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THE HILARIOUS UNIVERSE



The Hilarious Universe

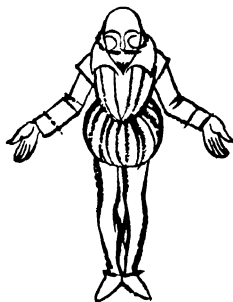
BEING ANGELA'S GUIDE TO
EINSTEIN—AND *THAT* CRUSH

By
RICHARD DARK
—
Pictures by
THOMAS DERRICK



BASIL BLACKWELL
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1932

By the same
DARK and DERRICK



SHAKESPEARE —
AND THAT CRUSH

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to English Literature

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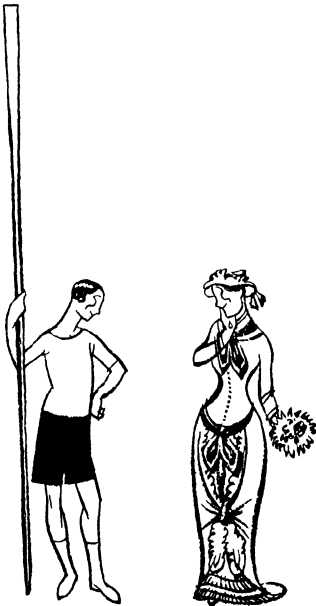
DEDICATED
WITHOUT PERMISSION
BUT
WITH THE DEEPEST RESPECT
TO
THE ASTRONOMER ROYAL

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TO BEGIN WITH

BENEATH the surface, Angela, girls of to-day are in essentials the same creatures that girls have always been, as may readily be seen (and heard)



The same creatures

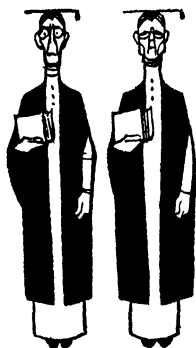
whenever a few of them are gathered together. We still refer quite naturally to 'a giggle of girls,' just as

we do to 'a covey of partridges' or 'a gaggle of geese.' Their outlook on the World, however, is very different



Women novelists

from that of their predecessors of a generation or so ago.



Women dons

At the end of the reign of Queen Victoria of blessed memory the Wench Revolution (or He-Mancipation of Woman) had not yet devastated Great Britain. Nearly all the liberal professions remained the monopoly of man. Of course there were women novelists—when have they not been with us?²—and there was a sprinkling of women dons (who were compelled to wear blue stockings which no one ever

saw¹) and of women doctors; but the sex did not

¹At that time, Angela, a maiden who showed a leg was called 'fast'; but however fast she may have been her grand-daughters easily out-strip her to-day.

practise as solicitors, auctioneers, cabinet ministers or policemen. Some gently-athletic young ladies played a



Athletic young ladies

tightly-corseted form of lawn-tennis; here and there little groups of the more desperate were beginning to



The more desperate

break out into hockey. That was their sporting limit. In other ways, too, they were less advanced. They never bathed in anything bolder than a blanket;

cigarettes were smoked only up bedroom chimneys; no vision of a cocktail had as yet flitted across their wildest dreams.

Female education was sound but limited. It comprised



Timid glance



mathematics up to Rule of Three, with an occasional timid glance at the isosceles triangle; geography, with special reference to the tributaries of the Yorkshire Ouse; historical anecdotes belying the true characters of Alfred the Great and Wat Tyler; the subjunctive mood of the more obsolete

irregular French verbs; science as far as H_2O ; Shakespeare, Scripture and the current lyrics of that simpler day. The last three were studied with great thoroughness. The statement has been made—and we may well believe it—that 95 per cent. of the girls of the English upper, upper-middle, dead-middle and lower-middle classes who left school in the year of Victoria's second jubilee were on terms of close intimacy with *The Merchant of Venice*, had recited (with tears) Mrs. Heman's masterpiece, *Casabianca*,¹ and could not be caught out over Chushanrithaim² or the cost of the cloak-rooms in Solomon's Temple.



With tears

¹Also, in some regrettable cases, variants of this poem (without tears). Girls will be girls.

²Judges.

Well, Angela, we have changed all that. Not without a struggle. Tradition



Hopelessly opaque

dies hard and the minds of parents and head mistresses are often hopelessly opaque. We ourselves seem to remember a time when rugby football still ranked merely as an 'extra' in the most up-to-date ladies' seminaries, and when it was a moot

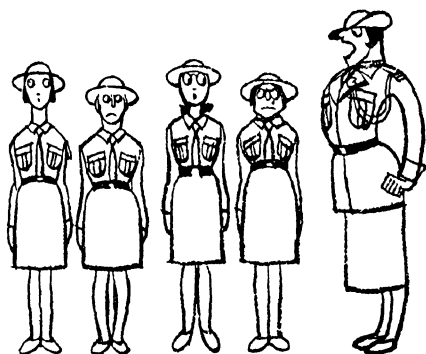
question whether the daughters of the more evangelical clergy should be told what a conic section really was. At last, however, girls have come into their own. No knowledge is withheld from their eager gaze; the World is at their feet. Setting formal education aside, let us consider



Milk a cow

for a moment just a few of the everyday activities of that vast and growing sisterhood known as the Girl Guides. An average G.G. of sixteen is required to be ready at a moment's notice to milk a cow,

form fours,¹



run a hotel,

use a theodolite,



¹Given the necessary quorum.

knit a pair of stockings without help over the heels,



build a bungalow,



extract teeth and



Operate for appendicitis

operate for appendicitis.¹ She must have read six books which are 'real literature.'² She must be able to distinguish between rooks, ducks and five other British birds, whether at rest or on the wing (and between their eggs—at rest); to spot in three



Real literature

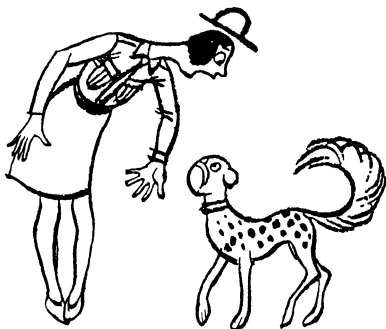


Able to distinguish

¹In the event of the patient's ultimate recovery a bar is here added to the proficiency badge.

²Any best-seller written before the year 1900.

guesses four of our commoner trees and four breeds of dog, by either foliage or bark; to throw a cricket ball fifteen yards and catch it at three. Is there anything these girls cannot do?



Four breeds of dog

Of course, you know all this, Angela, you're a Guide yourself. Never mind; we had to jot it down for the sake of the argument, to lead up to the real point we want to make and which we are now rapidly approaching.



Studying the modern girl

After studying the modern girl from all possible and some impossible angles, we venture

with great diffidence to suggest that there is one point at which she is not completely armed. We have questioned many of her, including several G.G.'s who are practising astronomers, and we are forced to the conclusion that though she knows her World, *SHE DOES NOT KNOW HER UNIVERSE.*



*She does not know
her Universe*

Certain vague notions appear to be floating in her mind—that the stars are a long way off and are made of coal-gas, that the Moon causes the Gulf Stream and the Channel Crossing, that the Earth spins on its axle once in 365 days and goes round the Sun in 24 hours; but what does she know of the work of Galileo, Newton and Einstein—names that should be on every Brownie's¹ tongue? Nothing. In the following pages we have tried to give you and your

¹Brownie: a Girl Guide still in the egg.

sisters, Angela, some idea of various theories advanced by these and other great thinkers; we have endeavoured to show you what a dreadful muddle they have made of the whole thing; and, finally, we have appended a short and simple scheme of the Universe based on common sense and our personal observations.



I

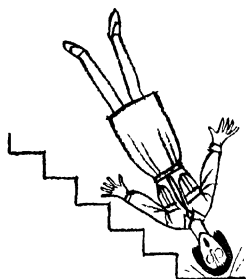
BEHOLD THE GREEKS



Plato

THERE was once a philosopher called Plato, who declared that the World was a shadow of something—he didn't exactly know what—which existed he couldn't be quite positive where, though he rather thought it was in heaven; and since his time there have been various others who have denied the existence of matter altogether. It is not necessary to take these people seriously; we mention them merely in order to show you, Angela, what the human mind is capable of in sublimated cases when it gets really out of hand. After all, you've only got to fall downstairs on to your head or to beat it perseveringly against a brick wall to

appreciate the solid reality of matter, while a glance out of your schoolroom window should convince you that



Solid reality

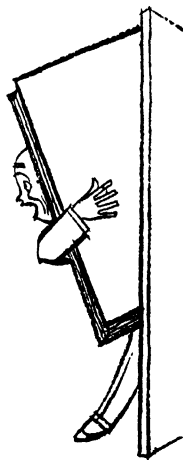
this jolly old World undoubtedly exists and that you are bang in the middle of it. The question is, what is it and how did it get here? This conundrum forms part of what is known as the Riddle of the Universe and has never been finally answered either

by philosophers or by scientists. It never will be.

Science, it is true, is more practical than philosophy, since it starts from the bottom and not from the top; but the weak spot about it is that, though always progressing, it never gets absolutely there. As soon as one fellow has discovered a 'Law of Nature' and written a big book about it, another comes along and writes a bigger book saying what a genius the first chap



A law of nature



is and showing that if you turn his law upside down or sideways it won't work and isn't a law at all really, and suggesting a better one of his own; and then somebody else upsets *his* apple-cart. This explains the notorious humility of modern scientists; they know that the only thing they really know is that they can never be quite certain of anything for more than five minutes. It also accounts for the occasional apparent flippancy of some of them. During recent years eminent scientists¹ have thrown off several almost amusing books about stars



*Notorious
humility*



So lightsome a spirit

and nebulae and atoms and the ether and two frightful impossibilities called relativity and the fourth dimension. Why have they dealt with these solemn subjects in so lightsome a spirit? Partly, no doubt, in order to produce best-sellers; let us not forget that they, too, have to

¹By an eminent scientist we mean an F.R.S.; no others need be considered. The Royal Society was founded by Charles II, a monarch justly celebrated for his sense of humour.

face the income-tax collector. But there is another reason. These men smile on paper to hide their breaking hearts. They realize, each and all of them, that in a little while their names will be mud—honourable mud, if you like, but still mud—and so they just pretend they don't care.



Face the income-tax collector

A brave gesture, Angela.

Nevertheless, scientists and philosophers, though for the most part 'in wandering mazes lost,'¹ have during the last two or three thousand years gained some glimpses of the truth about the World. The first



A brave gesture

of these was vouchsafed to the Ancient Greeks. Taking them by and large, the Ancient Greeks, especially the

¹As the poet Milton observes of the infernal members of the first debating society on record. You might look it up in *Paradise Lost*, Book II,

more ancient ones, were physically and mentally a re-



A remarkable crowd

markable crowd. When they were not engaged in putting the shot¹ incredible distances, or doing the hundred in a level nine seconds, they were usually composing poetry of a simple but singularly deathless character.

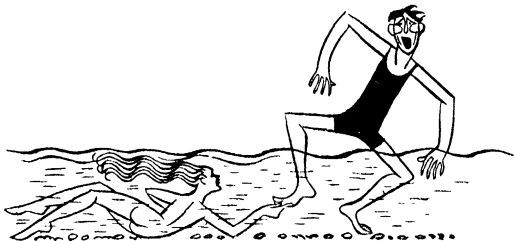
In the performance of these feats they were egged on by the gods, who in those days were extremely



Egged on by the gods

¹An anachronism, Angela. They really used small rocks,

mately with the human race. The shores of the eastern Mediterranean were thick with gods and demi- and



Tickled your toes

semi-demi-gods, many of them distinctly abandoned beings. It was impossible to enter a wood without putting up a Faun or a Satyr, Oreads and Naiads scuttled about the hill slopes or tickled your toes when you took a dip in a stream; while the upper nuts—Zeus, Hera, Pallas and Co.—had a permanent pitch on the top of Mount Olympus, where they lolled about



Zeus, Hera, Pallas and Co.

and drank barrels of nectar and quarrelled with each

other and interfered in a most uncalled for way in the affairs of the World below. As a result of this the Homeric Greeks, with their quick, imaginative child-minds, jumped to the conclusion that what are now known as natural phenomena were manifestations of divine or demonic activity and front-page news-specials. 'Look!' they would exclaim, as they watched the Sun rise of a morning, 'there's that chap Phoebus Apollo off away up again! Attaboy!' When a storm came on at sea they would shake their heads and wonder what silly fool had been irritating Daddy Poseidon to make him raise such a hull of a baloo out there. And if they felt an earthquake or saw a volcano growing restive they



That chap Phoebus Apollo

said, 'Ah, those Titans again, trying to break out and bottle Zeus!' And perhaps a few of them half hoped



Daddy Poseidon

that some day the Earth-Born really would get the old fellow.



Lost their faith

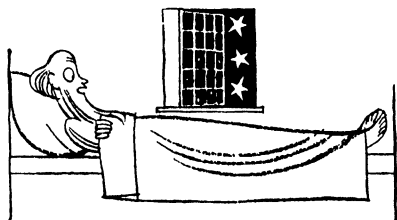
But children grow up, unfortunately, and nations too, and presently the Greeks lost their faith in the gods and some of them started thinking. Amongst other things they thought a lot about the World, till at last one bright brain got a wave. Being a noticing sort of person, this man, Pythagoras by name, observed that with the lapse of time Nature generally appeared to run to curves; in fact, most of the older objects seemed round or roundish—for example, the Sun and Moon and hills and pebbles and elderly human beings. Well, the Earth itself was the oldest thing of all.



*Older objects
seemed round*

Was it a disc, then, like, say, a gramophone record? No;

not if, as he suspected, it was in motion, or it would wobble. What could the darned thing be? Finally,



Trying to count the stars

as he lay in bed one night trying to count the stars unconcernedly sliding past his open window, he hit it. The Earth was a globe. Moreover, it revol-

ved in space, together with the Sun, Moon and planets, round an invisible central fire whose light was reflected on to it by the Sun. Of course, this made the old notion about Atlas holding up the world on his shoulders a pure wash-out; but he couldn't help that. In any case, the gods were getting to be back numbers and had retired on half-pay; so it was quite all right.

Pythagoras was a genius. He was also a mathematician, and can hardly have been a very nice man, or he would surely have kept to himself his heartrending discovery about the squares on the sides of a



A pure wash-out

right-angled triangle, which has been responsible for

untold bucketsful of schoolgirls' tears throughout the ages.

Mostly in the B.C.'s—don't let's worry about actual dates, because what does it matter when people have been dead such a long time?—there were other Greek philosophers, capital fellows and deep thinkers all, whom we can't decently avoid mentioning; but as we have been requested to limit this chapter to 2,154 words, there isn't room for more than a brief note on each of them.

Thales of Miletus: a business man who dabbled in physics and astronomy after office hours; but if



Schoolgirls' tears



A business man

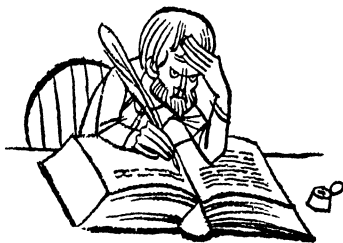
anyone insinuates to you that he discovered that the Earth was an orange you can tell them from us that they are wrong, because he didn't.

Democritus: he and a friend were the first to discover an atom, which they kept in a match-box and gradually tamed by kindness. It was an ugly, bullet-



Democritus (and friend)

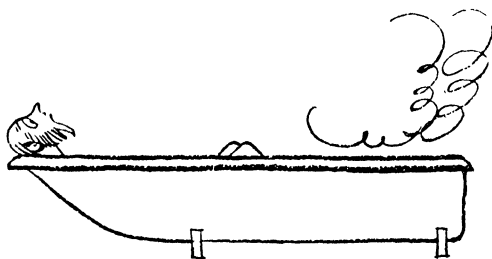
headed little creature, much less attractive than its modern descendants.



This man knew everything

Aristotle: this man knew everything and wrote the father and mother of all encyclopædias—in Greek, too!

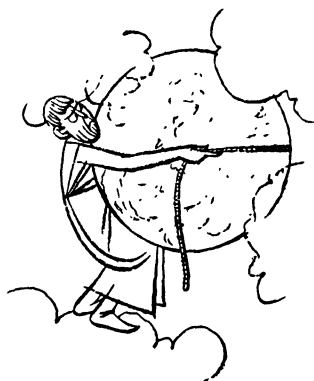
Archimedes: started the science of hydrostatics one



Slacking in his bath

day while slacking in his bath; also mechanics—why levers lever and pulleys pull and all that; but what he really enjoyed most was—would you believe it?—geometry. Here he found out, as near as nothing, how much longer the diameter of a circle is than

its circumference—or was it the other way round? Anyway, he did it.



Took the waist-measurement of the Earth

Eratosthenes: took the waist-measurement of the Earth, making it a little too small; but of course with advancing years the old thing may have got stouter since his day.

Strabo: for long confused by some historians with an early patent breakfast-food and by others with a primitive vacuum-cleaner; there seems, however, to be no doubt that he was an actual man and committed a geography of the world in seventeen books, of which only one, unfortunately, has been lost.

*Strabo**Pomponius Mela*

Pomponius Mela: not really very important, but we liked his name so much that we have put him in for the sake of euphony. Forgive us and forget him, Angela.

So much for them. We now come to a person of great importance, Claudius Ptolemy, who hung out at Alexandria in the second century A.D. As a geographer and cosmographer Ptolemy had three great advantages: (1) an extremely clean and tidy mind, (2) a flash-light imagination, (3) the ignorance of his contem-

C. PTOLEMY
(NO CONNECTION WITH ANY
OTHER FIRM OF THE SAME NAME)
PRACTICAL COSMOGRAPHER
AND GEOGRAPHER

*At Alexandria*

*Fill in face to taste.

poraries, slightly more abysmal than his own. He was consequently able to accomplish a great deal—and get



Badly wanted doing

away with it. First of all he had the world redecorated with proper degrees of latitude and longitude, a thing that badly wanted doing. Then he drew a map of the world. In this he made a few trivial mistakes: for instance, he left out the western hemisphere, either from ignorance of its existence or respect for the Monroe Doctrine;¹ he also filled up the whole of the southern

¹ The Monroe Doctrine summed up the attitude of the early Americans towards Europe. Briefly it amounted to this: 'we don't want to discover you and we should be obliged if you would kindly refrain from discovering us.' There is much to be said for it, and it seems a pity that it should afterwards have been so totally disregarded by Columbus and Chicagoan millionaires.

hemisphere with Africa and, by joining that continent to China in the far east, cleverly converted the Indian Ocean into an inland sea, a feat unattempted by modern geographers. Still, it was quite a nice map, and more interesting, in a way, than the one by Mr. Bacon on your schoolroom wall.

Having thus satisfactorily disposed of the Earth, he



To have a stab

decided to have a stab at the Universe as a whole. Here the heavenly bodies gave him a lot of trouble. They were obviously all in motion and just as obviously not merely dodging carelessly about anyhow, but according to some general plan. What was the big idea? The tackling of such a tough problem demanded heroic measures, and Ptolemy was not the man to shrink from taking them. To clarify his intellect still further he

voluntarily gave up beer and tobacco and went in for a strict training diet of Dover soles and poached eggs. The treatment was successful. In a very short time he evolved a theory which topped the league for 1400 years—a triumph for local talent.¹ The Universe, as he envisaged it, was a sort of colossal onion with movable



Gave up beer and tobacco

skins. In the middle was the Earth, a fixed ball, surrounded by air. Beyond the air came a succession of rotating crystalline skins or spheres, as he called them, to each of which a heavenly body was securely riveted and thus made to go round the Earth.² At least, that was his original

¹As a matter of fact, a rather similar universe had been suggested by a predecessor of Ptolemy's, who died of a disease called trigonometry, which he had invented himself.

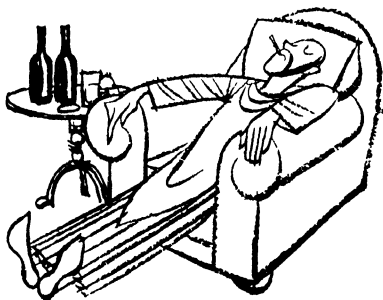
²As the spheres rotated they emitted a faint hum on notes varying with their size. Owing to the noise made by aeroplanes, the B.B.C. band and the Concert of Europe, this 'music of the spheres' is nowadays practically inaudible; but it may still sometimes be caught by people in balloons and, on quiet nights, by remote mountain-dwellers endowed with ears of the larger variety.

plan; but as the number of skins was limited, and the Sun, Moon and planets moved at different rates and so insisted on bagging one apiece, he had to lump the whole fixed-star crowd together on the outside one. This didn't matter, though, because they were all going at the same pace; so they raised no objection.



Sent out a slave

After completing his scheme and making a watertight job of it, Ptolemy sent out a slave for a packet of Virginia cigarettes, a large beefsteak and two bottles of India pale ale, and retired from active business.



II IN A MEDIAEVAL BUNKER

PTOLEMY is followed by a long gap due first to the Decline and Fall of the Roman Empire, poor



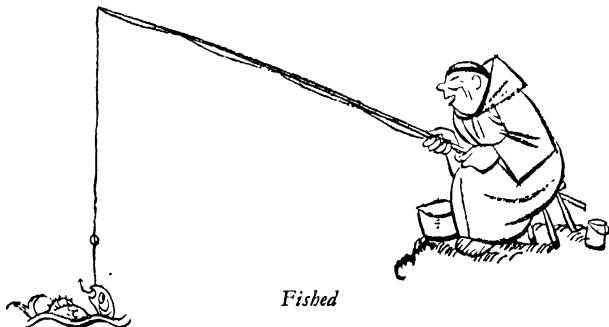
Decline and fall

thing, and secondly to the Middle Ages. These lasted about a thousand years, off and on. During the earlier part of them society was divided into two layers. In the lower you did all the work and led a dogsbodyish sort of life and just stayed put and obeyed orders. In



A dogsbodyish sort of life

the upper you had a choice: if you wanted a quiet time you joined the Church and fished and wrote Latin



Fished

prose; but if this didn't appeal to you, you went joy-fighting all over the place till your career was ended by



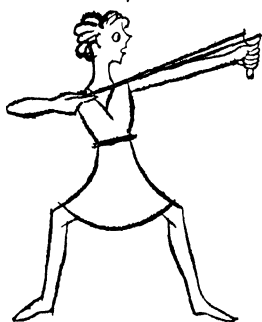
Joy-fighting

a fellow with a quicker battle-axe or a stouter meat-safe than your own.¹

The early Middle Ages, then, being a period when

¹Of course, being a girl, Angela, you wouldn't have had a chance of going in for these exhilarating scraps; women were not allowed to compete. You would have worn a kind of nightgown all day and had your hair done in two long plaits (if it ran to it) and mooned about inside an uncomfortable castle—all hall and no bathroom—with nothing to relieve the monotony of plain sewing or embroidery except the faint excitement of constantly expecting to be left a widow at any moment. Or you could have become a nun; but that was duller still.

beef was more highly esteemed than brains, were not



Not a practical cosmographer

particularly favourable to the advance of scientific thought; indeed, most people, if they ever bothered to reflect about the World at all, pictured it as a kind of very large circular table, the top of which, as it had been rather hurriedly turned out in six days, had been left unplanned with a

lot of knots and knobs on. Here and there some monks had heard about the Greek theories, but unfortunately those of them who were interested in such questions looked to the Scriptures as their first authority, often quoting, for instance, casual cosmographical remarks dropped by the Psalmist David. This was a pity, because David, though in a class by himself with the catapult and the Jew's harp, was not a practical cosmographer. Perhaps if he had foreseen how his words would be taken he would



Holy old bishops

have been more careful—at least, one may be permitted to hope so. The monks were also completely under the thumbs of a number of holy old bishops, who in

the early days of the Church had made themselves so unpleasant to everybody who contradicted them that at length, to avoid further trouble, it had been generally agreed to call them Saints and Surly Fathers and leave it at that. The only Greek thinkers these Surly Fathers had any use for were some followers of Plato,¹ who, though heathens, of course,



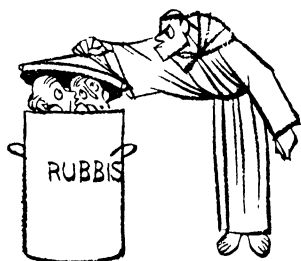
Followers of Plato

were almost respectable and so vague that their teachings could be brought pretty well into line with the early Church or, for that matter, with nearly anything. The others they just wiped off the slate, because it was simply impossible to make them fit in with Genesis or Job or David. So they had to go. The consequence of this was that at the very time when the Greeks were on the point of developing some really sensible ideas

¹Be so good as to refer to page 12.

about the World and the Universe and things in general, the Church put the lid on them.

To get some notion of early mediaeval theories about the Universe, let us glance at Cosmas Indicopleustes.



Put the lid on them

This pilgrim, after doing a fair amount of globe-trotting for those days, retired into a monastery on Mount Sinai, an ideally quiet spot for literary composition. Here, in a silence broken only by the music of the spheres¹ (which

he probably thought was caused by angels at harp-practice), he fairly let himself go in his *Christian Topography*. According to friend Cosmas, the Universe was a rectangular plane exactly twice as long as it was broad. In the plumb middle of this, encompassed by ocean, was the 'round world' of Scripture; beyond the ocean was the outer world where men lived before the Flood. So far so good, and very neat, too. But what about the Sun? Well, of course, the Sun was a difficulty, especially owing to his inconsiderate habit of showing off so in the summer and sulking in the winter. Cosmas, however, was not to be floored by a mere heavenly body. The Sun, he decided, was a disc forty miles in diameter revolving round a conical mountain two hundred and fifty miles high in

¹Page 27, if you don't mind just looking back.

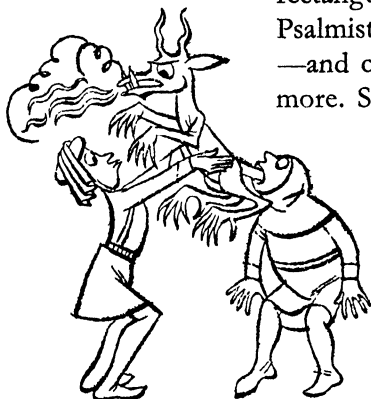
the extreme north, round its summit in summer and its base in winter, which caused the difference in the length of the days. Perhaps he really felt a bit uncertain about this mountain, which, after all, was taking him rather off his biblical beat; at any rate, you will notice that he was careful to put it right at the top of the map, where nobody had ever been. The rest of his scheme was Old-Testamentally sound and copper-bottomed. The universe was vaulted by the 'four walls of the sky,' meeting in the 'dome of heaven,' each wall pegged down to one of the corners of the outer world. Some way up the sky was the firmament, its floor covered, naturally enough, by 'the waters that be above the firmament.' Beyond that was Paradise, a region of high lights and vivid colouring but uncertain lay-out. As for the Earth being an orange or the inside of an onion or in motion or anything like that, 'Well,' said Cosmas, 'I ask you!'



*'Well,' said Cosmas,
'I ask you!'*

Far be it from us, Angela, to throw stones or even to shoot peas at Cosmas Indicopleustes. Apart from the respect one cannot but entertain for a pilgrim with a nickname of five syllables, we admire him for his fatuous optimism in imagining that rational human beings would swallow such a theory. As a matter of fact, though, the human beings of his day were not

rational, any more than they are now; they would swallow anything—fairies, dragons, ogres, enchanters,

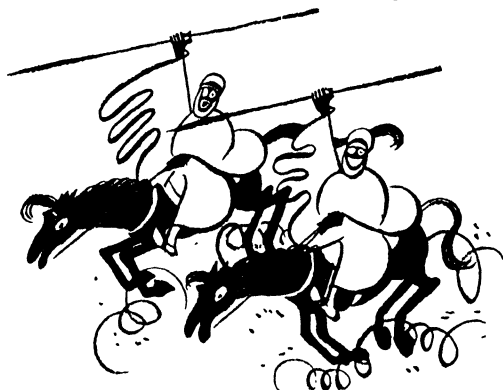


Swallow anything

rectangular universes, the Psalmist—absolutely anything—and come back and ask for more. So perhaps he wasn't so stupid as one might think.

While, however, Europe was, from a scientific point of view, sunk in the intellectual apathy of the Dark Ages,¹ in another quarter considerable progress

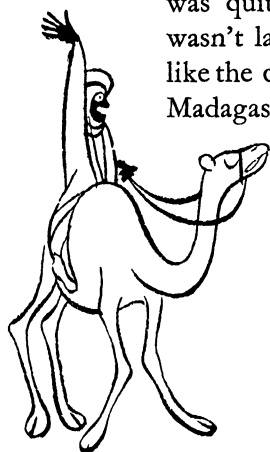
was being made. The Arabs were going all out. During



The Arabs were going all out

¹Always bottle a phrase like that, Angela. It is guaranteed to return the penny in any school-certificate examination.

the seventh and eighth centuries these hairy sons of the Prophet mopped up¹ the Indian Ocean, Palestine, Asia Minor, the whole of North Africa and nearly all Spain—pretty thrustful work, as you will admit. But they were not all mere cutters and carvers; many of them had quite extensive brain-pans. Moreover, since they were not debarred by religious scruples from the study of science, when they managed to get hold of a lot of the old Greek manuscripts there was no one to say: ‘This doesn’t agree with David or the Fathers of the Church, so in the first place it is pure tripe and in the second a damnable heresy.’ Consequently they just went ahead and got on with it. They were extremely keen on astronomy and geography, especially geography, which



Home from a camel bike



was quite a fascinating study when it wasn’t ladled out to you in boring lists like the capes of Ireland or the exports of Madagascar, which you have simply to take on trust, but you made up your own maps and commercial products from what you remembered when you got home from a voyage or a camel-hike.

¹Metaphorically and colloquially speaking, of course.

About A.D. 830 the Caliph Almamoun built two observatories at Bagdad and roped in at his court there all the Mohammedan scientists he could lay his hands on, among them Solyman the Merchant, who was really Sindbad the Sailor; and some time later the Mohammedan Moor Edrisi constructed for Roger the Norman of Sicily a celestial sphere and terrestrial disc of silver

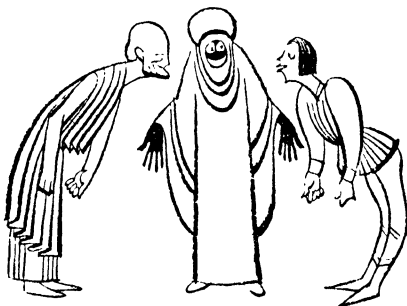


Began to wake up

showing 'all the circuit of the known world and all the rivers thereof.' For this achievement Roger made him a Count of Sicily and gave him the silver that was left over when he had finished. We will not describe Edrisi's map beyond saying that it was something like Ptolemy's but different.

The Arabs, then, kept the study of geography and cosmography from fizzling out, and when, in the later part of the Middle Ages, the people of Europe turned over and yawned and began to wake up and show signs of wanting to learn something for themselves,

they said, 'Allow us to re-introduce you to the old Greek philosophers,' and did so. Incidentally they also



'Allow us to re-introduce you'

made them a present of the modern numerals, thus causing decimal fractions. To many schoolgirls this

may seem a doubtful benefit; but have you ever thought, Angela, what a ghastly business it would have been if you had had to work all your sums in Roman figures? Be grateful to the Arabs who saved you from that.



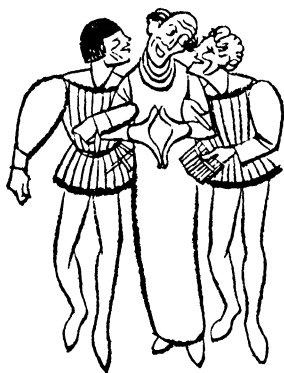
Charlemagne

From the time of Charlemagne, who was crowned Roman Emperor on Christmas Day, 800,¹ a revival of learning took place in western Europe.

Continual rushing about and scrapping were quite

¹A date good-naturedly selected by the Pope as an exceptionally easy one to memorize.

enjoyable, and healthy and invigorating, too, so long as you always came out top dog, but by degrees an increasing number of people began to think that perhaps after all they might be more profitably employed than in perpetually screwing their neighbours' necks. So far, all education had been given in monastic schools, but as these were now getting crowded out, new non-church ones were started, some of which grew into universities. At the universities you were



Nice to the masters

put in the Elementary Department to begin with and afterwards moved up to the Higher Grade. Here, in addition to arithmetic, you had to take geometry, astronomy and music, whether you liked it or not. The geometry wasn't so bad as it might have been, though, because the props were learnt without the proofs, which made it simpler. Besides, if you were nice to the masters and didn't rag them but encouraged

them, you could often get them off the lesson and gently lead them on to discuss all sorts of fascinating topics—whether real things were the ideas of things or just the things themselves or a combination of both; how all the four elements had got jumbled up after the Fall;¹ where Hell was exactly; how many angels could sit on the point of a needle without crowding, and so forth. They would prattle away for hours on such subjects and never notice that you were playing noughts and crosses or having forty



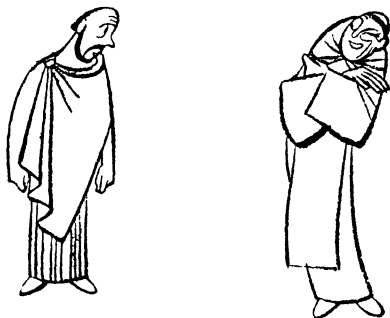
Prattle away for hours

winks—especially if you had acquired the knack, so invaluable to pupils of all ages, of going to sleep with your eyes open.

As a result of this increased education, round about the twelve hundreds or, as one might say, the thirteenth

¹Of Adam and Eve, shortly before the birth of Pinch-Me,

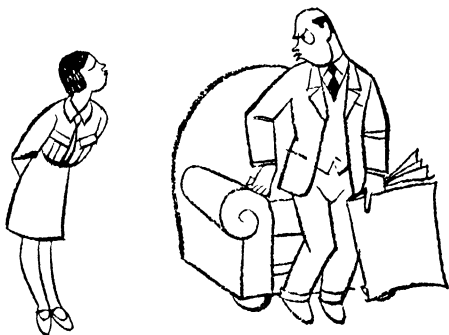
century, there was a boom in science, and at cosmographical chit-chats it began to be freely whispered that Ptolemy's scheme of the Universe had been a pretty sound effort. Finally the Church decided to make the best of a bad job and give Ptolemy the glad eye.



The glad eye

It is interesting to notice that at this period several Englishmen showed distinct signs of intelligence. Robert Grosseteste (*anglice* Fathead), though a bishop, invited Greek scholars to come to Oxford with their books, and Friar Roger Bacon actually announced that the only way of getting at real truth in science was by making experiments for yourself. For saying this, and also for making some justifiable but upsetting remarks about the Surly Fathers, he was imprisoned by the Pope for a good many years. But his ideas survived him. Amongst other things he knew about the mariner's compass and described how to make a telescope; also motor-cars and flying-machines.

This, Angela, brings us to the end of the Middle Ages—at least, it doesn't quite, really, but we fear you might find St. Thomas Aquinas, Duns Scotus and possibly even William of Occam rather tough nuts for a girl of sixteen to crack; so perhaps they won't mind if we leave them with just an honourable mention. Of course, if you insist on knowing something about



Ask your father

them, you can always ask your father when he gets home from the office; but we are inclined to think that he will share our opinion.

III

THEN THE RENAISSANCE STARTED

SCHOOLGIRLS and, for that matter, schoolboys, too, are all agreed that the Renaissance was one of the most extraordinary things in the history of Europe. In their essays, in their letters to their uncles, one constantly comes across such expressions as 'the Renaissance,



Elderly young boys

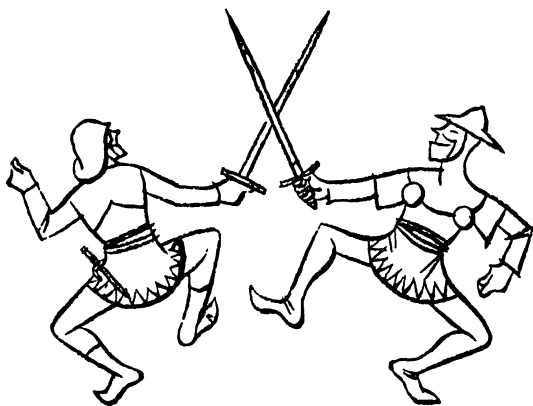
, the glorious dawn of modern history,' or, 'that marvellous achievement of the fourteenth, fifteenth and sixteenth centuries, the Renaissance,' or, when words fail them, simply 'the Renaissance.' They are never tired of talking and writing about it, and many of them waste hours of valuable out-of-school time in studying

its various phases. Only last week we happened to catch a fragment of conversation between two rather elderly young boys, laden with books and obviously on their way home from the treadmill. 'What's that old blighter Jones set for to-night?' asked one. 'Oh, the Renaissance,' replied his companion.

'Good egg!' exclaimed the first, 'I swotted it all up last week, so I can go to the pictures.'

Nevertheless, Angela, even at the risk of carting coals to Cardiff, we must inflict on you at least a portion of the oft-told tale. Whatever his particular stunt, no self-respecting historian can hope to avoid the Renaissance—it isn't done.

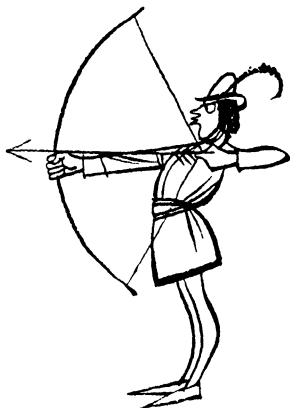
The Renaissance, then, which has been the cause of most of the troubles of the world for the last five hundred years, broke out in Italy at the end of the Middle Ages and spread like a fungus over the whole of Europe. Before that everything had been quite all right. People were comfortably settled down in their



The necessary touch of variety

various countries, living peaceful lives except for an occasional spot of fighting with other nations which lent just the necessary touch of variety to existence.

Through the week they went contentedly about their ordinary jobs; on Sundays they attended church in the morning and practised archery or nine-pins or got a little rattng or cock-fighting in the afternoon. There was, as a rule, plenty to eat and lots of beer to wash it down with; appendicitis had not been invented. Over their heads, day and night, Ptolemy's onion-skins went merrily buzzing round the celestial circus-ring. And when closing-time came the



Archery

Church, provided they hadn't done anything too absolutely outrageous, guaranteed them a pre-paid passage across the Jordan and a seat in the stalls. What more could anybody want? Yet it is often just when people are well off



Or nine-pins

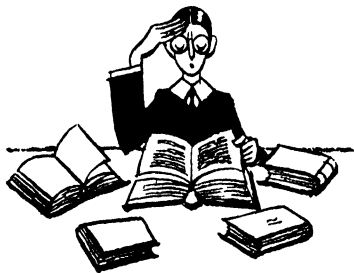
that they don't know it. In the fourteenth century many

of them began to get restless in a vague sort of way, and then in the fifteenth and sixteenth several unfortunate things happened which turned the World upside down and somersaulted it into modern history.



Began to get restless

The first catastrophe was the invention of printing. This multiplied almost indefinitely the number of books, especially of the Greek and Latin poets, many of whom were quite unfit to be read by anybody but the monks. Now books are in any case bad for people, because they put all sorts of wrong ideas into their heads; yet, owing to the short-sighted folly of parents, ever since the invention of printing even the youngest and tenderest children have been encouraged in the fatal habit of reading. 'Give my Bobby a book,' said a proud mother to us not long ago, 'and he's as good as gold.' We made no reply; it would merely have distressed her. But as we watched Bobby poring over '*The Three-Year-Old's Encyclopædia of Things no Child Should Know*,' or what-



Fatal habit of reading

ever it was, we realized that he had taken the first step along the primrose way to the Sunday papers and the everlasting bonfire.¹ The mediaeval idea that reading ought to be confined to the clergy, because they alone are sufficiently hardened to be uninjured by it, was a sound one and should never have been allowed to drop.

Secondly, there was the dreadful exploit of Christopher Columbus. This mossless stone, after rolling about for some years as a deck-hand with a Mediterranean shipping company, got a job ashore in Portugal; but work, as such, always gave him a vague feeling of uneasiness and before long the wanderlust gripped



As a deck-band



A ten-cent-store in Lisbon

him again. One day he happened to be poking about in a ten-cent-store in Lisbon when he came across a stack of guide-books labelled 'Where to go for your Summer Holi-

days,' with a coloured map on the cover by a person

¹Not ours, Shakespeare's.

called Toscanelli. This map put an idea into his head. The discovery of America was long overdue. Why not have a dart at it? Next morning he changed his coat, went round to the palace and requested help from the King of Portugal.

'Discover what?' asked the King of Portugal.

'America, your majesty.'

The King of Portugal, who was a sensible man and not looking for trouble, beckoned to his chief gaoler. 'The padded cell,' he said, and called



Went round to the palace



'The padded cell,' he said

for the next case. So Columbus had to change his waistcoat, too, and was put away for a bit.

When he got out he went to the King of Spain and suggested that he should lend him a few ships.

'My dear fellow!' said the King of Spain.



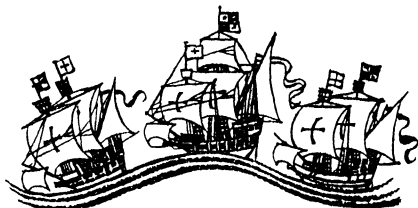
'My dear fellow!' said the King of Spain

It was the same with the King of England and all the rest of them. Nobody would touch it. The last thing they wanted was to get mixed up with America. In despair Columbus took to walking about the roads with his little boy, begging everyone he met to lend him a ship. At length the Queen of Spain, a public-spirited woman, wrote and asked him to leave her country for her country's good. This was exactly what he wanted. By giving her name as a



With his little boy

reference he managed to get three ships on easy-payment terms, delivered in plain vans, and sailed



Three ships

away shortly before sunrise on the day the first instalment was due.

Discontent soon arose among the crew of the flagship, who were a very mixed lot and included an Englishman and two Scotchmen. They complained



They complained

that the pancakes tasted of bloater paste, and the Englishman said the tinned asparagus wasn't a patch on what he had struck at Dartmoor. Moreover, they

were sick of rummy and bridge, and they couldn't play deck-cricket any longer because the first mate had hit so many sixes that all the balls had gone overboard. They asked Columbus to turn the ship round and take them home. Columbus soothed them by promising to put the cook and the first mate in irons, and made a long speech in which he said what fine fellows they all



Made a long speech

were, especially himself. 'It is a far, far better thing I do,' he concluded, 'than I have ever done.' His words had the desired effect. The men, children at heart, were quite won over; they forgot to cut his head off and sat down happily to tea.

A little later they mutinied again. The last bottle of gingerbeer was practically finished, even Aunt Agatha's hour on the wireless was losing its appeal, and the baseball fans were afraid they would not get across in

time for the game between Pittsburg and New York City. Things were looking really serious when suddenly Columbus pointed to what appeared to be an aeroplane approaching from the west. As it drew near they saw it was an eagle with a wing-spread of sixty feet and the letters U.S.A. inscribed in block capitals on the underside of its tail. The skipper was overjoyed. 'Oh, Baby!' he cried, in a momentary lapse into the

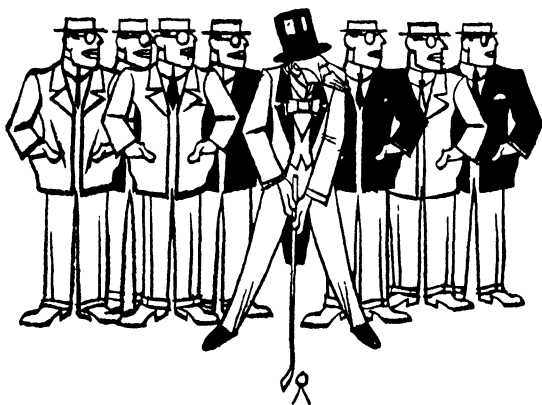


On the underside of its tail

idiom of the Western world, 'I'll say that's a cute little fowl!' and every man stood to attention while the cabin boy obliged on the gramophone with *John Brown's Body* and the *Te Deum*. The bird circled slowly over them, then, refusing with a sneer on its beak the breadcrumbs offered it by Columbus, flew back the same way as it had come.

On the following afternoon they reached what seemed to be an unfrequented part of the coast, and

Columbus put on his sword and plus-fours and rowed with a landing-party to the beach. Here in the middle of a stretch of beautiful turf he found a small flag flying. This he removed and threw away, and planted in its place the royal standard of Spain. The ceremony was just over when the President of the U.S.A., who was spending a holiday there, arrived at the green (the twelfth) with seven companions.



The President of the U.S.A. with seven companions

‘Say, mister, what in Hades¹ do you reckon you’re doing?’ he demanded.

Columbus explained that he was—er—Columbus, so to speak.

‘Huh,’ said the President.

¹Only he said it in American. The Classical Renaissance had not yet reached the U.S.A.

Columbus added that he had annexed the continent in the name of his patroness, Queen Isabella.

The President pulled thoughtfully at his beard, a silky goatee of the latest pattern. 'I reckon you'd best get out of this quick,' he said.



'I reckon you'd best get out of this quick'

Columbus began to expostulate, but the other cut him short. 'Two of these here guys¹ with me are plain-clothes cops,' he murmured.

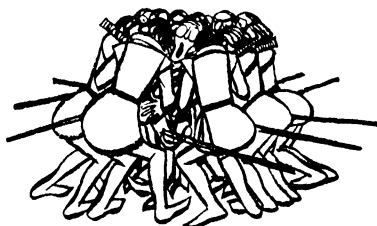
'Oh, well,' said Columbus reluctantly.

So they rowed off again to the ships and went back home without even having visited the Woolworth Building. But Columbus had discovered America; nobody could deny that.

Soon afterwards a largish ship, belonging to a fellow called Magellan, set out west from Spain and in three years all but fourteen days came back the wrong way,

¹Transatlantic for an adult male human being.

from the east, thus proving that the earth really *is* an orange.¹ As we have noticed, scientists had long suspected this; indeed, most of them actually believed it; but to the ordinary lads of the village such an unpleasant revelation, coming as it did on the top of



Turned on the Pope

printing and America, seemed the absolute limit, and to relieve their feelings a whole crowd of them turned on the Pope and bit him with great heartiness and ferocity. This is known as the Reformation, and was the last straw but one. We shall come to the last directly.

And now, Angela, we have to ask ourselves a question. While all these terrible things were in progress, what were the scientists, and more particularly the astronomers, doing? Were they asleep? Alas, no! Astronomers never sleep except on cloudy nights, and then only with one eye at a time, and at this

¹Magellan himself never reached home. At the Philippines he went ashore and, getting separated from his companions, disappeared into the interior either of the islands or, more probably, of the cannibals who inhabited them.

period they were very much awake. Especially a person called Copernicus. This son of a Hun, whose real name was Nicolaus Copernob, but he thought it sounded slightly less objectionable in Latin, publicly announced in the year 1530 that Ptolemy had been



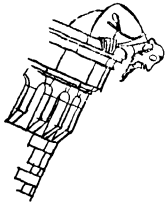
Copernob

talking through his hat, and that the Earth was a small spinning-top being whipped round in an everlasting circle by that big bright boy, the Sun. Of course, everybody at first pooh-poohed and tut-tutted this ghastly idea, and the Pope, though not strictly an astronomer, pronounced it to be absolute rot and stood up for Ptolemy like a man. But unfortunately half Europe now took no notice of anything

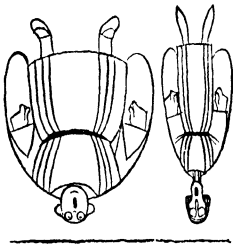
the Pope said, and the finishing touch was put to the new theory by an Italian named Galileo. Galileo Galilei, in an unlucky moment for humanity, forsook his ice-cream barrow to become a scientist. His great object was to prove everybody a fool except Copernob, whom he rather



Forsook his ice-cream barrow



liked. The first thing he did was to take two town-councillors, a light one and a heavy one, to the top of the Leaning Tower of Pisa and drop them to the ground together. Naturally the betting was pretty well any odds on the big one getting home first. But the result was a dead heat. Having by this simple experiment proved that the whole of mechanics was wrong, Galileo went off laughing to his house and sat down and made a telescope. When he had finished it he asked some professors to have a look at the sky, but they funked



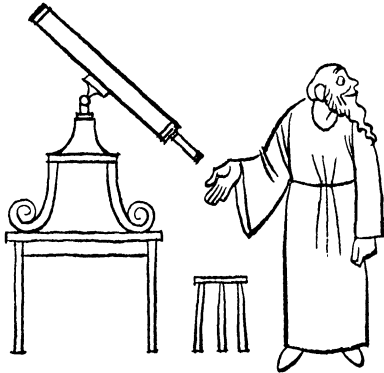
Dead heat

it. However, other people were only too willing. And what did they see? Well, the only thing they *didn't* see was the Man in the Moon, and he was gone for ever. In his place there were a lot of ugly mountains and chasms spread across a world closely



Went off laughing

resembling our own. Then they looked at the planets, and there they were, surrounded by moons and



To have a look

rings and things, just like us, only more so. But the most sickening surprise of all was the Milky Way.



They funked it

For centuries simple folk had loved to gaze at that broad ribbon of faint, far-off light, spanning the whole

arch of the night sky, the threshold, surely, of the greater brightness of Paradise beyond. And now what was it? Just a lot more stars, millions upon millions of flickering suns stretching away into a fathomless void.

Modern astronomy had begun. The World was soon to dwindle to a miserable speck of star-dust, and man

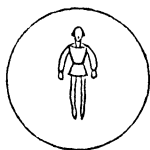
practically

to

NOTHING

NOTHING

o



IV
AND NEWTON DEVELOPED



Sir Isaac Newton

SIR ISAAC NEWTON, the celebrated astronomical detective who unmasked the secret inner workings of the notorious Solar System, emerged among the mutton-heads of Woolsthorpe, a hamlet in the fat, flat county of Lincs., on Christmas Day, 1642 (O.S.¹). Woolsthorpe was (and may possibly still be) some six miles from Grantham, a pleasant agricultural

¹Which makes all the difference, of course.

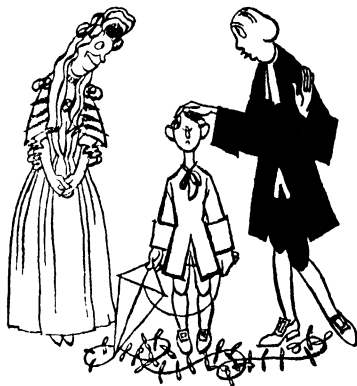
kind of town with a very upstanding church and quite a decent hotel; and on reaching the age of twelve the boy went to the Grammar School there. For a time he displayed the usual early dullness of genius, which often takes a lot of maturing in the wood; but after a bit, despite all the efforts of his teachers, he began to think and, once set going, his brain kept tick, tick, ticking away with ever increasing velocity till the 20th of March, 1727, when it stopped.



*Dullness of
genius*

As his mother (a re-married widow of the name of Smith) intended young Ike to be a farmer, after a couple of years she very properly considered his education finished, and had him home; but his uncle,

the rector of Burton Coggles, having discovered that the lad had invented a kite, said he possessed too much imagination for agriculture, so they sent him back to school again. He at once began to come on very fast. Some one gave him a work on logic, which he read right through. Another friend gave him a copy of Euclid. He took the book, glanced at one or two of



Too much imagination for agriculture

of

the props, and threw it away. The thing was too easy for him. In 1661 he passed the Little Go at his first shot and entered Trinity College, Cambridge. Here, as at school, he failed to create a very striking impression to begin with, but as a matter of fact he was just lying doggo and working more on his own than like an ordinary undergraduate. In four years he



Too easy for him

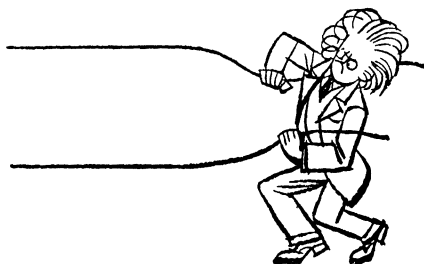
got his B.A., and almost directly afterwards invented fluxions.¹ Beyond remarking that fluxions are far harder than fractions and are, indeed, a particularly frightful form of advanced mathematics, we will not pause to describe them to you, Angela, much as we should like to do so; you will not require them either for the School Certificate Examination or during your subsequent career. It is, however, interesting to notice *why* Newton invented them. Was it from sheer love of figures, or hatred of humanity, or a hankering after notoriety, or what? Nothing of the kind. He invented fluxions because *he wanted them to save him trouble in his calculations*, much as somebody once



Got his B.A.

¹Afterwards called, rather slightly, the Infinitesimal Calculus, a much bigger thing than the name would seem to indicate.

invented a wheel to trundle a barrow with or a saw to cut wood. This will show you what an absolute top-notch at sums of all kinds Isaac already was at the age of twenty-three. And here we must call your attention to another point about him. One often hears of pure mathematicians, and many of them, no doubt, fully deserve the epithet; but Newton was not only a pure but also a strictly honourable mathematician. He was essentially a straight thinker. He never tried to make parallel lines meet in



To make parallel lines meet

infinity or anywhere else, and he never in all his life pretended that he had at any stage of his career seen a triangle whose inside angles totted up to anything more or less than exactly two right-angles. Would that we could say the same of some of his successors!

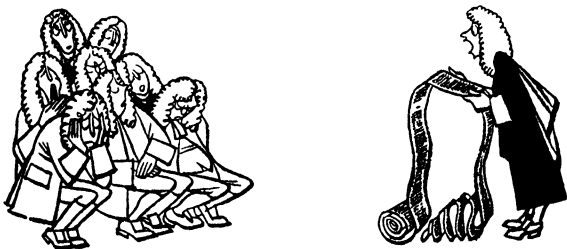
There were now only two things that the authorities could do with Isaac: make him a fellow of the College

or put him in an asylum. After a good deal of deliberation they chose the former alternative, and in 1669 he rose to be a professor of mathematics. This made him absolutely safe, since a university professor, though a



A good deal of deliberation

lusus naturae,¹ is regarded as harmless and has carte blanche to say, write and do pretty well anything he likes. A little later the Royal Society took him to its



Retaliated

bosom and elected him a fellow. He immediately retaliated by inflicting on it a long essay on Optics, or

¹Or, as we should say, a sport.

the Science of Light. This composition is still extant, Angela, but we do not advise you to read it; it would probably confuse you even more than it has ourselves. Two points, however, stand out in it with remarkable clearness: (1) light was not what the Royal Society or anybody else thought it was—far from it; (2) Newton had had to leave Cambridge for two years owing to the plague, and this had interrupted his studies; otherwise he would almost certainly have been able to tell them what light actually was instead of what it wasn't.

It was perhaps rather a fortunate circumstance¹ that Newton was obliged to abandon Cambridge for Woolsthorpe for the two years referred to, because it



The well-known apple²

was during this interval that his thoughts were first directed to the subject of gravity by the well-known apple. If he had remained at the 'Varsity he would have

¹Or an unfortunate one; it depends how you look at it. Of course, in a way it led to Einstein.

²You were expecting this picture, so we've put it in.

missed the apple, and it would just have done its little bit and rotted away on the ground, unhonoured and unsung, without being noticed by anybody who had the nous to connect it with astronomy.



Had his eye on the Moon

Directly Newton saw the apple fall to the ground it occurred to him that perhaps the Moon was doing the same thing. He had had his eye on the Moon for some time. He knew that she was revolving round the Earth; everybody knew that. But why she was content to do so instead of skating off on her own straight away through space and really seeing a bit of sidereal life—that no one could understand. Now, though not, terrestrially speaking, a suspicious or interfering sort of man, where the heavenly bodies were concerned Isaac was distinctly a Nosey Parker, and he began to smell a rat. Was it possible that the Earth had a secret pull on the Moon, as she had on the apple, which was just sufficient to keep her in her place and prevent her giving notice to quit? After simmering in his head for awhile, this idea at length came to the boil and he proceeded to do a



Began to smell a rat

long sum about it. The first time it came out wrong, but he worked it through again and got it right. His suspicions about the Moon proved to be entirely justified. The Earth had her on a string and she couldn't leave her situation. All she could do to get even with her mistress was to try to tamper with



A long sum

the water supply; but she was so feeble that this merely caused the tides, which were really quite a good thing for us, if she had only known it. This discovery led to a much bigger one.

'The years 1685 and 1686,' says Vol. MUN to ODD of that most useful work, the *Encyclopædia Brit-*

annica (now being given away with combined bookcase, gramophone and bathroom), 'will ever be memorable in the history of science.' It is not often that the *Enc. Brit.* permits itself such outbursts of enthusiasm, and in this particular instance it may well be forgiven, for it was during these two years that Newton composed nearly the



*The Mathematical Principles of
Natural Philosophy*

whole of his great treatise on the Mathematical Principles of Natural Philosophy, a book which may

still be placed with perfect propriety in the bookshelf of any British nursery.¹ It contains the results of his researches from the apple onwards.

After settling the Moon, Isaac had tackled the planets. Here, too, he had something to go on. He knew that they revolved round the Sun. He was also familiar, just as you, Angela, and we ourselves are, with Kepler's law² that they move in ovals, and that the squares of the periodic times which they take to describe their orbits are proportional to the cubes of their mean distances from the Sun—o-u-t spells out, you're "it." All that was as clear as mud. But why? What was the reason? Well, it was probably a case of the Earth and the Moon over again, an everlasting tug-of-war, so to speak. The Sun was pulling at the planets and they at the Sun, but he was so much bigger than any of them that they couldn't shift him and he just sat in the middle and smiled and told them to get on with it. And what about the other stars? They were suns, too. Every night you could see them twinkling away in the same relative positions, as

¹That is, of course, if children should be allowed to read at all, which is doubtful. May we refer you to page 46?

²We ought perhaps to have mentioned John Kepler (1571-1630) in our chapter on the Renaissance; but his laws seemed to us so obvious (if one can really swallow the Solar System) that we didn't think them worth bothering about. You've only got to watch the planets trotting round the Sun to see at once for yourself that what Kepler said above was perfectly correct. Still, he was the first fellow actually to make a note of it, and, if it isn't too late, we should like to take this opportunity of thanking him for troubling to do so.

steady as rocks. Why weren't they, and the Sun himself, falling about all over the place and colliding and exploding and causing a general bust-up? Once more, gravity, merely gravity. Isaac felt sure that would explain everything; but it was more difficult to prove it this time, because the planets were much farther away than the Moon, while the distances between the stars were, of course, stupendous. However, he determined to have a try. First of all he got hold of several scientific friends, especially the Astronomer Royal, and pumped them dry of every bit of information they



Pumped them dry

could give him. Then he sat down to do the hardest sum of his life. This colossal calculation ran into over a hundred sheets of foolscap and entailed the use of addition, subtraction, multiplication, long division, cross tots, practice, rule of three, vulgar and decimal fractions, square root, cube root, brackets, factors of

all varieties, simultaneous and quadratic equations, plane and solid geometry, trigonometry, statics,



Came out right

dynamics, the use of the globes and the slide-rule, and (of course) fluxions—and at any moment a single slip might have ruined the whole thing. But he never faltered, and did each line twice over; and at last the answer came out right. He knew it was right, because it was the one he wanted. It ran thus: Every particle of matter in the universe exerts a pull on every

other particle which is bigger the bigger their combined mass and smaller the bigger the distance between them. This is the famous Law of Gravitation or Gravity—you can say which you like.

When Newton's book appeared with the answer at the end, everybody saw at once what a simple thing it really was, and at least one person claimed that he had already worked it out on his own; but, as Isaac said, he hadn't published a book about it, anyway, so it didn't count. Some foreigners also, particularly a man



A simple thing

called Leibnitz, who was jealous of Newton, maintained that he was no philosopher because, though he had discovered gravity, he couldn't explain it. In reply to this Newton said that the mere fact that he hadn't done so showed that nobody could, and if they didn't believe him they'd better have a shot at it themselves. They and Newton were very good friends really, though, and when a little later he had an attack of mumps on the brain, they were quite distressed at the thought that they

*Jealous*

might possibly lose him. Astronomers and politicians are like that; professionally they are all scratch and

*Quite distressed*

bite, but as private individuals they have hearts of gold and are as thick as thieves. Fortunately he

disappointed everybody's fears by getting better,

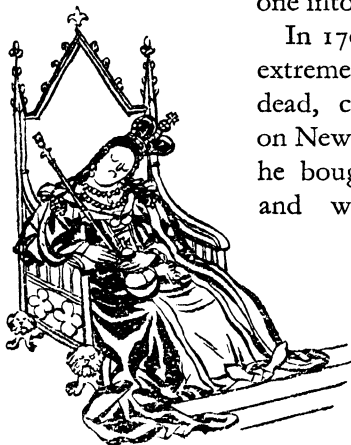
All this time he had not been too well off. He was just a common Cambridge don, and none of his inventions had brought him any money; you can't patent a thing like fluxions or gravity. By the middle of the 'nineties, however, his brain had become such a by-word all over Europe, Asia, Africa, America, and the Channel Islands that the Government felt they



Getting better

must do something for him; so they gave him a job as Master of the Mint, with a salary of £1,000 a year and the usual permission to turn up at the office as late as he liked and take whatever long week-ends he wanted. This was a sound move on the part of the Government. Besides being so good at figures, Isaac was such an honest, simple-minded old boy that he could be safely trusted to keep his fingers out of the till, and even when improvements were made in the coinage and tons of worn-out guineas and shillings were called in

and minted into fresh ones, he never slipped a single one into his pocket.



Not yet dead

In 1705, Queen Anne, already extremely sleepy but not yet dead, conferred a knighthood on Newton, and soon afterwards he bought a new coat and wig and went to Court. When

George I came to the throne, Sir Isaac became very friendly with the Princess Caroline, who, though married to the King's son, was otherwise a very intelligent wo-

man. His friendship with this lady and the fact that he began to put in a lot of time at theology made some people imagine that his mind was giving way, and in order to test this suspicion his old friend Leibnitz very thoughtfully sent over a mathematical problem for him to tackle. It was 'to find the orthogonal trajectories of a series of curves represented by a single equation.'



Very friendly

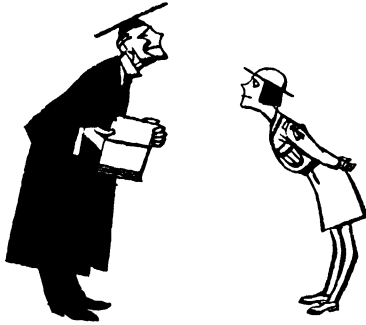
This nasty thing was sprung suddenly on Newton one evening just when he had got home and was feeling pretty played out after a heavy day's minting; but he sat down and did it before supper, with one hand, thus proving that, if proper precautions were taken, it was quite possible to cultivate Scripture and Royalty without injuring the brain.

In 1727 this great man was buried in Westminster Abbey. We will leave him there.



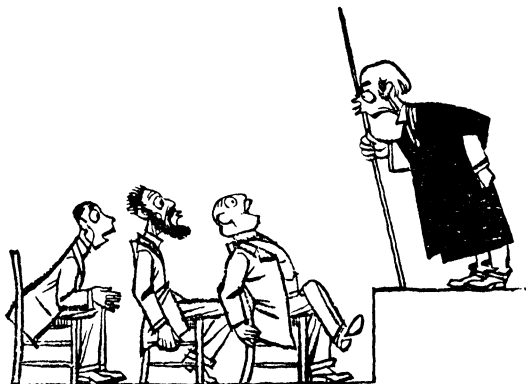
MODERN ASTRONOMY, WHICH IS ABSURD

IN the present chapter, Angela, we propose to summarize for you some of the more glaring results of astronomical research during the last couple of hundred years or so. This sounds rather a mouthful, but it really offers little difficulty. It is not as if we had had to carry



out the investigations for ourselves; other people have been good enough to undertake them for us, and all we have to do is to give you a concise account of what they have discovered, or rather, imagine they have discovered, because, between you and ourselves and the nearest lamp-post we regard most of their conclusions as pure moonshine. One of the most astonishing things about mankind is its readiness to swallow

the fairy tales of science, especially of astronomy; and this is true not only of human beings in the stricter



Fairy tales of science

sense of the word, but of the harder-boiled types of business and professional men, like stockbrokers,



Professional men

solicitors and archdeacons, ordinarily so remarkable for their clearness of vision. Yet when one comes to

think of it, on what slender foundations does even modern cosmography rest! The sharpest-sighted of our astronomers have never yet seen a star as anything bigger than a pin-point of light. The Moon, coy creature, has never shown them more than the back of her head. What is her face like? Has she got a face? They don't know. And what is there inside our planet, as they call it? Is the Earth a hot-water bottle? Is it a



The hind legs of the Great Bear

gasometer? Is it stuffed with cotton wool? They can't tell us. And these are the men who have no hesitation in affirming that the Sun is subject to nettle-rash, and who claim that they can put Sirius in a pair of kitchen scales and have measured the hind legs of the Great Bear. Still, they

are in their way able fellows, and the universe they have invented is certainly a clever one and seems to hang together all right, if one could only believe in it. Probably the real snag about it is that it is *too* clever. Now what do they tell us?

Long, long ago—before the War, before the Flood, before animalvegetableandmineral, and then add as many noughts as you like and even if you don't take away the number you first thought of the answer in years will still be far too small—there were

no stars in the Milky Way. There was only a large cloud of thin gas called a nebula; and when we say large we mean really large—millions of millions of millions of cubic miles of it, and then some. No one knows how it got there or where it came from; it was just there. For a time it didn't move. Then something happened; perhaps somebody in another nebula¹ sneezed and enabled the force of gravity to get busy, but this is not certain. At any rate, the cloud suddenly began to split up into millions of smaller ones, which swirled and twirled and whirled off from the main body and started on their own. Incidentally, each of these young gas-clouds, though of course millions of times smaller than its mother, was millions² of times bigger than anything, except its mother, that you can possibly imagine.



Sneezed

As time passed, the whole brood gradually became

¹We have spoken of the Milky Way as having once been a nebula (plural *nebulae*, Angela). All the stars that you can see with the naked eye, and lots that you can't, are the Sun's brothers and sisters and the children of this nebula. But astronomers who look through large telescopes—especially in the U.S.A., where telescopes, like stories, run very big, and the mountain air is extremely clear and exhilarating—say that beyond the Milky Way there are other masses, some as yet merely gas-clouds, some in the star stage—in fact, other Milky Ways. Personally we don't believe this and we advise you not to think too much about it. It will only make you dizzy.

²There seem to be a good many millions in this paragraph, but modern astronomy deals in little else; and you can always substitute billions or trillions if you want to—it makes no difference.

more compact in structure, less in size (though still enormous), and globular¹ in shape, till at length they had shrunk to round bonfires or, as we should say, suns or stars. Why bonfires? Because the space through which they moved was one vast blackness, and so it was laid down in the celestial by-laws that all stars must carry lights. Unfortunately, as soon as they lit up they all caught fire and have ever since been blazing away and emitting heat and light in the most extravagant fashion—so much that a good many are already burnt out and floating round invisible, a positive danger to



traffic. The danger, however, is less than one might think, since though the stars, when you look at them through a telescope, seem as thick as a swarm of bees, they have really lots of room and are millions of millions of miles away from each other. Thus collisions are of rare occurrence.

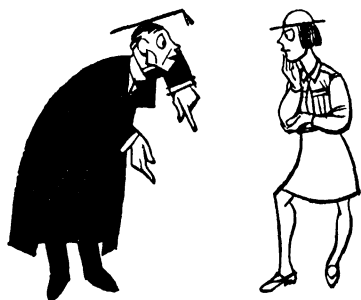
¹We trust you have not forgotten what Pythagoras noticed on page 19,

Curiously enough, though, we owe our existence to the fact that the Sun once very nearly came to grief in an affair of this kind. He was pottering along through space in a quiet, gentlemanly way, exhibiting the regulation firework signals to show everybody exactly where he was, when he noticed a stranger crossing his course. He immediately made for the intruder and shouted out to him to bear away. The other, an unpleasant-looking tough of twice the Sun's tonnage, pretended he hadn't heard and came steadily on, firing broadsides of gravity the while. At length, when they were at quite close quarters, the Sun, now thoroughly annoyed and, to tell the truth, rather frightened, put his tongue out at him. This was what the other had been waiting for. He loosed off a last round of gravity and then rolled chuckling back on to his own beat. When the coast was clear the Sun tried to draw in his tongue again, but found to his surprise that he couldn't. It was riddled through and through with gravity and as stiff as a poker. There was only one thing to be done. With a savage but muffled curse he shut his mouth and bit it off.

The tongue (which, by the way, was millions of miles long) was now stranded and began to feel somewhat lonely. The



temperature, too, outside the Sun was a good deal lower than what it was used to. On the other hand, independence was always something, and to be a heavenly body on your own gave you a sense of self-importance. Thus the tongue was pulled two ways; it was attracted towards the Sun and at the same time rather glad to get outside him. In the end it hit on a compromise. It decided to stick to him in a semi-detached sort of fashion by making rings round

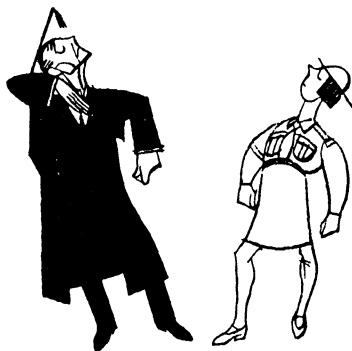


him at a distance just sufficient to keep it warm while preventing any possibility of its being swallowed again. As it turned out, this proved to be a sound scheme. But the tongue had forgotten one thing.

It was a cigar-shaped affair, and to be a cigar-shaped heavenly body for any length of time is against the rules. No sooner had it started cutting rings round its parent than the celestial police fired a lot more gravity at it and smashed it to pieces. These became round balls, and one of the smaller of them was our World. Let us follow the fortunes of this particular pellet a little further.

Being outside the Sun and also free of the rest of the tongue, the World began to cool down and in the course of ages solidified from a gas to a liquid, till it

became a very large drop of hot water surrounded by clouds of steam, but still with a lot of gas inside it. Then the outside hardened into a rock-crust full of bumps and hollows. The latter gradually filled up again with water from the clouds and formed the oceans. Finally, when the temperature had fallen to a certain point (which we will not specify, because we don't know it), minute portions of the crust began to wriggle. They had come alive. This is supposed to have been in 4,000,000,004 B.C., or, as time is reckoned in the Cosmos, about five minutes ago. After passing through all sorts of forms, life has now reached its highest development

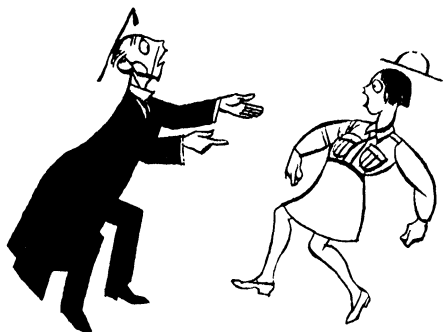


Its highest development

(so far) in a type which may well be represented by you, Angela, and ourselves, the reader and authors of this veracious little book.

What has the Sun been doing since the loss of his lingual appendage? The poor fellow has been dying by inches, or perhaps, we should say, by ounces. To be strictly accurate, he has been, and still is, losing weight to the tune of four million tons a second. For this, though distressing for him, we may be thankful, because it has meant a constant fall in his temperature,

If he had remained as big and hot as he was in his younger days the human race could never have come into existence. As it is, the amount of heat he shoots at us at present is just sufficient to keep us out of the oven on the one hand and the cold-storage refrigerator on the other. As soon as the balance is upset, as it will shortly be in the latter direction, we shall be—well, we just shan't be any longer. By shortly we mean in an hour or two; but don't be alarmed, Angela, because



Don't be alarmed, Angela

that is only cosmically speaking; it will be millions and millions of our years.

Assuming all this to be correct (which we should be sorry to do), we now see what a very, very small potato modern astronomers make man out to be. He has managed to wriggle into existence simply and solely as the result of what one can only call a vulgar brawl between two utterly insignificant heavenly bodies, and

before you can say 'Knife' or 'Jack Robinson' or anything else that is uttered very suddenly and quickly, he will be gone. It is humiliating, Angela. We are left with one consolation, and one only. Owing to the remarkable efficiency of the celestial traffic regulations, such scraps between star and star as we have



*What is the good
of being unique*

described must be very infrequent, and even supposing they do occasionally occur, it is quite possible that none of the others has had exactly similar consequences. Thus man may be unique. But what is the good of being unique if you're nothing more than a foot of film in a cosmic Hollywood reel? Let us get off this painful subject and talk about light.



It is humiliating



Talk about light

Light comes from the stars. Every living star in the sky spends every moment of its time in manufacturing light and flinging it recklessly away in all directions. The planets also pretend that they are doing the same thing. For instance, to look at that deceptive hussy Venus any fine evening, you might think she was a budding sun. But she and all the rest of her crush are really only little tin-pot light-reflectors. Ask her to wink, and she couldn't do it

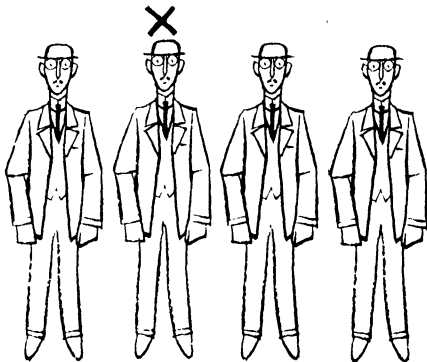


Popular with astronomers

to save her life. That is the star-test; if you can't wink you don't count. Light is the quickest thing there is. It travels at the rate of 186,000 miles

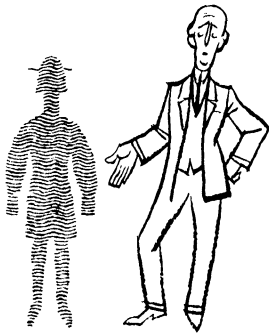
a second, which seems an odd, unround sort of number to choose, but there it is and we can't get away from it. This is a velocity far greater than that of any terrestrial body except an electron or a speed-cop. Sir Isaac Newton thought that a ray of light was a stream of bullets, but we now know that this is wrong; it is actually a lot of very rapid waves. (This, though right at present, will also, of course, be wrong in a short time.) The fact is, waves are pretty popular with

astronomers at the moment. Have you ever met an astronomer, Angela? We don't mean in the street or



Much like other men¹

at a football match or the Boat Race; you might easily have done that without knowing it, because to the outward eye they are much like other men, and few of them to-day wear the distinguishing skull cap and long white beard. We mean face to face, say across the tea-table. If so, we wonder if you realize what impression you made on him. How did he regard you? We can tell you. If he was over thirty² he regarded you as nothing more than just a complex



Just a complex system of waves

¹The Astronomer is indicated by a cross.

²They age very rapidly.

system of waves, waves of electrons. One of the



Makes one's head swim

most eminent and popular of our F.R.S.'s has recently said, 'What we are finding is waves. We are beginning to suspect that we live in a universe of waves, and

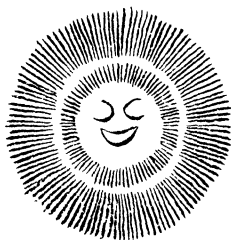
nothing but waves.' It fairly makes one's head swim, doesn't it?



A secret meeting

Well, this undulatory idea is no doubt very jolly, but there is a difficulty about it. Light may be waves, but waves want something to waggle in, and a few miles away from the Earth's surface there's nothing, only space. So some years ago a lot of astronomers held a secret meeting and invented a thing they called the Ether to explain how light gets about the universe. Now whatever opinion one may have of astronomers and physicists, it is impossible to deny that they possess imagination, and on this occasion they gave it free rein. The result was remarkable. To do its job properly the

Ether, which was supposed to occupy the whole of space, had to fulfil certain requirements. Accordingly they made it harder than steel and denser than lead, yet so perfectly elastic that it offered no resistance to bodies moving through it; it was also intangible and invisible. This was the crowning achievement of modern astronomy before Einstein, with whom we shall deal faithfully in the next chapter but one.¹



¹On reading through this chapter we find we have left the Moon out. We hasten to assure her that it was a pure oversight and no slight was intended. She was a bit of the original tongue, and was too small and timid to go round the Sun alone like the other planets. But according to the rules you had to go round something, so she chose the Earth.

VI

SO IS THE ATOM

PEOPLE are accustomed to refer to the atom in slighting terms—those of them, that is, who are not scientists. The latter never speak of it save with bated breath. To take a single instance: when assisting



A private view

at a private view of a new-born infant, admittedly a revolting object, we often, on recovering our power of speech, remark that it is 'a quaint little atom.' Yet, though of meagre proportions an atom, in the mature bloom of its beauty, is, to such as can appreciate and love it, incomparably more attractive than the



'A quaint little atom'

half-baked offspring of the human or, indeed, of any other species.

Of all creatures, known and unknown, the atom is the smallest.¹ It is so small that you cannot cut it in two with a safety-razor blade—hence its name. You

couldn't even try to, because you wouldn't know where it was. The modern atom is invisible. If this is so, how, you may well ask, do we know that it exists? The answer is, we don't. The only thing we do know is that it must. It is well to bear this in mind when reading books on the atom; otherwise you may easily be deluded into imagining that

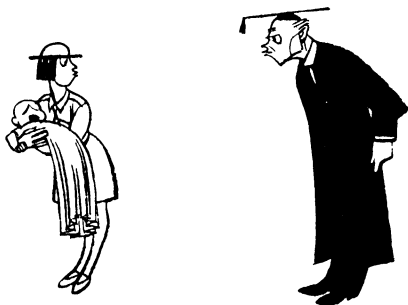
The modern atom

some of these scientists have actually got tame specimens in cages and have been studying their habits for years.² This is not the case; none of them has ever seen one, even through a microscope. How, then, you may ask again—and probably will ask, since, being a girl, you have of course taken

¹It is supposed to be just about as much smaller than a moderately-stout girl-guide of sixteen as she is smaller than the Sun; and when you reflect, Angela, that an expert packer could cram one million three hundred thousand Earths into the Sun and still leave room for her pyjamas and a large bottle of bath-salts, you will see what a teeny weeny thing an atom is.

²Like Democritus, who caught an atom on page 22; but that was, we need hardly say, one of quite a different variety.

sides with that miserable baby in the first paragraph—how can we speak of what no one has ever seen as being beautiful? Don't try to hurry us, Angela. Be patient, and you shall know all.



Taken sides

According to the Greek Democritus and as pictured by dear old Sir Isaac Newton, the earlier atom closely resembled a minute bullet and was, for its size, extremely massive. Its successor, the child (heaven help it!) of the modern scientific imagination, is mostly composed of hot air, or, to be more accurate, of space. It is, in fact, almost entirely a great little emptiness; and we may tell you in confidence, Angela,

• *The earlier atom*

that if it were possible to pump all the space out of the millions and millions of atoms of which you yourself are built up and to squeeze their solid parts

together into a single lump, you would be too small to be seen by the naked eye (which, we may add, would be a pity). Even scientists are really nothing more than glorified gas bags.

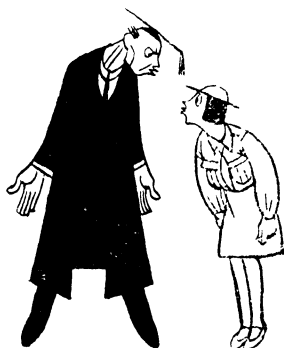
In the middle of this wee space-chamber sits the nucleus—if one can speak of sitting where there is nothing to sit on; perhaps we should say, the nucleus is suspended; at any rate, there it is. The nucleus is made of positive electricity, that is, of real electricity, of electricity that positively is electricity. You must remember this and not think of it as composed of lead



Avoid the errors of the older philosophers

or iron or gravel or anything like that. Let us at all costs avoid the errors of the older philosophers. Round and round the nucleus buzz the electrons, made of negative electricity, an inferior brand. These busy little bodies cut their circles at a perfectly appalling speed; yet, though in some cases there are a lot of them, they

are so orderly and well-conducted that there is no jostling or crowding, which is really rather wonderful when one considers that their aerodrome often has no lights. But they have eyes like cats and can see quite well in the dark. Neither the nucleus nor the electrons take nourishment of any description, but the latter require a certain amount of heat to keep up their circulation. Not too much, though. At excessively high temperatures they get excited, run off the course, and never find their way back again. The middle of the Sun, where the thermometer frequently registers fifty million degrees (Fahrenheit) in the shade, is full of lonely nuclei¹ darting aimlessly hither and thither with piteous cries in search of their lost electrons. On the other hand, excessive cold is just as bad for the electrons. It makes them numb and sluggish; their eyes glaze, their pace slackens, and they finally meet an awful death by crashing on the nucleus.



With piteous cries

‘Why,’ we hear you exclaim at this point, ‘an atom is just like the Solar Cistern!’²

¹Or nuclei, if you insist on it.

²System, Angela, not cistern. Bear this in mind when taking your exam. for the G.G.’s astronomer’s badge.

You are quite right, Angela, it is; and this is what makes it so beautiful. You see now, don't you, how favourably its perfect symmetry compares with the irregular contours of the infant mentioned at the beginning of this chapter? In fact, in the eyes of a scientist, the baby's single redeeming feature is that, if analysed, it would be found to be composed of atoms; and no doubt many a one would, with the mother's permission, be more than willing to melt it down.



VII

AND AS FOR EINSTEIN—!

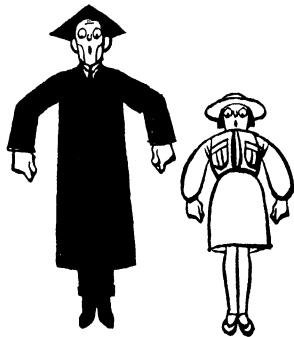
SO far, Angela, it has been pretty plain sailing. Some of the figures may have stunned you slightly. The idea of a nebula being so remote that its light takes



Our bodies are humming

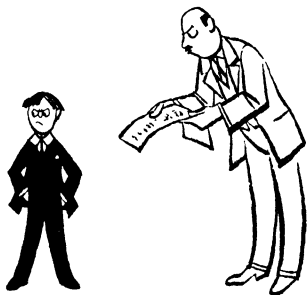
140 million years to get to us even by the non-stop route at the rate of 669,600,000 m.p.h. seems distinctly far-fetched, while to pretend that our bodies are humming with myriads of little planets is obviously absurd. But one expects blows of this kind when dealing with the modern universe; besides, you needn't

believe such statements, you know; we don't ourselves. But, when all is said and done, they are at least understandable; by raising ourselves on our toes and taking a long, deep breath we can grasp them, in a way. In this chapter, however, we are coming to some theories which lie quite outside the reach of the ordinary human intellect,



Taking a long, deep breath

and of which one of our foremost and kindest-hearted scientists has said that unless you are a mathematician you can't possibly hope to grasp them. Now with all our faults and foibles, Angela—and no doubt their name is legion, as whose are not?—we have never, not even in our school reports as a boy, been accused of being mathematically-minded, at least, not in the ultra-modern sense. What we mean is, we can add 2



Our school reports

and 2 together and make the answer come to 4, with any man; but that is our limit; we can't stretch it to 5. It is, then, with a certain diffidence that we approach the



Never piloted an aeroplane

task of explaining to you what is more or less Greek to ourselves. Still, as they told the fellow who said he had never piloted an aeroplane, there's no harm in trying; so if you care to come up with us we will do our best, and if we crash you will never feel it.

In the first place, you must know that astronomy and physics have recently fallen into the hands of a gang of last-word

mathematicians, so lofty of brow that when completing Schedule E they habitually use the Infinitesimal Calculus to reduce their income to its lowest terms. They are scattered in twos and threes over the civilized world, and one particularly little active group is at present located at Cambridge (Eng.), which has of late years become quite an intellectual hot-spot. Probably the worst of the whole crowd is A. Einstein, of Germany, who, though not really an astronomer, has by sheer sum-power done more damage to the universe than any human being of this or any former age. Of whom more anon.



*A. Einstein,
of Germany*

Of course, they are horribly clever; it would be useless to deny it. Look at the following fairly algebraical equation, if you can bear to do so.

$$\text{If } P_c X = \sqrt{\frac{3 \text{ mph } \cos klg \left(\frac{\text{BSA} - \text{MG}}{2 \text{ am}} \right)}{\text{ob}(d - n)}}$$

What on earth is the value of X, given that

$$\text{BP} + = \frac{\text{velocity of light}}{45 \text{ mpg}} ?$$

What meaning does this convey to you, Angela, or even to ourselves? Very little, we fear. Here and there we catch in it glimpses of items that strike us as vaguely familiar, but if we slogged away at the thing for hours

we should fail to solve it. But put it in front of one of our mathematical professors, preferably a Scotchman. It doesn't matter where he is, or what he is doing. Put it in front of him in his bath on a Saturday night, or when he is just going to play his fifth and possibly last putt on the eighteenth green at St. Andrew's. He will give you an answer straight away, almost without bothering to look at it. To these men such sums are child's play. They can do far harder things.



Just going to play his fifth

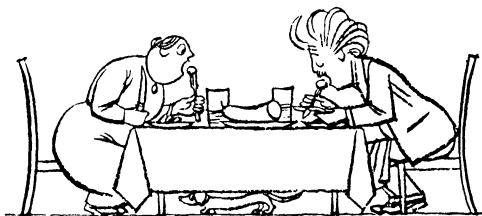


Looks such a nice man

They can think round corners in the Fourth Dimension. They can take an ordinary tennis-ball and turn it inside out without splitting the cover—not actually, of course, but mentally; they can *see* themselves doing it. Can you? We hope not. Now what has brought them to this fearful pass?

Well, it is all owing to a thing called Relativity, which was invented by Albert Einstein. Some sentimentalists are inclined to pity Einstein, because he looks such a nice man. They regard him as a victim of circumstances. They say that he probably never

realized at the time what he was doing, and that after taking the first fatal step he was drawn almost insensibly and quite against his better nature into a career of crime from which there proved to be no escape. We do not share this charitable view. His appearance, which is no doubt harmless enough, almost certainly affords no true index to his character. Many of these mathematical desperadoes have the innocent air and frank,



Went on eating his dinner

merry eyes of little boys. It is a mask. Could you but pierce this, you would be shocked by the cold, calculating ferocity of the brain behind the face. But you shall read the facts, Angela, and judge for yourself.

In the year 1905, after thinking deeply for several minutes, Albert Einstein suddenly said in German and a propos of nothing in particular, 'Nature is such that it is impossible to determine absolute motion by any experiment whatever'—and then went on eating his dinner as if nothing had happened. Considering the rather strained relations between England and Germany at that period, and the fact that it was experiments

in just this direction that British scientists had been trying for some time, it was a tactless remark to make; but the London press decided to ignore it and it was hushed up. The Germans, however, began to encourage Albert Einstein in every possible way, and in 1913 he was made Director of the Kaiser Wilhelm Physical Institute in Berlin with instructions to go full-steam ahead. By 1915 he had completed both his Special¹ and his General² Theory of Relativity. For-



Began to encourage Albert Einstein

tunately, the sinister aims of the German Government were only partially successful. The publication of Einstein's theories, it is true, caused a revolution in British scientific circles, but as a corresponding one occurred simultaneously in Germany itself, it worked out about fifty-fifty. It is pleasant to be able to add that when the War was over British physicists, like the

¹For use in physics laboratories.

²For ordinary domestic use.

sportsmen they are, were among the first to congratulate the German professor on the greatness of his achievement in having upset all their previous ideas.



Sportsmen they are

That it was a remarkable achievement is proved by the fact that ever since the appearance of the Theory of Relativity scientists all over the world have been mainly occupied in trying to understand (1) if it has any



Trying to understand

meaning, (2) if so, what? So far, probably the only person who could give a really conclusive answer to both these questions is Albert Einstein.

The chief result of the principle of Relativity has been to destroy absolute motion, absolute time and absolute space, absolutely. There is in fact only one thing that Albert Einstein has not been able to touch—the speed of light. This is so quick that it has escaped him up to the present, but if he ever gets his hands on it, it is pretty certain to go the way of the rest of them. Let us take these murders in turn.

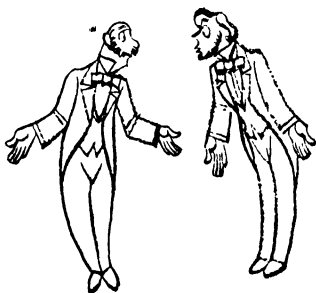


*The World itself
seems to pause*

What do we mean by absolute motion? Think of your head mistress, Angela, entering the Assembly Hall to read morning prayers. As she swims down the floor, the girls and mistresses—even the French mistress—are temporarily stilled. The World itself seems to pause and hang arrested in the heavens. If it were actually doing so, your head mistress' motion would be absolute, because she would be tra-

versing not merely the surface of the planet but space itself at a speed of approximately two knots. This, however, is not the case; the world is rolling on as usual, and its rotation is carrying the dear lady at a speed of several hundred m.p.h. She is also sharing in its motion round the Sun, say nineteen miles a second, and in that of the Sun as a member of the Milky Way, which is itself probably trotting round something else—and so on and so forth. Really, she seems to be moving in all sorts of directions at once at quite alarming speeds,

though she is conscious of only one motion, across the floor of the Assembly-Hall. The motion of all bodies, in short, is relative to that of other bodies, themselves in motion. It was thought at one time that the ether, which was supposed to fill all space and to be at rest, would provide a means of measuring absolute motion; but when they tried to find the Earth's speed through it the dear old planet didn't appear to be moving at all, which was absurd (or, at any rate, they thought so).

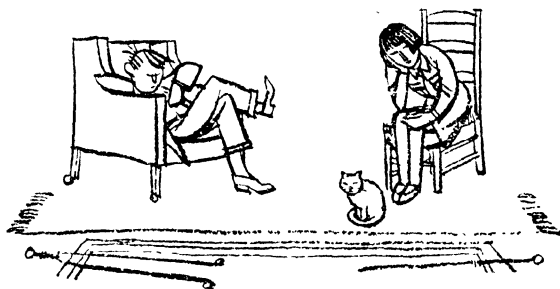


Which was absurd

So they were just obliged, very reluctantly, to wash the ether out altogether. Albert Einstein said it didn't really matter, because he had a mathematical equation in his waistcoat pocket which would do all its ordinary jobs. All the same, we were sorry, personally, to lose the ether. Though thin and slippery, it seemed something to hang on to, better than just a row of figures.

So much for absolute motion; now for absolute time. Here again, following the example of our best F.R.S.'s, we will proceed by means of an illustration.

Let us suppose that the hour is 7.15 p.m., and that you and your young brother Richard are sitting together by the drawing-room fire; and, if it be possible, let it be



By the drawing-room fire

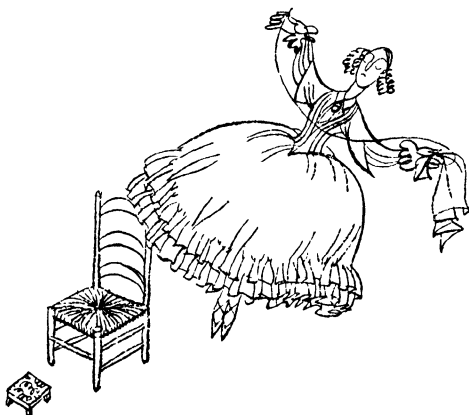
granted that Richard is thinking of presenting you with a bar of milk chocolate. Let us suppose, too, that the shade of your great-grandmother, invisible to both



Your great-grandmother

of you, is occupying a third chair in the room. She is still semi-attached to the family and, perceiving the

struggle in Richard's mind, is watching the dear boy with interest. Ghosts, however, are restless creatures,



Hops off

and Richard is a long time in deciding. Growing impatient, she suddenly hops off for a blow through space. After all, it makes no difference to her; she can see you from anywhere. A quarter of an hour passes, and during that interval your brother has won his silent battle. The bar of chocolate has changed hands and has, as a bar of chocolate, passed out of existence.



*Surprise and
disappointment*

At this point (7.30 p.m.) your great-grandmother glances back, and to her surprise and disappointment sees the

chocolate still reposing in Richard's right-hand trouser-pocket. The fact is, she has forgotten to close her throttle sufficiently and has been travelling at the speed of light. Now for anyone progressing at this speed time remains stationary. Thus at 7.30 she is looking at you at 7.15. Whose time is the genuine article, the sort of thing you would expect to get from



Get from a policeman

a policeman or a post-office—hers or yours? Obviously, she can't be wrong. Your grandmother (still here) is, as you know, always right; how much more, then, your great-grandmother! And yet. . . Well, the truth is, Angela, you are both correct, because there is no longer any such thing as one absolute time throughout the universe, and you and she each have your own.¹

¹We may add that if your G.-G. had really stepped on the gas and gone all out and exceeded the celestial speed-limit—that of light—as spirits are entitled to do, she would have actually passed back through time and would have been seeing you at, say, 7 o'clock or even earlier. Incidentally, this explains why ghosts never grow any older; they are always dodging about fast enough to checkmate time. It also enables them to indulge in their morbid habit of periodically re-enacting some particularly gruesome scene of their earthly career; by simply accelerating sufficiently they can always hark back to such incidents whenever they want to.

The idea of space not being absolute presents more difficulty. We are used to thinking of it as a sort of large room without walls, for holding everything that exists, and things themselves as being so long, so broad and so thick, and actually here or there in space. Exceptions to this rule about things may seem to occur, but they generally turn out to be more apparent than real. For instance, you may remember Richard's remark to you last week about his classical master. The



Requested him to do it again

latter had taken an adverse view of a piece of Latin prose submitted to him by your brother and had requested him to do it again; and though the man was really rather a favourite of Richard's, this had so lowered him in the boy's esteem that he hazarded the opinion that 'Old Brown was not all there.' However, if pressed, Richard would no doubt have contended that he was referring not so much to Mr. Brown's body as to his mind, which he regarded as two-dimensional only—that is to say, possessing possibly length and certainly thickness, but no breadth at all. So, as a mind

is hardly a material object, perhaps this is not a very good illustration. The fact is, Angela, we are finding this particular bit very hard to tackle. But we mustn't



Very hard to tackle

give up. Let's see, where did we leave your great-grandmother? Floating about somewhere beyond Nep-



Floating about somewhere

tune, wasn't she? Very well, leave her there for a moment. Now to take just one of the dimensions of space, what we may call its up-and-downness. As you

stand on the Earth and look at, say, the Moon above your head, that is up; and if you were standing on the Moon and looking at the Earth, *that* would be up, though of course really the opposite direction. In fact, any direction straight away from the surface of any heavenly body is an upward one relatively to that heavenly body. But your great-grandmother, being at present entirely disconnected, has no sensation of upness or downness, only of awayness or distance; and if



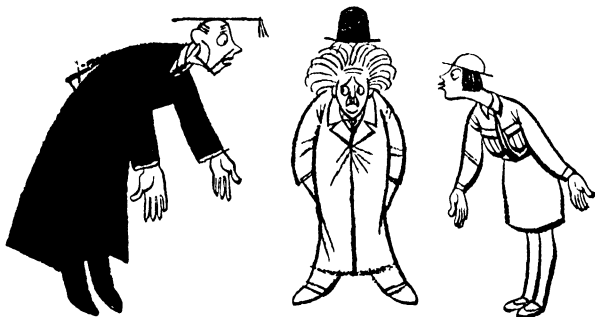
No sensation of upness or downness

it were not for the presence of various planets, stars, comets, etc., she would have no sensation of that either. Space in itself doesn't possess any dimensions at all; they exist only in a relative sense. Thus absolute space is just a figment of your and our imagination.

To sum up, Angela: (1) we have no idea where we are going; (2) we can't say what time it is; (3) we don't

know where we are. Everything is in a complete muddle, and all through this man Albert Einstein.

No matter where one commits a murder, except perhaps at sea,¹ an awkward problem immediately arises:



All through this man Albert Einstein

'What can I do with the body?' Whatever precautions one takes, bits if not the whole of it are nearly always discovered by some interfering poke-nose. Albert Einstein was now confronted with this difficulty. He had



Buried it quietly

three corpses on his hands. Being an astute and resolute fellow, he adopted a bold plan. No questions, he felt sure, would be asked about Absolute Motion; it wasn't wanted and it didn't count. So he just

buried it quietly in his back garden. He was right.

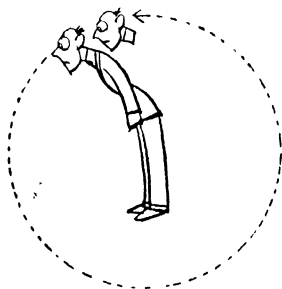
¹Sharks will undertake anything, and make no extra charge for buttons or boots.

No one bothered about the old thing. But with Absolute Time and Space it was quite another pair of shoes. People would miss them. A fuss might easily be



Other members of the gang

made. So he got some other members of the gang¹ to help him, and between them they first hammered the now nearly rigid bodies of Time and Space together till it was impossible to tell one from the other, and then bent them into a four-dimensional Space-Time Continuum. The result is that the universe is now curved instead of straight, and if you stand and stare hard enough in front of you you can look right round the Continuum at



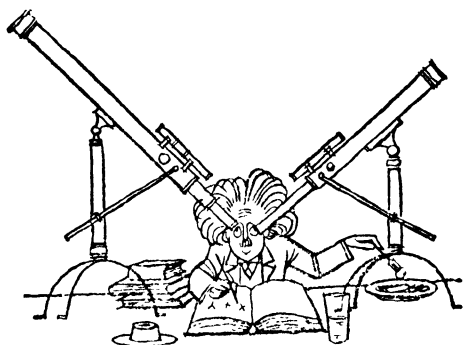
The back of your own neck

the back of your own neck. This cunning move was also successful. The new name sounded so imposing that a general impression arose that the murderer had

¹Especially a person called Minkowsky,

really done his victims a favour by turning them into something grander than they had ever been before. Thus he got away with it completely.

Since then Albert Einstein's life has been one of incessant and dreadful activity. He has deduced the



Dreadful activity

Law of Radiation by actually daring to use the Generalized Bohr Atom¹ instead of Planck's Linear Oscillator, a thing few men would have had the courage to do. But he fears nothing; he just took the G.B.A. in his hand and scratched it behind the ears, and it purred at him like a cat. He has found out things about molecules that have made them blush with shame and rage. He has detected light in not running straight. He has knocked the Law of Gravitation endways. But these achievements are merely side-lines. So far, his reputation rests mainly on his Theory of Relativity. So far,

¹A larger and more savage creature than the common atom.

we say; he is only fifty-three. A solemn thought, Angela.

Meanwhile, what of the universe? In these pages we have seen it as an onion, a flat board with a cover, and an orange. In the hands of one of Einstein's disciples it has lately become a wrinkled soap-bubble, while another declares it is an egg-boiler. Whom are we to believe? In any case, let it not be Albert Einstein himself. Just of late that man of wrath has been ominously silent; but it is known that he already regards the material universe merely as the X of a mathematical equation, and there seems little doubt that before long he will get the answer he wants:

$$X = 0.$$



VIII

THE THING IS SIMPLE, REALLY

AND yet, Angela, the world goes on. After all the efforts of astronomers and mathematicians first to reduce it to a speck of sidereal dust and latterly to think it out of existence altogether, this seems strangely obstinate of the World. It seems almost cheek. But here it is, the same big, solid, hefty lump of land, water and whatever is in the middle of it, as it has always been. And the stars, which we are told are really colossal masses of blazing gas or, alternatively, bits of the great O of Einstein's final answer—the stars, as far



Friendly little lamps of the night sky

as we can see, are neither this nor that, but remain for us, as for Adam, just friendly little lamps of the night sky.

Frankly, we don't believe a word of all this modern quack about the universe, and in our opinion it has



been given too much rope. Copernicus and Newton and the rest of those previous old boys are now beyond our reach, but surely we could, if we chose, do something to check the criminal activities of our present-day as-



tronomers. For their own sakes, too, we should try to save them from themselves; after all, they are our brothers. It is, indeed, high time definite steps were taken. A strangely hilarious note has of late crept into some of their writings. Not long since we read a book by one of them on the first page of which he confessed that he was sitting in two chairs at two tables¹ and could see twos of everything all over the room.



Rounded up

What is one to make of such statements? The fact is, *these men ought not to be at large*. They should be rounded up

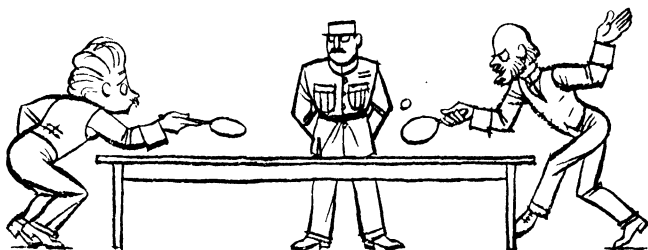
¹One made of wood, the other (he said) of electricity and space,

and placed in a home, situated preferably on the southern shore of Iceland. Here, adequately housed and fed, provided by day with plenty of healthy



Manual work

manual work and in the evening with light but wholesome literature and indoor games, and, most im-



Indoor games

portant of all, cut off by continual atmospheric depressions from communion with the heavenly bodies, they would have a chance to reform. One or two might,

nay, probably would, develop poetry, but this could be cured by special dieting and in any case would do little harm. After a term of ten years they should be released on ticket-of-leave and furnished with a small sum of money and a free passage to the upper Amazon valley



Upper Amazon valley

or central Africa. Their books should, of course, be called in and burnt.

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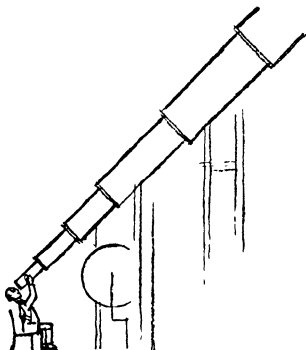
And now, Angela, you are expecting us to fulfil the promise we made you on page 11 and to set before you our own scheme of the universe. We are ready, more than ready, to do so. But first a word in your ear. Our theory, *in the completed form in which we shall present it*, is a simple one; it is short, it is easy, it has been stripped of its higher-mathematical clothing, a child can understand it. We do not propose (it would, indeed, be sheer

cruelty) to inflict on you the hair-raising calculations through which, with the aid of a ready reckoner, we



Hair-raising calculations

have so painfully waded; we will spare you the details of the laborious researches we have undertaken in the British Museum, the Bodleian, the Vatican, the Universities of Paris, Harvard, and Peking, and the popular-science section of the library of our local Teachers' Guild; we will make no mention of the midnight and



Enormous telescopes

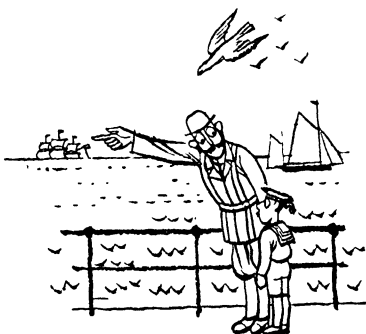
other oil we have burned during years of unremitting study, of the enormous telescopes through which we have surveyed every quarter of the starry heavens, of the numberless scientists and astronomers of Europe, Asia, America and Polynesia whom we have inter-

viewed and smitten, for once, into astonished silence. Not a syllable of all this shall escape our pen. We will

give you our results in their brief, naked simplicity, merely remarking that we have up our sleeve such irrefutable proofs of every statement we shall make that there can be no reasonable doubt of our theory's being instantly accepted by any intelligent person (including, of course, those of your own sex) who cares to correspond with us on the subject.¹

Let us begin with the Earth, which is obviously in the middle of everything. How did it get here? We cannot say. It must either have come into existence out of nothing, which is a miracle, or else have had no beginning at all, which is equally hard to understand. It doesn't matter, anyway.

What is the shape of the Earth? To ascertain this we have made various experiments. In our early boyhood we were always told, during the family summer



In our early boyhood

holidays, to watch ships fading slowly head-first (or tail-first—we can't remember which) below the horizon instead of merely falling over the edge anyhow. Our father said that this proved that the Earth was an

¹ To all whom it may concern :

If you really *must* write, kindly address us care of our Publishers, Oxford or New York, and enclose 2s. 6d. P.O. for office expenses. N.B., no circulars, no bills.

oblate spheroid, and as he always kept the telescope and could see better than we could, we took his word for it. Later on we corrected this impression. By means of careful observations, taken mainly from the Calf of Man and the upper seams of Arthur's Seat,¹ we satisfied ourselves that the Earth is a round oblong about half way between a rugger and a soccer football.

One often hears it confidently asserted that the Earth revolves on its axle. Is this true? Is it attached to a bar of any kind? It was once. The axle was cut off by Henry VIII to annoy the Pope, but a portion of it still



Cut off by Henry VIII

goes right through the globe and its ends can be seen sticking out at the top and bottom. These are now known as the North and South Poles. The Earth, however, no longer revolves round it (if it ever did), as you may easily prove by a simple experiment. Go and stand beside the North Pole for one minute. Don't move or fidget or start scratching your name on it; just stand quite still. Then run down to the Equator. If you

¹A low but geologically interesting mountain outside Edinburgh. We live near it.

go straight you can't miss it, because it encircles the Earth's waist as a plainly visible imaginary white-chalk line three inches wide. Stand on this, again for one minute, and whatever you do, be careful not to rub it

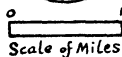
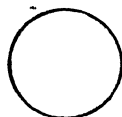


Hot and sticky

out or smudge it, or trespassers really will be prosecuted. Do you notice any difference? None at all, except that instead of being half frozen you are feeling hot and sticky all over. Now don't you see that if the Earth had been going round at the Equator at a thousand miles an hour, and taking you with it, you

would have been standing in a simply appalling draught? You do see that, don't you? Very well, then. The Earth is at rest.

Apart from aeroplanes, which don't count, the nearest of the heavenly bodies is the Sun. The Sun, following the example of the Earth, has adopted a globular shape. His surface is covered with hot gold, which is kept at a constant temperature partly by internal combustion engines and partly by radiation from the Earth. Though his size cannot be gauged with any accuracy, he is certainly very much bigger than he looks and quite possibly not less than a mile in diameter. He revolves round the Earth once in twenty-four hours by Big Ben and is always exactly on time. Why does he rise earlier and climb higher in



The Sun

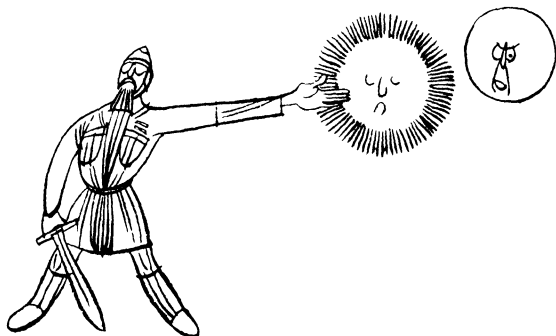
summer than in winter? Well, you see, when it is our summer it is their winter down under and vice versa. The Sun, realizing this and being a glutton for warmth, has arranged his revolutions in a sort of spiral. This ensures him a little variety and a maximum of fine weather. Not long ago his calculations were nearly upset by the rather inconsiderate introduction, without giving him adequate notice, of summer time instead of the G.M.T. with which he was familiar; but he got



A horde of Amorites

right again by taking a quick jump forward at the beginning of April and standing easy for an hour at the end of September. The only other authenticated instance of any irregularity in his rounds occurred about 1200 B.C., over Palestine. The Jewish forces, commanded by General Joshua, a man of infinite sagacity and resource, were engaged in wiping out a horde of Amorites and only wanted a little extra daylight to

make a job of it. Suddenly the General raised his hand and ordered the Sun to stop. The latter, mistaking his blue uniform for that of a policeman, did as he was



Raised his hand

told and actually allowed himself to be held up for several hours. The Moon did the same. If she hadn't, she would have run into the Sun from behind, because at that period she used to follow him at an equal

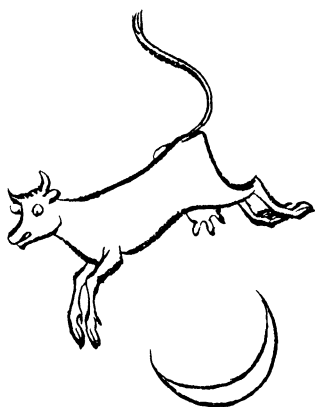


Solitary man and a dog

distance from the Earth. She was, however, very angry about it, and made such a fuss that the celestial authorities decided to shift her into another orbit farther off. That is why she is now so much colder than the Sun. She is the same shape and, though really larger, looks about the same size, owing to her greater remoteness in

space. Her outside is of chilled silver. For many centuries she has been inhabited by a solitary man and a dog,

who must both be possessed of remarkable vitality,



since the temperature is practically arctic. Only once, it is said, has the monotony of their existence been broken. Many attempts have been made by daring novelists and others to get to the Moon from the Earth. Except in a single instance, all have failed, and even then the mark seems to have been

overshot and no landing effected. Tradition has it that on the 29th February of some year unknown a British shorthorn cow jumped over the Moon. On that occasion the dog is stated to have laughed.¹

About the insides of the Earth, Sun and Moon we know nothing. Perhaps it is as well.

The stars seem to have been an afterthought.² They are of two varieties. The planets, seven in number, are by way of being young worlds and, though at present very small, may



Star



in time increase considerably in size. They are

¹We give the story for what it is worth. The documentary evidence for it is slight.

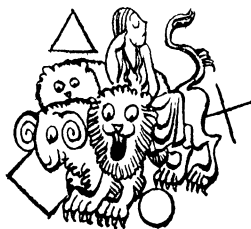
²At least, according to Genesis i, 16.

farther off than the Sun, and as they get round the Earth in the same time, must therefore be travelling a good deal faster than he does. Life, indeed, for them is one long, anxious rush, which retards their growth. However, this suits us all right. We don't want them



Making eyes growing as big as we are. That might easily cause all sorts of complications and unpleasantnesses. They are better as they are. The most precocious of them is Venus, who can usually be seen at twilight making eyes all over the sky.

The fixed stars are quite different. They are pretty little electric lamps and are attached to a transparent shell¹ of triplex which encases the upper air to prevent its being blown off into space. Formerly, before it was sawn off, the pole which runs through the centre of the Earth used to extend as far as this air-cover in both directions and provided a real axle for it to revolve on. The shell no longer has any support of the kind, but such is the force of habit that it continues to turn slowly round the Earth once in twenty-four hours just as if the axle were still there. The lamps are arranged in groups representing not only crosses, triangles, squares and circles, but also lions, bears, rams, virgins and other interesting animals. Unfortunately, as many of the stars

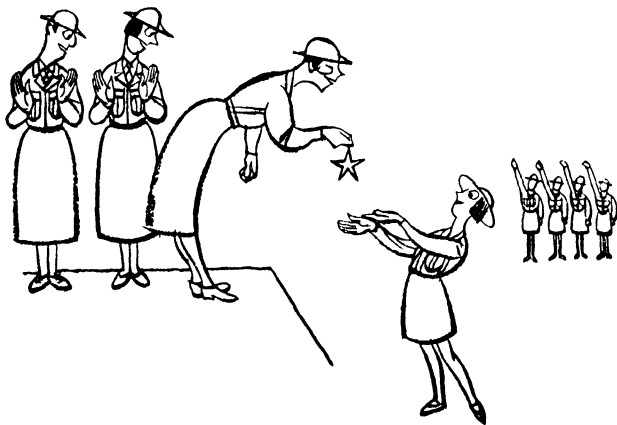


Interesting animals

¹So Ptolemy wasn't so far out, after all.

are too small to be seen from the Earth, large gaps occur in the designs which make it impossible for us to appreciate their true beauty. They were not, however, constructed for our benefit, but for that of the Sun—to show him where the air-casing was so that he shouldn't barge into it by accident, and to give him some instruction in the elements of geometry, zoology and mythology.

You see, Angela, the thing is very simple; indeed, it is possible to learn the whole of astronomy, or, at any rate, the part that really matters, in about five minutes. Once you have thoroughly grasped this last chapter, you've got it. So go ahead and take the exam. for your astronomer's badge as soon as you like—and the best of luck to you, dear girl.



SEEDED INDEX

COMPILED BY A YOUNG FRIEND; WITH INTRODUCTORY REMARKS AND FOOTNOTES BY THE AUTHOR

No one, I imagine, who has read this volume is likely to question my veracity when I say that it has entailed a mass of research work, more indeed than I should care ever again to cram into a space of three weeks. It has also cost a lot of hard, high thinking, in trains and buses and lifts and armchairs, with the eyes sometimes open and sometimes shut. When operated at full speed, lifts are a great aid to concentration of thought. I have often hired one at a block of offices near my house for a couple of hours after closing time and given the boy a generous tip to go hell for leather. It was, I remember, one evening just at the beginning of the fortieth drop—when I was experiencing a sensation of absolute detachment from all the world, including my own inner fixtures—that I really got a glimpse of the meaning of Einstein's Theory of Relativity. I lost it again before we got to the bottom, but for the moment it had been as clear as mud. I mention this to give you some idea of what I went through in merely planning the book. Next came the actual writing of it, first in pencil and after that a fair copy in ink—over 18,000 words and a good many necessitating the use of a dictionary. Finally there was the proof-reading—a ghastly job. I was now quite played out and fit for nothing but six months' complete rest in the Rockies or the South Pacific or somewhere quiet like that. *And then they demanded an index.*

Do you know, I felt I really couldn't. We had a long argument about it (conducted on one side, at least, though I say it, with great restraint), and matters were beginning to look really serious when I suddenly recollected a young friend of mine, a Girl Guide who has recently won her Index-Maker's proficiency badge. I asked her if she would do me one of those good turns in which Scouts and Guides are popularly reputed to specialize. She said, "With pleasure, at twopence a word," and she took it I wanted a good long exhaustive index. I said, "Not at all; make it as short as possible and leave out everything you can." She said, "Well, then, funny, I suppose?" I said, "What do you mean by funny? This is not a humorous book." She said, "Isn't it? Well, the pictures are." I said, "That was the artist, not me; he can't help it." She said, "Well, you ought to have warned him." I said, "I wish you wouldn't keep on saying 'well' like that. It makes me giddy." She said, "Oh, very well; but all the same it certainly *is* humorous in parts." I said, "Have it your own way." So she had it and did the thing and charged me £5 6s. 6d. for it (with carbon copy, which I never asked her for).

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¹A better definition than mine, I fancy. She has her points.

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¹Spiteful—what?²She probably thought this was an American animal.³Her view, not mine.⁴Getting at me again.

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¹Idiot! Claudius. He wasn't a film star.

²The little cat! She thought she really had me there. But this is not, as it happens, a book on astrology. In my opinion, the sole value of this index lies in the revelation it affords of the working of the modern young female mind. What *was* Baldwin doing in 1928? Heaven help us all Amen.

