Arthur Koestler

The Sleepwalkers

A History of Man's changing vision of the Universe

With an Introduction by Herbert Butterfield

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3 The Universe of the Schoolmen

1. *The Thaw*

I have compared Plato and Aristotle to twin stars which alternate in visibility. Broadly speaking, from the fifth to the twelfth century, Neoplatonism in the form in which St Augustine and the pseudo-Dionysius had imported it into Christianity, held the sway. From the twelfth to the sixteenth century, it was the turn of Aristotle.

Except for two of his logical treatises,[1] Aristotle's works had been unknown before the twelfth century – buried and forgotten, together with Archimedes, Euclid, the atomists, and the rest of Greek science. What little knowledge survived had been handed down in sketchy, distorted versions by the Latin compilers and the Neoplatonists. Insofar as science is concerned, the first six hundred years of established Christendom were a glacial period with only the pale moon of Neoplatonism reflected on the icy steppes.

The thaw came not by a sudden rise of the sun, but by ways of a devious Gulf-stream which wended its way from the Arab peninsula through Mesopotamia, Egypt, and Spain: the Moslems. In the seventh and eighth centuries, this stream had picked up the wreckage of Greek science and philosophy in Asia Minor and in Alexandria, and carried it in a circumambient and haphazard fashion into Europe. From the twelfth century onwards, the works, or fragments of works, of Archimedes and Hero of Alexandria, of Euclid, Aristotle, and Ptolemy, came floating into Christendom like pieces of phosphorescent flotsam. How devious this process of Europe's recovery of its own past heritage was, may be gathered from the fact that some of Aristotle's scientific treatises, including his *Physics*, had been translated from the original Greek into Syriac, from Syriac into Arabic, from Arabic into Hebrew, and finally from Hebrew into medieval Latin. Ptolemy's

Almagest was known in various Arab translations throughout the Empire of Harun Al Rashid, from the Indus to the Ebro, before Gerardus of Cremona, in 1175, retranslated it from the Arabic into Latin. Euclid's *Elements* were rediscovered for Europe by an English monk, Adelard of Bath, who around 1120, came across an Arabic translation in Cordova. With Euclid, Aristotle, Archimedes, and Ptolemy recovered, science could start again where it had left off a millennium earlier.

But the Arabs had merely been the go-betweens, preservers and transmitters of the heritage. They had little scientific originality and creativeness of their own. During the centuries when they were the sole keepers of the treasure, they did little to put it to use. They improved on calendrical astronomy and made excellent planetary tables; they elaborated both the Aristotelian and the Ptolemaic models of the universe; they imported into Europe the Indian system of numerals based on the symbol zero, the sine function, and the use of algebraic methods; but they did not advance theoretical science. The majority of the scholars who wrote in Arabic were not Arabs but Persians, Jews, and Nestorians; and by the fifteenth century, the scientific heritage of Islam had largely been taken over by the Portuguese Jews. But the Jews, too, were no more than go-betweens, a branch of the devious Gulf-stream which brought back to Europe its Greek and Alexandrine heritage, enriched by Indian and Persian additions.

It is a curious fact that the Arab-Judaic tenure of this vast body of knowledge, which lasted two or three centuries, remained barren; whilst as soon as it was reincorporated into Latin civilization, it bore immediate and abundant fruit. The heritage of Greece was obviously of no benefit to anybody without some specific receptiveness for it. How this readiness to rediscover its own past, and be fertilized by it, as it were, arose in Europe is a question that belongs to the field of general history. The slow increase in security, in trade and communications; the growth of towns and the development of new crafts and techniques; the invention of the magnetic compass and the mechanical clock, which gave man a more concrete feeling of space and time; the utilization of water power, and even the

improved harnessing of horses, were some of the material factors which quickened and intensified the pulse of life and led to a gradual change in the intellectual climate, a thaw in the frozen universe, a diminution of apocalyptic fear. As men ceased to blush at the fact of having a body, they also ceased to be frightened of using their brains. It was still a long way to the Cartesian *cogito ergo sum*. But at least the courage was reborn to say: *sum, ergo cogito*.

The dawn of this early, or 'first' Renaissance is intimately connected with the rediscovery of Aristotle – more precisely, of the naturalistic and empirical elements in him, of that side of Aristotle which is averted from his twin star. The alliance, born of catastrophe and despair, between Christianity and Platonism, was replaced by a new alliance between Christianity and Aristotelianism, concluded under the auspices of the Angelic Doctor, Thomas Aquinas. Essentially, this meant a change of fronts from the negation to the affirmation of life, a new, positive attitude to Nature, and to man's striving to understand nature. Perhaps the greatest historical achievement of Albert the Great and Thomas Aquinas lies in their recognition of the 'light of reason' as an independent source of knowledge beside the 'light of grace'. Reason, hitherto regarded as *ancilla fidei*, the handmaid of faith, was now considered the bride of faith. A bride must, of course, obey her spouse in all important matters; nevertheless, she is recognized as a being in her own right.

Aristotle had not only been a philosopher, but also an encyclopaedist in whom a little of everything could be found; by concentrating on his hard-headed, down-to-earth, non-Platonic elements, the great schoolmen brought back to Europe a whiff of the heroic age of Greece. They taught respect for 'irreducible and stubborn facts'; they taught 'the priceless habit of looking for an exact point and of sticking to it when found. Galileo owes more to Aristotle than appears on the surface . . .: he owes him his clear head and his analytic mind'.[2]

By using Aristotle as a mental catalyzer, Albert and Thomas taught men to think again. Plato maintained that true knowledge could only be obtained intuitively, by the eye of the soul, not of the body; Aristotle had stressed the importance of experience – *empiria* – as against intuitive *aperia*:

> It is easy to distinguish those who argue from fact and those who argue from notions. ... The principles of every science are derived from experience: thus it is from astronomical observation that we derive the principles of astronomical science.[3]

The sad truth is that neither Aristotle himself, nor his Thomist disciples, lived up to their lofty precepts, and as a result scholasticism went into decline. But during the honeymoon period of the new alliance all that mattered was that 'the philosopher' (a title for which Aristotle acquired the exclusive monopoly among the schoolmen), had upheld the rationality and intelligibility of Nature; that he made it a duty of man to take an interest in the world around him by observation and reasoning; and that this fresh, naturalistic outlook freed the human mind from its sickly infatuation with the Neoplatonic *Weltschmerz*.

The renaissance of learning in the thirteenth century was full of promise – the stirrings of a patient who emerges from a long, comatose state. It was the century of Robert of Lincoln and Roger Bacon, the first who understood, far ahead of his time, the principles and methods of empirical science; of Peter Peregrine, who wrote the first scientific treatise on the magnetic compass, and of Albert the Great, the first serious naturalist since the Plinys, who studied insects, whales, and polar bears, and gave a fairly complete description of German mammals and birds. The young universities of Salerno and Bologna, of Paris, Oxford and Cambridge, radiated the new fervour of learning which had brought on the thaw.

2. *Potency and Act*

And yet after these great and hopeful stirrings, the philosophy of nature gradually froze up again in scholastic rigidity – though not entirely this time. The reason for this short splendour and long decline can be summed up in a single phrase: the rediscovery of Aristotle had changed the intellectual climate of Europe by encouraging the study of nature; the concrete teach-

ings of Aristotelian science, elevated into dogmas, paralysed the study of nature. If the schoolmen had merely listened to the cheerful and encouraging timbre in the Stagyrite's voice, all would have been well; but they made the mistake of taking in what it actually said – and insofar as the physical sciences are concerned, what it said was pure rubbish. Yet for the next three hundred years this rubbish came to be regarded as gospel truth.[4]

I must now say a few words about Aristotelian physics, for it is an essential part of the medieval universe. The Pythagoreans had shown that the pitch of a tone depends on the length of a cord, and had thus pointed the way to the mathematical treatment of physics. Aristotle divorced science from mathematics. To the modern mind, the most striking fact about medieval science is that it ignores numbers, weight, length, speed, duration, quantity. Instead of proceeding by observation and measurement, as the Pythagoreans did, Aristotle constructed, by that method of *a priori* reasoning which he so eloquently condemned, a weird system of physics 'argued from notions and not from facts'. Borrowing his ideas from his favourite science, biology, he attributed to all inanimate objects a purposeful striving toward an end, which is defined by the inherent nature or essence of the thing. A stone, for instance, is of an earthly nature, and while it falls toward the centre of the earth it will increase its speed, because of its impatience to get 'home'; and a flame will strive upward because its home is in the sky. Thus all motion, and all change in general, is the realization of what exists potentially in the nature of the thing: it is a transition from 'potency' to 'act'. But this transition can only be achieved with the help of some other agent which itself is in the 'act';[5] thus wood which is potentially hot, can be made *actually* hot only by fire, which is *actually* hot. Similarly, an object moving from A to B, being 'in a state of potency with respect to B', can only reach B with the help of an *active mover*: 'whatever is moved must be moved by another'. All this terrifying verbal acrobacy can be summed up in the statement that things only move when they are pushed – which is as simple as it is untrue.

Indeed, Aristotle's *omne quod movetur ab alio movetur* – whatever is moved must be moved by another – became the main obstacle to the progress of science in the Middle Ages. The idea that things only move when they are pushed seems, as a modern scholar remarks,[6] to have originated with the painful motion of oxcarts over bad Grecian roads, where friction was so great that it annihilated momentum. But the Greeks also shot arrows, threw the discus and spears – and yet chose to ignore the fact that once the initial impulse had been imparted to the arrow, it continued its motion, without being pushed, until gravity brought it to an end. According to Aristotelian physics, the arrow, the moment it ceased to have contact with its mover, the bowstring, ought to have fallen to the earth. To this the Aristotelians gave the answer that when the arrow started moving while still pushed by the bow, it created a disturbance in the air, a kind of vortex, which kept dragging it along its course. Not before the fourteenth century, not for seventeen hundred years, was the objection raised that the air-commotion caused by the arrow's start could not be strong enough to make it continue its flight against the wind; and furthermore that if a boat, kicked away from the shore, continued to move merely because it was pulled along by the commotion in the water which the boat itself had caused, then the initial kick should be sufficient to make it traverse the ocean.

This blindness to the fact that moving bodies tend to persist in their movement unless stopped or deflected, prevented the emergence of a true science of physics until Galileo.[7] The necessity for every moving body to be constantly accompanied and pushed along by a mover, created 'a universe in which unseen hands had to be in constant operation'.[8] In the sky, a host of fifty-five angels were needed to keep the planetary spheres moving around; on earth, each stone rolling down a slope, and each drop of rain falling from the sky, needed a quasi-sentient purpose functioning as its 'mover', to get from 'potency' to 'act'.

There was also a distinction between 'natural' and 'violent' motion. Heavenly bodies moved in perfect circles, because of

their perfect nature; the natural motion of the four elements on earth was along straight lines – earth and fire along vertical, water and air along horizontal lines. Violent motion was everything that departed from the natural. Both types of motion needed movers, spiritual or material; but the heavenly bodies were incapable of violent motion; hence objects in the sky, such as comets, whose motion was not circular, had to be placed in the sub-lunary sphere – a dogma to which even Galileo conformed.

How is it to be explained that a view of the physical world, so fantastic to the modern mind, could survive even the invention of gunpowder, into an age when bullets and cannon-balls were flying about in obvious defiance of the prevailing laws of physics? Part of the answer is contained in the question: the small child, whose world is still closer to the primitive than to the modern mind, is an unrepentant Aristotelian by investing dead objects with a will, a purpose, an animal spirit of their own; and we all revert to Aristotle in moments when we curse an obstinate gadget or a temperamental motor-car. Aristotle regressed from the abstract-mathematical treatment of physical objects to the animistic view, which evokes so much deeper, primordial responses in the mind. But the days of primitive magic were then past; Aristotle's is a highbrow version of animism, with quasi-scientific concepts like 'embryonic potentialities' and 'degrees of perfection' imported from biology, with a highly sophisticated terminology and an impressive logic-chopping apparatus. Aristotelian physics is really a pseudo-science, out of which not a single discovery, invention or new insight has come in two thousand years; nor could it ever come – and that was its second profound attraction. It was a static system, describing a static world, in which the natural state of things was to be at rest, or to come to rest at the place where by nature they belonged, unless pushed or dragged; and this scheme of things was the ideal furnishing for the walled-in universe, with its immutably fixed Scale of Being.

So much so, that Aquinas' celebrated First Proof of the existence of God was entirely based on Aristotelian physics. Everything that moves needs something else that moves it; but this regress cannot go on to infinity; there must be a limit to it, an agency which moves other things without itself being moved; this unmoved mover is God. In the following century, William of Ockham,* the greatest of the Franciscan schoolmen, made mincemeat of the tenets of Aristotelian physics on which Aquinas' First Proof rested. But by that time scholastic theology had completely fallen under the spell of Aristotelianism – and particularly of the most sterile, pedantic, and at the same time ambiguous elements in Aristotle's logical apparatus. Another century later Erasmus cried out:

> They will smother me beneath six hundred dogmas; they will call me heretic and they are nevertheless Folly's servants. They are surrounded with a bodyguard of definitions, conclusions, corollaries, propositions explicit and propositions implicit. Those more fully initiated explain further whether God can become the substance of a woman, of an ass, of a pumpkin, and whether, if so, a pumpkin could work miracles, or be crucified. ... They are looking in utter darkness for that which has no existence whatever.[9]

The union between the Church and the Stagyrite, which had started with so much promise, turned out to be a misalliance, after all.

3. *The Weeds*

Before we take leave of the medieval universe, a brief word must be said of astrology, which will crop up again repeatedly in later parts of this book.

In the days of Babylon, science and magic, calendar-making and augury, were an indivisible unity. The Ionians separated the wheat from the chaff; they took over Babylonian astronomy, and rejected astrology. But three centuries later, in the spiritual bankruptcy following the Macedonian conquest, 'astrology fell upon the Hellenistic mind as a new disease falls upon some remote island people'.[10] The phenomenon repeated itself after the collapse of the Roman Empire. The medieval landscape is grown over with the weeds of astrology and alchemy, which invade the ruins of the abandoned sciences.

* 1300–49.

When building started again, they got mixed up in the materials, and it took centuries to clean them out.*

But the medieval addiction to astrology is not merely a sign of 'failure of nerve'. According to Aristotle, everything that happens in the sub-lunary world is caused and governed by the motions of the heavenly spheres. This tenet served as a rationale for the defenders of astrology, both in antiquity and the Middle Ages. But the affinity between astrological reasoning and Aristotelian metaphysics goes deeper. In the absence of quantitative laws and causal relations, the Aristotelian thought in terms of affinities and correspondences between the 'forms' or 'natures' or 'essences' of things; he classified them by categories, and sub-categories: he proceeded by deduction from analogies, which were often metaphorical, or allegorical, or purely verbal. Astrology and alchemy employed the same methods, only more freely and imaginatively, undeterred by academic pedantry. If they were weeds, medieval science itself had become so weedy, that it was difficult to draw the line between the two. We shall see that Kepler, the founder of modern astronomy, was chronically unable to do so. No wonder, then, that 'influences', 'sympathies' and 'correspondences' between planets and minerals, humours and temperaments, played an integral part in the medieval universe, as a semi-official complement to the Great Chain of Being.

4. *Summary*

'In the year 1500 Europe knew less than Archimedes who died in the year 212 B.C.,' Whitehead remarks in the opening pages of his classic work.[11]

I shall try to sum up briefly the main obstacles which arrested the progress of science for such an immeasurable time. The first was the splitting up of the world into two spheres, and the mental split which resulted from it. The second was the geocentric dogma, the blind eye turned on the promising

* Even today, when the house-physician diagnoses *influenza*, he unknowingly ascribes its cause to the evil *influence* of the stars, from which all plagues and pestilences are derived.

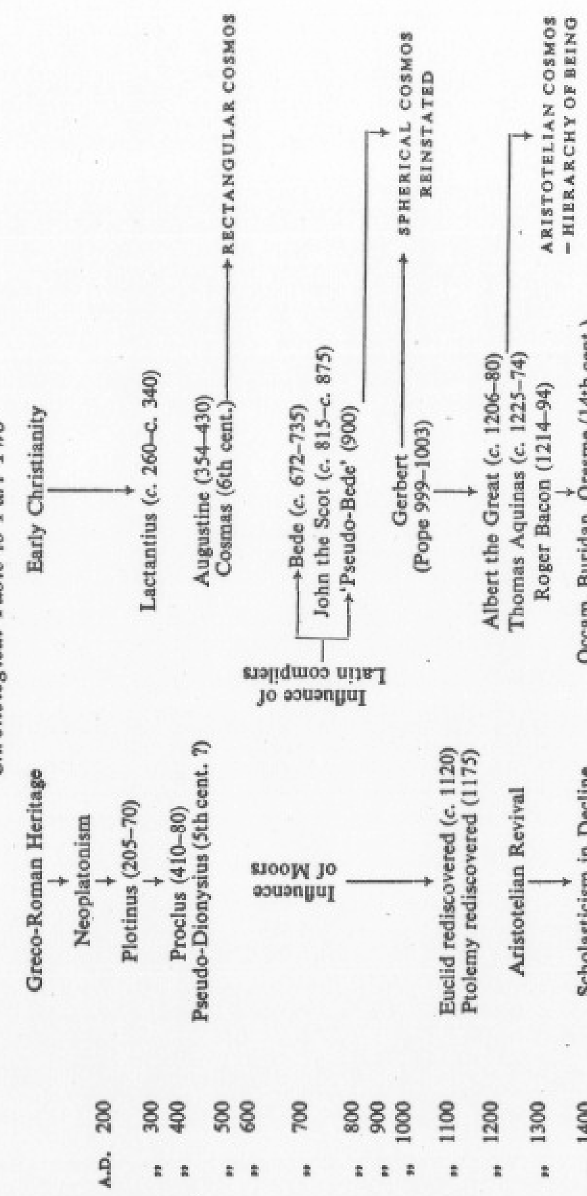
line of thought which had started with the Pythagoreans and stopped abruptly with Aristarchus of Samos. The third was the dogma of uniform motion in perfect circles. The fourth was the divorcement of science from mathematics. The fifth was the inability to realize that while a body at rest tended to remain at rest, a body in motion tended to remain in motion.

The main achievement of the first part of the scientific revolution was the removal of these five cardinal obstacles. This was done chiefly by three men: Copernicus, Kepler, and Galileo. After that, the road was open to the Newtonian synthesis; from there on the journey led with rapidly gathering speed to the atomic age. It was the most important turning point in man's history; and it caused a more radical change in his mode of existence than the acquisition of a third eye or some other biological mutation could have achieved.

At this point the method and style of this narrative will change. The emphasis will shift from the evolution of cosmic ideas to the individuals who were chiefly responsible for it. At the same time, we plunge into a new landscape under a different climate: the Renaissance of the fifteenth century. The sudden transition will leave certain gaps in continuity; these will be filled in as the occasion arises.

However, the first of the pioneers of the new era did not belong to it, but to the old one. Though born into the Renaissance, he was a man of the Middle Ages: haunted by its anxieties, ridden with its complexes, a timid, conservative cleric, who started the revolution against his will.

Chronological Table to Part Two



Part Three. The Timid Canon