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THE BIRTH OF THE MECHANISTIC WORLDVIEW

(And consequently: the redundancy of the God concept)

P J A Fourie
University of the North

Abstract

Western civilization, dominated by modern technology, finds itself in a theological crisis, because of the experience of the redundancy of God as far as the efficient functioning of the world is concerned. The article traces the origin of this development to the astronomer Johannes Kepler. His successful critique of Aristotelian physics is particularly illustrated by his laws of elliptical planetary movement, challenging the Aristotelian teaching that heavenly bodies must move in circles.

The further significance of Kepler's work lies in its breaking of the century-old ontological bond between theology and science, which subjected scientific knowledge to the alleged supreme judgement of theology and teleological speculation. By giving natural science a dignity on a par with that of theology and metaphysics, the result was a bitter conflict between science and theology - a conflict of which the search for a solution is only lately showing signs of being taken seriously.

1. Introduction

Have you ever imagined Da Vinci specialising in aerospace, Michelangelo in office design, and Stradivari designing electronic hearing aids? Indeed, had these Italian geniuses been born in the 20th century, the technological domination of this century would have 'streamed' them into more practical pursuits before their true genius could emerge (cf editorial The Star, 29.4.1987).

An overstatement? Possibly not, especially if one regards the growing revolution the computer is creating, to mention only the newest fad of modern technology. To such an extent has this technological commodity grasped the world's imagination, that already in 1983, instead of a 'man of the year', the popular Time magazine could choose a 'machine of the year' (Time, 3.1.1983, 10). Schuurman (1977:64) perhaps rightly talked about a 'computer theocracy' which he saw developing.

Unlike four or five decades ago, however, technological innovation is no longer accepted as automatically progressive. The massive demonstrations against nucleur use and the important role ecology has started to play in the politics of certain countries, serve to illustrate this point. 'Yet the forces producing new technologies are still everywhere in place' (Strivers 1984:50). Despite increasing fears for uncontrolled technological growth, our century has irrevocably become a time of 'calculating, experimenting, of method, of the exact natural sciences' (Küng 1978:23).

In the mind of modern man, the wonders of science have to a great extent replaced the wonder of God. We have reached a stage where there is much talk about a technological crisis confronting the world. The educational emphasis on science and engineering produced technological know-how and comforts -- but '"know-how" is nothing by itself; it is a means without an end, a mere potentiality, an unfinished sentence' (Schuhmacher 1980:72-77). The as yet unresolved question is: what will be the last sentence of the present technological age? An epitaph to the destruction of the nations of the world (cf Howe 1971:35)?

Underlying the apparent crisis of our technological civilization, according to Altner (1980:125), we fundamentally have a 'theological crisis'. No wonder then, that the subject of science and technology (called 'Siamese twins' by Von Weizsäcker 1975:5) is getting increasing attention from theologians. 1) The question for systematic theology has lately to a very great extent shifted from a constant redefining of the rules of the theological game within the confines of certain hypotheses to a more fundamental one: the quest for the reality and credibility of these hypotheses themselves. Within the South African context, one needs only to refer to the book by Wentzel van Huyssteen, *Teologie as kritiese geloofsverantwoording* (1986), and the acclaim by which this book was received, to understand how much interest this subject has aroused lately.

In this article we will endeavour to give a short overview of where the roots of the modern scientific method lie, and as a result, the roots of modern technology. Although the methodology of science has changed significantly over the past century, as was clearly indicated by a philosopher of science like Thomas Kuhn (cf his *The structure of scientific revolutions* 1962,1970), the popular mind often does not share in this, and still very strongly functions with a classic mechanistic scientific concept of science. 2)

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1) One needs only to refer to a number of conferences the WCC held on the topic of science, technology and human development since the early 1970's, and the first world conference held by this body on this theme in 1979.

2) This new approach is a movement away from the determinism of positivism. The reason, however, why it seemingly has so little effect on the popular mind, is because of the appeal of the technology that modern science has produced. The appeal of modern technology lies in its functionality, its relative simplicity and its reliability in everyday life (cf eg Von Weiszäcker 1976:5). Further, it gives the hope of fulfilling an old dream of man, namely to control the threatening 'Gegenüber' of nature (Sachse 19'79:70).

2. Johannes Kepler

Johannes Kepler was born in 1571 in Württemburg. At the time of his birth, Nicolaus Copernicus had been dead for about thirty years. Galilei Galileo was only seven years older than Kepler. Although primarily a theological student at Tübingen university since 1589, he also had to study astronomy and physics. In this way, through the lectures of Professor Mästlin, he first met the Copernican theory about the system of the universe - although at this stage a very controversial issue because of its alleged conflict with Holy Scriptures. Mästlin, however, not only mentioned Copernicus in his classroom lecturers to his students, but also pointed out to them superiorities of Copernicus over Ptolemy (Rosen s a:318). In the course of time, Kepler would see himself as Copernicus' disciple: he, Kepler, was standing at the door of a sanctuary, with Copernicus the high priest, busy at the altar (Kepler in a letter to Herwart von Hohenburg, quoted by Hemleben 1979:53). Kepler made it a life assignment to prove that the Copernican model did not only represent another method of calculating in astronomy, but indeed a totally different and new approach to the universe itself - 'the setting of a new goal for the study of the heavens, a new fashioning of the picture of the universe' (Caspar 1962:xxv). In so doing, however, Kepler himself became the high priest at the altar, and Copernicus doing the service at the door (cf Hemleben 1979:53).

The epochmaking contribution of Kepler for the method of natural sciences makes Fritz Kraft (s a:305) speak about a 'Keplerian Revolution' (in contrast to the popular 'Copernican Revolution'). In future, empirical observance and measurement would form valid criteria for the formation of all theories on nature. The age-old theoretical aspect of mathematics, combined with the aspect of observance in physics, would become the future foundation of modern science. All hypotheses had to be validated through a process of empirical testing, and were only tolerated in as far as they could be described in terms of size and number. Rombach (1965:301) thus quite justifiably called Kepler 'the father of the exact sciences'.

To the modern technological dominated mind, the foregoing sounds rather common, if not obsolete - let alone epochmaking! It will, therefore, be necessary to sketch a short background of the Aristotelian physics which dominated the field up to the time of Kepler.

3. Aristotelian Physics

The question that puzzled the Aristotelian mind most was: what is the true reality that lies behind the changing scene of man's perception through his senses? Surely, behind all sensual perception, there should be a purpose. 'The guiding principle in Aristotle's view was teleology: the axiom that everything that happens is done for a certain end, and that the whole cosmos with all that it contains is the result of previous planning' (Sambursky 1956:31).

The answer to this teleological problem was called *ousia* (substance). *Ousia* represented the fixed identity of things in the midst of constant change. All forms of change were attributes of a specific substance, and were bound to the inner nature of that substance. These changes were caused by *archai*, or source principles. True scientific knowledge about an object was therefore to know the *ousia* and the *archai* of that object; scientific knowledge implied knowledge about the 'why' and the 'whereto', rather than the functional 'how' of an object. 'To have scientific knowledge of a fact, is a) to know that it is so; and b) to know the reason why it is so' (Fraassen 1980:21; cf also Sachse 1980:270: 'Science is knowledge that is founded ["begründetes Wissen"]. Knowledge is founded when one does not only know that something is, but also its cause. One knows the why, when you know the cause.').

This teleological approach to science also dominated Aristotle's view on cosmology and astronomy. According to its inner nature or *ousia*, each object in the whole universe has its own natural location, and constantly moves in the direction of one fixed point, which is the earth in the centre of the universe. The universe, is, however, divided into two sharply distinguishable regions, namely the earthly and the heavenly. The nature of an object, and consequently its movement towards the fulfilment of its essential being, its *ousia*, depends on in which of the two regions it has its location. Rectilinear movement presents all earthly movement, and this kind of movement is subject to temporariness. Circular movement, however, is eternal and representative of the heavenly region. Circular movement knows no beginning and no end. It is therefore the simplest and most original, and thus the most perfect, of all movement (cf Aristotle's *De Caelo*, as in the text of Sambursky 1978:111-112).

The next logical step is to enquire after the cause of the heavenly circular movement, because in his *Physics* Aristotle accepted as a maxim that all movement must inevitably be caused by something else (cf the Aristotelian text as in Sambursky 1978:107). Along the line of causality he argues until he reaches a so-called First Mover, which himself is not moved. This First Mover can also be called God. This implies that, through an analysis of the ontological structure of all reality, the logical necessity of God, as the foundation and purpose of all knowledge, has been established. With this step we have reached the climax of Aristotle's teleology.

The significance of all this for the scientific method in Aristotelian physics (the comprehensive study of the natural world) was that knowledge was only regarded as true knowledge in as far as it revealed the *ousia* and the *archai* of things. Physics (or nature) referred to that which was revealed in its true essence.

Thus *physis* and *alêtheia* (truth) became synonomous concepts (cf Heidegger 1976:269). This truth, however, was an abstraction from the contingent world of natural phenomena, as perceived through the senses. Scientific knowledge had become a theoretical game. Aristotle's physics, in the last analysis, was none other than a '"speculative" (*theoretikê*) project' (Yaffe 1979:79). Another scholar once commented 'He (Aristotle) lived in theory and was absorbed in it' (Krüger 1958:12). The scientific method became purely deductive: from an a priori set of principles, one could deduct all scientific knowledge.

As a result, own research became superfluous. The cultural history of mankind, all that it had produced over a period of centuries in terms of reflection and generalizations, became the source book for learning and research. 'Whoever wanted to set foot on the path of science, was compelled to learn the true knowledge of the world in the books of tradition and from the sages' (Rombach 1965:77). Only after the destruction of this attitude, research in the real sense of the word could start and science in the modern sense develop. This major breakthrough was achieved by Kepler.

4. The heritage of Johannes Kepler

We have already indicated that Kepler was introduced to the Copernican theory by the Tübingen Professor Mästlin. Already in his first book, *Mysterium Cosmographicum* of 1596, Kepler made no secret about his choice in favour of the Copernican theory. He even goes as far as stating unambiguously that no religious scruple will prevent him from taking Copernicus seriously (cf the text as in Duncan 1981:15).

This choice is all the more remarkable when one considers the strong rejection that, particularly in Protestant circles 3), existed of the Copernican model. Already in 1539 Luther, with reference to Copernicus, said: 'So it goes now. Whoever wants to be clever must agree with nothing that others esteem. He must do something of his own. This is what that fellow does who wishes to turn the whole of astronomy upside down. Even in these things that are thrown into disorder, I believe the Holy Scriptures, for Joshua commanded the sun to stand still and not the earth' (Table T Talk 4638).

4.1 Hypotheses

At this point it needs to be explained what, in the time of Kepler and his immediate predecessors, was understood under the concept 'hypothesis'. A set of hypotheses was any model, particularly in the field of astronomy, that could provide logical and mathematical explanations on problems regarding the size of planets, their various distances from one another, and a variety of velocity measurements. This did not at all, however, imply that these explanations reflected the physical reality of the material world. Not even the then commonly accepted Ptolemean model of the universe was regarded as such. The point is, the Ptolemean system that was taught in the days of Kepler, already deviated to a large extent from the original Aristotelian

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3) An interesting debate exists on the issue whether Copernicus was not originally approved of by the Pope, although this theory has recently increasingly been rejected by historians, and probably rested on a wrong assumption by one of Kepler's first biographers, Baldi. According to Hayli (s a:199), the quicker and repudiative response from the side of Protestantism has to do with the conflict of Protestants with the Catholic Church. In this conflict, Holy Scriptures to the Protestants were the only source of authority over and against the Pope, and in the Copernican model they saw a serious attack on this authority.

concept of the universe. Ptolemy himself had introduced the so-called *punctum aequans* (equant), which was the point around which the epicycle of each planet moved, and was a point that did not coincide with the centre of the earth, but was situated somewhere on the connecting line between the earth's centre and the sun. This modification had been necessary to account for the apparent irregularities in the movement of the planets. By the time of Kepler, this system had undergone further additions in terms of equants and epicycles, and had become quite complex. Not to be forgotten, however, is the fundamental point of agreement between Aristotle and Ptolemy: the earth formed the immovable centre of the universe, and, as 'holy truth' (the deviation of which would have been regarded as blasphemy - cf Von Weiszäcker 1976:102), that the celestial bodies moved in perfect circular form. Therefore, in as far as the essence of things was concerned, Ptolemy's model was only a useful hypothesis. As far as the physical structure and the reality of the cosmos was concerned, it was still Aristotle who called the tune. And thus the thought was born: the hypotheses of astronomy were to be understood only as instrumental to the provision of mathematical-geometrical calculations, without any 'physical reality' attached to them.

In the light of the preceding, the proloque that the Lutheran minister Osiander wrote to Copernicus' life work *De Revolutionisbus* (published in 1540), makes sense: 'It is not necessary that his (Copernicus') hypotheses should be true, nor even probable. This alone suffices, that they provide a computation that tallies with the observations ... As far as hypotheses go, let no one expect any certainty from astronomy, since this study cannot provide such. Otherwise, if one takes models ... to stand for reality, one leaves this discipline more ignorant than before he entered it' (text as in Gingerich 1975:303). Copernican teaching, in other words, was very useful in making mathematical calculations, but should finally only be regarded as pure model or as theory, with no correspondence whatsoever to the particular reality in the physical world.

That the same line of thinking would still prevail 50 years or so later when Kepler first published, almost goes without saying. In response to an article which he had intended to form the introductory chapter to his *Mysterium Cosmographicum*, and in which he had tried to prove that no conflict existed between the Biblical view and the Copernican system, Kepler was advised in a letter by Professor Hafenreffer of Tübingen not to bother about whether his hypotheses referred to existing realities at all. In fact, it was impossible for reality to conform to the detailed hypotheses of every expert. It was, therefore, irrelevant for Kepler to show that his hypotheses, or those of Copernicus, were reconcilable with the Bible (Caspar 1962:71).

To avoid 'physical hypotheses' was also the advice Kepler received from his old tutor, Professor Mästlin (KGW VII:187). To this, he emphatically replied: 'I call my hypotheses physical. ... I resolved, to accept only those things about which I have no doubt that they are real and therefore physical' (KGW VII:188).

To summarise then, what Kepler understood under hypotheses, especially those for astronomy, is best described in the words of Westman (s a:715): 'A geometrical hypothesis in astronomy is physically true when it corresponds directly to, or describes the motion of, real bodies in space and when these motions are accounted for in the simplest and most regular possible manner'.

4.2 Epistemology

The immediate effect of the preceding for the scientific method in general (not only in astronomy), was a replacement of the prevailing domination of the deductive method over the inductive method, or, to put it in a different way, the preferential acceptance of a priori knowledge over a posteriori knowledge. As we have already indicated, certain a prioris were uncritically accepted as divine axiomas, even contrary to what was established through experimental observation. In the words of Sambursky (1956:89): 'Wherever experiment and theory were in conflict, it was the experiment that was found to be faulty'. Since Kepler, the situation had been reversed.

The most important two epistemological principles which functioned in Kepler's scientific investigation to nature, are the following (cf Wollgast & Marx 1977:50):

1. Each philosophy of nature had to proceed from experience. For a statement to be regarded as scientific, it had to correspond quantitively to the observations of nature.

2. The scientist should under no circumstances appeal to the authority of others; the only authority for him is nature itself.

4.3 Practical result

The practical result of this different epistemological approach led to the formulation of the well-known two Keplerian laws. In their modern formulation, they sound as follows (cf Crombie 1977:413):

1. Planets move in elliptical orbits, with the sun as the focal point.

2. Planets do not have uniform motion, but every planet moves in such a way that a connecting line between the centre of the planet and the sun will cover an equal surface in equal time.

(In actual fact, the second law was formulated before the first, and had to account for the irregularities an earthly observer noticed in the movement of the planets, namely quicker at perihelion, i e nearest to the sun, and slower at aphelion, i e furthest from the sun.)

For the modern reader, Kepler's discovery might sound rather insignificant: it makes little difference whether the planet orbit is a circle, or an ellipse deviating little from the circular shape. 'Yet Kepler's prodigious step forward consists precisely in the fact that with his ellipse proposition he had overthrown for all time the two-thousand-year-old axiom, according to which every motion retrograde in itself must of necessity be a uniform circular motion' (Caspar 1962:140). We have, in fact, with the overthrow of such an important Aristotelian principle, the birth of a new methodology in the natural sciences.

One should, however, not make the mistake of regarding Kepler as a kind of freak who was totally uninfluenced by the thinking of his day. In his *Astronomia Nova* (published 1609), in which he discusses these laws, he himself acknowledges this dependence, but also his first break with traditional astronomy: 'My first mistake was to regard the planetary orbit as a perfect circle. I was robbed even more by this mistake, because it had been taught with the authority of all philosophers, and was in accordance with metaphysics' (KGW III, 263). This, however, makes his discovery so much more remarkable. It also, to some extent, proves the truth of what Thomas Kuhn should say many years later about the role of socio-historical circumstances in the formation of new scientific theories (cf his *The structure of scientific revolutions*). 4)

We have already referred to Kepler's public acceptance of the Copernical system. Again here, the cultural influence of Aristotelian physics should not be underestimated: behind the changing and complex scene of man's perception, lies one and a simple first principle or cause. This was precisely the appeal of Copernicus' system for Kepler - its simplicity: 'She, nature, loves simplicity, she loves unity. Nothing ever exists in her which is useless or superfluous, but more often she uses one cause for many effects. Now under the customary hypotheses there is no end to the invention of circles, but under Copernicus' a great many effects' (*Mysterious Cosmographicum*:76,77).

5. The mechanistic worldview

Frequently now we have credited Kepler for giving birth to a new methodology in the natural sciences. Surely, one should be careful not to forget that, as we have just indicated, he was very much a child of his day. 'One should bear in mind that in Kepler the whole of the philosophy of nature of the late Middle Ages was still very much alive, and that it was out of this milieu that he broke with his new astronomy and physics', Gerlach very aptly comments (1972:23). Nevertheless, his role as the pioneer of the modern material sciences is indisputable (Hübner:1975, 111).

Kepler forms a sort of bridge between two eras. We will now consider more closely the precise nature of his novelty.

The Keplerian achievement confronts us with a breakdown in the century-old ontological bond between theology and science, whereby theology played the dominant role, and was regarded as the queen of all sciences. It was particularly in the 12th and 13th century that the basis for this relationship between theology and science was laid. It was during this time that the Western world became more

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4) Brackenridge also comments properly on the influence of socio-historical circumstances when he says: '... it is clear that when Kepler begins, he is committed to the traditional method of astronomical analysis that employs circles and uniform angular motion: the principle of orbital circularity. When he finished, he had replaced circular orbits with elliptical orbits, and uniform angular motion with uniform areal motion (1982:275).

acquainted with the complete works of Aristotle, particularly through the Arab world. 'The Middle Ages saw with admiration and with awe what the human spirit could achieve, without the light of the divine revelation' (Howe:1954, 18). Two principal figures in making Aristotle acceptable to the Christian Middle Ages were Albertus Magnus and his scholar Thomas of Aquino (1225-1274) (Crombie: 1977, 60).

The answer which Thomas supplied to the problem of the relation between faith and reason, or theology and natural science (Aristolelian style), is well-known. He accepted the existence of a dual foundation for truth: through reason, in the field of natural truths; and through the Bible, in the field of supernatural truths. Basically, however, truth was only one, because God, who gives all truth, is one. The truth of science and the truth of theology thus formed an ontological unity. The truth of the Bible was revealed to man, and as such elevated above reason, but never in conflict with it. Conversely, reason was independent and functioned according to its own laws, but could only be brought to its full depth by faith. In this sense there existed full independence, as well as intense harmony, between the two fields. Knowledge of the natural world, however, was regarded as inferior compared to the higher knowledge of revelation. Thus, practically speaking, revealed knowledge had the final say, whenever conflict existed between the truth of the Bible and that of reason.

Kepler shared this view of a dual foundation for truth. In theology the authority of the Bible and authoritative persons ruled. In natural science, the authority of reason ruled. He rejected the idea that biblical knowledge had the final word in the case of a conflict between the findings of science and the Bible. The following Keplerian statement has achieved fame: 'In theology rules the power of authorities, in the philosophy of nature reason. Holy to me is Laktanz ..., Augustine, ... the clergy of our day; but even more holy to me is the truth, when I, with all due respect to the teaching of the church, scientifically prove that the earth is round, ... very insignificant and small, and that it has its orbit amongst the stars' (KGW III:38). Scientific and theological knowledge received the same dignity - and so the seed for an eventual breakdown in the relationship between scientific and theological knowledge, in which the former had been subordinate to the latter, was sown.

Certainly, in the mind of Kepler, this breakdown had not yet taken place. He was still too much a child of his day. In the last analysis, he still regarded scientific and theological knowledge as forming an ontological unity. The reason for the apparent split between the two epistemological fields was to be found in sin that had distorted the original unity. However, 'God's word to man in nature ... runs parallel with God's word in the Bible' (Hübner 1975:384). The task of the astronomer and scientist, therefore, was that of a priest: to interpret and to explain the text of God's word as given in the book of nature. Man did possess this ability, because he had been created in the image of God, and as such he was capable of pursuing the thoughts of God in nature (cf Kepler's letter to Herwart von Hohenburg, KGW XIII:309). In this sense, Kepler still very much shared in the old idea of universality, as represented in the classical medieval philosophy and theology.

This does not, however, minimise the important consequence of what I have termed an 'ontological breakdown', erupting between theology and natural science, due to Kepler, to such a point of total separation and independence that the French mathematician, physicist and astronomer, Pierre Simon Laplace (1749-1827), could reply to Napoleon Bonaparte's question as to the place of God in his mechanistic view of the cosmos: 'Sire, je n'ai pas eu besoi de cette hypothese' ('Sir, that hypothesis I do not need' - cf Richmond 1966:133).

That the God concept became redundant in as far as a scientific understanding of the world was concerned, and the worldview as such increasingly mechanistic, can be best illustrated by the way in which Kepler at different times of his life described the cause for planetary movement. In the 1596 edition of *Mysterium Cosmographicum*, this cause was still called 'soul' (*anima*) as a type of divine principle. In the 1621 edition, he spoke about 'power' (*vis*). Kepler wrote: 'When one replaces the expression "soul" by "power", then you have precisely the principle on which the heavenly physics grounds itself'(KGW VIII:13).

Kepler, for the first time in history, applied the concept of a clock to creation. The intention was clear: like the complete working of a clock was totally dependent on the movement of a single little wheel, likewise the totality of movements in the cosmos could be reduced to a simple, corporal, magnetic power. 'My purpose is to show that the heavenly machine is no divine living being, but like a type of clockwork' (KGW XV:146).

With the above approach, the stage for scientific investigation into nature was cleared from all gods. In place of the Aristotelian question as to the 'why' of things, questions as to the cause, purpose and essence of natural phenomena, came the question as to the fundamental 'how' of things. The idea of the essence (*ousia*) of things went over into the idea of natural law. The task of the investigator of nature, which previously had been intrinsically bound to that of the theologian, was now to interpret all the perceptions of empirical observation in such a way that these perceptions become accessible to man's natural reason, apart from any authoritative or divine revelation or intervention. The foundation for a totally closed and mechanistic worldview, wherein determinism called the tune, and wherein the God concept has become an embarressment as to the explanation of the functioning of the universe, was irrevocably laid.

6. Conclusion

At the start we referred to Altner's view of a theological crisis underlying our present technological civilization. This crisis, although not in the least his intention, was, as was revealed in the course of time, the direct result of Kepler's approach. In as far as faith was still given a place, it had become abandoned to the realm of the private life, and had lost its earthly relevance.

Contemporary science, despite its tremendous technological achievements, has in many respects become more modest than the science of recent centuries. It says less than in the past of definitive laws, more of hypothetical theories; less of determinism, more of probability; less of 'truth', more of 'models'- models which are not to be understood as mental or visual replicas of reality, but as effective ways of thinking about reality for certain designated human purposes (WCC 1978:14).

Does this mean that the old conflict between science and religion, for which Kepler unintentionally laid the foundation, is dead? 'That is too cheerful a statement' (WCC 1978:16). The debate is an ongoing one. The most that can be said about it right now, is that changing attitutes in the scientific world are increasingly providing for fruitful soil in this regard.

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