are known to behave thus, why not the Earth also? The idea, far from looking impossible, has become an everyday fact.

When once we grant that our world is ever spinning round and round, carrying with her everything on and near her surface, then the daily movements of the Sun, the nightly movements of the Moon and stars, are explained. We see them *seem* to move merely because we ourselves are moving. We see them *seem* to come up from the east and go down in the west because we on Earth are being carried from west to east. It is much the same as when a man, journeying in a train from north to south, sees trees, fields, and villages appear to travel from south to north.

Not that this particular movement, this daily whirl of our Earth, is her only movement! And not that the Sun, Moon, planets, and stars have no real movements of their own! But just now, all we have to do with is the fact that the daily and nightly whirl of the skies around us is not real. It is only an appearance, brought about by the ceaseless spin of our small Earth. Other movements may be left alone for a while.

“Mysterious Night; when our first parent knew
Thee from report Divine, and heard thy name,
Did he not tremble for this lovely frame,
This glorious canopy of light and dew?”

“Yet ‘neath a curtain of translucent dew,
Bathed in the rays of the great setting flame,
Hesperus with the host of heaven came,
And lo, Creation widened in man’s view.

“Who could have thought such darkness lay concealed
Within thy beams, O Sun? Or who could find,
Whilst fly and leaf and insect stood revealed,
That to such countless orbs thou mad’st us blind?
Why do we then shun Death with anxious strife?
If Light can thus deceive, wherefore not Life?”

BLANCO WHITE

III. - THE SHAPE OF OUR EARTH

A man standing on the equator is carried, in the course of twenty-four hours, right round under the entire heavens. If he were gazing through all those hours steadily up into the sky, he might view the whole landscape of stars visible from this world — but for one hindrance. That hindrance is the radiance of sunlight, which in daytime shuts off the dim flicker of starlight. Could he cover up the Sun, and so secure twenty-four hours of darkness, he might survey all at a single stretch.

Not that the heavens would journey round him while he stood on a fixed and motionless world, but that he, on the whirling surface of our revolving globe, would be carried round swiftly under each part of the sky in turn, travelling always from west to east.

But a man standing farther north or farther south, and not on the equator, would not gain so full a view. Portions of the heavens would be hidden from him by the intervening solid body of the Earth.

There are many stars over the region of the south pole, which we in Britain and in other northern parts of Europe and North America can never see. And there are many stars over the region of the north pole, which people in southern Australia and south Africa can never see. It is only from the equator that a man might obtain a complete view.

Since the Earth is not, as was once supposed, a flat plain reaching to endless distances, but a round globe or sphere, its surface curves away from us, wherever we happen to be, till it passes out of sight at the horizon line. The curve is very gentle, but it is found in all parts of the world alike.

A very interesting proof of the round shape of our Earth is given in an eclipse of the Moon.

Sometimes, in our yearly journeying around the Sun — this is another of the Earth's movements — we pass exactly between the Sun and the Moon so that the three bodies are in a direct line. More often, it happens that either the Sun or the Moon is just a little higher or a little lower, and then the three are not in a line. But when it does so come about, the Sun casts a shadow of the Earth upon the Moon. And since the latter shines only by reflected sunlight, she at once becomes dim.

And — note this! — the shadow thrown by our Earth is a *round* shadow. As the grey shade creeps slowly over the bright Moon-face, it is always a *rounded edge* which moves onward. No matter which part of the Earth casts its shadow, the result is the same. England, India, Australia, America — these or other countries may face the Moon; but invariably the creeping shadow is round in shape, and the back edge following is round also.

If you hold up an orange between a lighted lamp and the wall — rather near the wall, and not too near the lamp — you will see that the shadow thrown by it is a round shadow. Turn it about as you will, offer one side after another to the lamp, and still the shadow will be round.

Then hold up a flat plate to the lamp, and you will find that the shape of the shadow depends on how you place it. In one position, and one only, it will cast a round shadow. In others, the shadow will be more or less oval; while, if you hold the plate *edgewise* towards the lamp, the shadow becomes only a straight, broadish line.

Do you see how strong a proof is given here as to the shape of the Earth? And it is one that comes again and again, every time we have an eclipse of the Moon.

And now about the size of the little world on which we live.

If a road could be made straight through its center, from one side to the other, perhaps on the equator, such a road would be nearly eight thousand miles long. A carriage drawn by quick horses, going at the rate of ten miles an hour, never lessening speed by day or night, might accomplish that distance in thirty-three days, or just over a calendar month. A train or a motor car, traveling fifty miles an hour, without a single break, might do the same in less than a week.

But with horses and engines, not to speak of passengers, halts are needed. And when we romance about going down into the Earth and out on the further side, in any such fashion, we are talking about an unknown region. The outside surface of our globe is more or less familiar; but not the inside.

A recent statement gives as the greatest depth of a mine ever yet sunk "the No. 3 shaft of the Tamarack mine in the county Michigan," which "reached a vertical depth of about 5,200 feet," that is, slightly under one mile. A mere scratching of Earth's crust! Even if we suggest a larger margin and say that no mine has reached a depth beyond two miles — what are two miles compared with eight thousand? True, parts of our ocean bottoms lie six or even seven miles below the ocean surface; but those depths are far beyond our reach.

Imagine what it would mean to delve four thousand miles below the surface of our Earth; four thousand miles away from light and air; nearly four thousand miles beneath our oceans. And to complicate matters, the inside of our world is believed to be intensely heated; so much so, according to one authority, that about thirty miles down the heat must be great enough to melt all solid rocks. If they are not there in an actually molten state, it is only because the immense pressure tends to keep them solid.

Such a road would indeed utterly dwarf the grandest engineering works of man.

Though a road of this kind is impossible, and though we cannot hope ever to dig or blast our way downwards until the opposite side is reached, yet the actual size of our Earth has been again and again reckoned. The size of any globe, both through the middle and around

the outside, may always be found out from careful measurements of parts of its surface. The work of surveyors comes in here, and such measurements have been made countless times, with calculations worked out from them.

We now know, as a matter of certainty, that the Earth is about eight thousand miles through from pole to pole or from side to side straight through the center, and about twenty-five thousand miles around at the equator.

By the “equator” we mean an imaginary line around the Earth, halfway between the north and south poles. And when we speak of the north pole or the south pole *in the heavens*, we mean always that point in the sky which lies just over our Earth’s north pole or our Earth’s south pole.

With regard to the shape of our Earth, it is, as already stated, a globe or ball. More strictly, it is like an orange, since it has slightly flattened poles. In scientific language, the Earth is an “oblate spheroid;” and in connection with this term, a little scene of past days comes to mind.

My father one day was showing cube shapes to two little girls, aged about nine and seven, explaining their names and uses. In a corner of the room, their small sister, only three and a half or possibly as much as four years old, was seated on the floor, playing happily with her toys.

Presently, to see how far his explanations had been understood, my father asked a question or two, and among them, “What is the shape of our Earth?”

Seven-years-old and nine-years-old tried to remember. But the baby in the corner, busied with her dolls, had listened to some purpose, and the pause was broken by a sweet little treble voice piping out — “An *oblate spheroid*, uncle!”

My father’s surprise and amusement may well be imagined.

And perhaps I cannot do better than mention here how deep is my debt to that dear father for his early lessons in science; lessons which familiarized me as a child with scientific modes of thought and expression; laying a firm foundation, upon which a superstructure of further study could so easily be reared. It was he who first awoke my

interest in such subjects; he who made Astronomy a living force in my imagination.

The teaching must have begun very early, for I well remember standing by his side, one wintry day, when I was certainly not more than seven or eight years old, asking why and how it could be that we were nearer to the Sun in winter than in summer, and yet were colder. A fire was burning, and he sat not far off. I can see now his fine, stately figure, the short-froaked child standing *by* his side, and the gesture with which he pointed to a fly on his knee. "See — if that fly were *one* inch nearer to the fire, would it feel any hotter?"

No; it would not. I understood that instantly; and though the real cause of summer and winter in the slant of Earth's axis did not become evident until long after, I did see then, with daylight clearness, that the difference of three million miles, compared with the Sun's whole distance, was no more than that one inch in the fly's distance from the fire. There was no need to ask more.

"Heaven's ebon vault,
Studded with stars unutterably bright,
Thro' which the moon's unclouded grandeur rolls,
Seems like a canopy which love has spread
To curtain her sleeping world."

P. B. SHELLEY.

PART II

**STUDYING THE
HEAVENS**

I. - GROUPS OF STARS

LIKE every study, that of Astronomy has to be from small beginnings. To start with a difficult textbook or with hard calculations would, in most cases, have no good result.

It is a study which ought to be followed on two lines at the same time. Much can be learnt from books; much also from actual observation of the sky. A beginner may choose one plan or the other; but the better mode is to use both plans.

Without books, a student of the skies stands in much the same position as an ancient astronomer of Chaldean days. He has to find out for himself those things which have taxed the minds of men through centuries. And without some amount of watching of the heavens, the known facts which may be learnt from books can never be quite so real to him if he does not use his own eyes to verify them, to the small extent which lies in his power.

Some teachers of astronomy prefer to start with the distant stars and work their way back to such heavenly bodies as lie nearer to Earth. Others think it wise to tackle first the nearer bodies and gradually wander farther afield. For instance, we may begin with our closest neighbour of all, the Moon, and with our brother and sister worlds, the planets, and with the great head and center of our system, the Sun; afterwards passing on to the stars.

But even from the first, we cannot ignore the stars. Night by night,