3. THE INCONSTANT HEAVENS

by Livio C. Stecchini

The modern system of astronomy is now so much received by all inquirers, and has become so essential a part even of our earliest education, that we are not commonly very scrupulous in examining the reasons upon which it is founded. It is now become a matter of mere curiosity to study the first writers on that subject.

David Hume, Dialogues Concerning Natural Religion (1779), Part II.

Only a few years ago astronomers were unanimous in dismissing as preposterous Velikovsky's contention that the movement of the heavenly bodies is affected by electromagnetic fields. Today creative astronomers are immersed in the study of electromagnetism. The historian finds difficulty in explaining how radical is this change that has challenged three hundred years of cosmological thought and has brought us back to the arguments of William Gilbert (1544-1603) and Johann Kepler (1571-1630)[1]. The newness of the revolution is evinced by the Einstein-Velikovsky correspondence wherein the former soon accepted as tenable the hypothesis of global catastrophes and, though originally quite opposed, at last became sympathetic even to the hypothesis of a recent origin of Venus as a planet. However, he persistently rebutted to the end of his life all argument that electricity and magnetism affect the motions of heavenly bodies.

Whereas astronomers are perplexed at the implication of the new picture of the universe as derived from the space probes, Velikovsky has been clear from the very beginning. In one of the first conversations I had with him ten years ago, he summed up this thinking by stating that one of the implications of his work is to reinstate Descartes as a rightful contestant of Newton in the understanding of the texture of the universe. Velikovsky quoted the following summation by Herbert Butterfield of the results of the famous contest between the two views of celestial mechanics: ‘The clean and comparatively empty Newtonian skies ultimately carried the day against a Cartesian universe packed with matter and agitated with whirlpools, for the existence of which scientific observations provided no evidence.’[2]. Velikovsky was confident that this evidence would be found, and it has been found. There is reasonable ground to hope that the new investigation which takes electric charges and magnetic fields into account will, first of all, succeed in explaining the behaviour of comets especially in the proximity of the Sun. The current explanation, according to which the pressure of solar light drives a cometary tail as a rigid rod at enormous velocities when the head is close to the perihelium, is not much more satisfactory than the one proposed by Newton when he said that the tails of comets turn away from the Sun for the same reason that the smoke from a fire ascends perpendicularly, or in the case of a moving body obliquely, in the atmosphere [3]. Thereafter, the case of planets like Earth or Jupiter, which are surrounded by a magnetosphere and move through the magnetic field permeating the solar system and the plasma winds that sweep through it, will come to quantitative analysis, too.

With new claimants to participation in the mechanism of the solar system, the problem of its stability is brought into new light.

PSYCHOLOGICAL PREMISES

Because of his psychoanalytic training and experience Velikovsky was able to realize that men tend to shunt off as fables the accumulated memories and records of cosmic cataclysms. Even biblical fundamentalists do not accept at face value what is told in plain language in a book that they purportedly interpret to the letter.

A few hundred years after the last upheaval, as dated by Velikovsky’s thesis, Aristotle struggled to refute the cosmology of Heraclitus; and Cicero, when other writers of his century such as Lucretius or Ovid were describing in detail what had happened, proclaimed *ita stabilis mundus est atque ita cohaeret ad permanendum, ut nihil ne excogitari quidem aptius possit* - 'the world is so stable and it holds together so well for the sake of permanence that it is impossible even to imagine anything more fitted to the purpose'[4]. Planets are gods, and because of their divine nature they keep a perfect and immutable order. In another passage Cicero expounds the same view in terms that became a creed both for medieval scholastic natural philosophers and, as I shall indicate, for the followers of Newton:

> In the firmament, therefore, there is no accident, no chance, no aimless wandering, nothing untrustworthy; on the contrary, all things display perfect order, reliability, purpose, constancy...Wherefore, that man who holds that the astounding orderliness and the incredible precision of movement of these celestial bodies, upon which the support and safety of all things are wholly dependent, are not directed by reason must himself be considered to be utterly devoid of the rational faculty [5].

But this was a reversal of the older beliefs in the Theomachy, or the struggle among the planetary gods. Critias, the cousin of Plato's mother, in his drama 'Sisyphus,' stressed the opposite view, defended by Democritus and his followers, that the belief in the planetary gods was linked with the worst of all human terrors. The following quotation illuminates also the question, with which I shall deal below, that the organization of the heavenly bodies came to be considered the foundation of ethics:

> He [Sisyphus] said the gods resided in that place
> Which men would dread the most, that place from which,
> As he well knew, mortals have been beset
> With fears or blest with that which brings relief
> To their tormented lives - there, high above,
> In that great circuit where the lightnings flash,
> Where thunder's baleful tumult may be heard,
> And heaven's starry countenance is seen
> (That lovely work of Time's skilled joinery),
> Where molten stones of stars descend ablaze,

> And wet rain starts it journey to the earth.
> Such were the consternating fears he sent
> To men, and such the means by which the gods
> Were settled in their proper dwelling-place
> (A pretty trick, accomplished with a word);
> And thus he quenched out lawlessness with laws [6].

Modern writers have suspected as much. John Dewey opens *The Quest for Certainty* (1929) with a chapter titled 'Escape from Peril.' He points out that fear is the spring of the search for immutable perfect entities, for the glorification of regularity and invariance at the expense of diversity and change. By rationalizing the beliefs in the heavenly bodies as gods and making them the expression of a higher realm (higher physically and morally) which is rational, regular, and unalterable, Aristotle set up the foundations of classical science.

In a similar vein, Freud [7] asks on what foundation does 'man build the feeling of security with which he armours himself against the dangers both of the external world and of human environment.' In answering he declares: 'Think of the famous dictum of Kant that mentions in one breath the starry heavens and the moral law in our heart. This combination sounds odd - for, what could the heavenly bodies have to do with the question whether a human being loves or murders another - but it touches a profound psychological truth.'

The passage of Kant (1724-1804) to which Freud refers is the conclusion of the *Critique of Practical Reason*:

> Two things fill the mind with ever-increasing wonder and awe, the more often and the more intensely the mind of thought is drawn to them: the starry heavens above me and the moral law within me.

But does the starry heaven inspire us rightfully with the feeling of stability, while it inspired the ancients with an all-pervading fear?

RENAISSANCE COSMOLOGY

Nicolas of Cusa (1401-64), in his *De docta ignorantia*, denied the qualitative difference between heaven and earth. He also rejected the rest of the related propositions of Aristotelian metaphysics and revived the heliocentric theory, and he stated that the earth is not perfectly spherical and that the orbits of the planets are not perfectly circular [8]. He claimed that heavenly motions do not have stability as an inherent quality, and formulated the hypothesis that some statements of ancient writers may be explained by their having seen a sky different from what was seen in his time. He defined science as 'learned ignorance,' because it is impossible to formulate an exact, eternal, and absolute description of the physical universe.

The position of Copernicus (1475-1543) was relatively conservative in that he combined heliocentrism with the traditional conception of circular movements (around the sun) and of a limited universe bounded by the sphere of the fixed stars. The opposition to Copernicus was determined by the realization that by giving mathematical structure to the heliocentric theory he lent support to the subversion of metaphysics that had been associated with it by Nicholas of Cusa.

Questioning of the text of Genesis began as a result of the Copernican theory: if the Earth is nothing but a planet revolving around the Sun, one may doubt that its creation was the result of a providential dispensation. A son-in-law of Osiander, the editor of Copernicus, uttered the first frank challenge to the divine authority of the biblical narrative: *neque mihi quisquam Judaeorum fabulas objiciat* [9]. Scholars began to doubt the notion that the universe had been created once and forever. They started to investigate ancient chronology, and laid down the foundations of geology and paleontology.

In the age of Reformation some religious apologists argued that a distinction must be made between the creation of the universe as a whole and the creation of the Earth: the biblical text referred to the latter creation.

Giordano Bruno (1548-1600), in his last and greatest work, *De immenso et innumerabilibus*, published just after his imprisonment, made clear the meaning of the assertion of the principle of *indifferenza della natura*. He denied the existence of a providential order in nature and hence of the stability of the solar system which is linked with the doctrine of circular movements; declared that only their imperfect astronomical observations permitted earlier scholars to believe that the heavenly bodies move in circles and in the long run return to their original position (*de vanitate circulorum et anni illius mundani phantasia platonica et aliorum*)[10]; and pointed out that astronomical movements are bound to be infinitely complex (*differentias et singularum differentiarum irregularitatem*) [11]. The belief in the simple and regular motion of the planets, he continued, is a delusory product of astrological thinking *sub fide vel spe geometricantis naturae*; it is necessary to free mathematical astronomy from Platonic and Pythagorean metaphysical accretions. From the relativity of motion follows the relativity of time; since no completely regular motion can be discovered, and since we possess no records which can prove that all the heavenly bodies have taken up exactly the same positions with regard to the Earth as those previously occupied by them and that their motions are rigidly regular, no absolute measure of time can be found [12].

The new conception of nature is epitomized in John Donne's poem, *An Anatomy of the World* (1611):

> And new Philosophy calls all in doubt...
> And freely men confess that this world's spent,
> When in the Planets, and the Firmament
> They seek so many new; then see that this
> Is crumbled out again to his Atomies.
> 'Tis all in pieces, all coherence gone...
> So, of the Stars, which boast that they do run
> In Circle still, none ends where he begun.
> All their proportions lame, it sinks, it swells.

Velikovsky has been scorned for blending the study of astronomy with that of geology, ancient traditions, ancient chronology, and ancient science. But in so doing he has followed the path of Renaissance scholars, since such a course is inevitable once the dogmatic belief in the incorruptibility of the solar system has been questioned. The new astronomy brought forth a series of studies on ancient traditions and chronology, and effected the birth of interest in Egyptian and Mesopotamian science. For instance, Father Athanasius Kircher (1601-80) founded the study of geology with his *Mundus Subterraneus*, while he initiated the study of Egyptian science with his *Oedypus Aegyptiacus*. In *Vicissitudo Rerum* (1600) John Norden refers to these speculations that have been revived by Velikovsky:

> The antique Poets in their Poems telled
> Under their fondest Fables, Mysteries:
> By Phaeton, how heaven's Powers rebelled
> In Fire's force, and by the histories
> Of Phyrrha and Deucalian there lies,
> The like of water's impetuity,
> In part concurring with divinity -
> The Priests of Egypt gazing on the stars,
> Are said to see the World's sad ruins past,
> That had betide by Fire and Water's jars:
> And how the World inconstant and unchaste,
> Assailed by these, cannot alike stand fast.
> Earthquakes and Wars, Famine, Hate, and Pest,
> Bring perils to the Earth, and Man's unrest.

Sir Walter Raleigh in his *History of the World* (1616) wondered how it could happen that the phases of Venus just discovered by Galileo seem to have been known to ancient authors. He listed the authorities who state that at the time of the flood of Ogyges 'so great a miracle happened in the star of Venus, as never was seen before nor in after-times: for the colour, the size, the figure, and the course of it were changed.' The catastrophe associated with the name of Ogyges, a time mark for ancient Greeks, took place simultaneously with Venus' complete metamorphosis. This statement made by Varro, 'the most learned of all the Romans,' on the authority of earlier scientists should have provoked interest in the time of Newton, when the working of the solar system was elevated to the state of a most exact science. But, whereas the gleaning of information from ancient authors contributed to more than one discovery of the new age of astronomy (the very heliocentric theory had been advanced on the authority of Greek and Roman writers), Newton pulled down the curtain on the use of ancient sources as an inspiration for astronomical research. The notion that the solar system may have a history, became (in the name of the new religion of science) as sacrilegious as it had been for the scholastics (Saint Augustine, A.D. 354-430, had taken a different position on the authority of classical authors).

On the eve of the establishment of Newtonian cosmology, the speculation on cosmic cataclysms had become so commonplace that in 1672 Molière, in his satire on the ladies who, captured by the new passion for science, studied astronomy, could make a joke of it (*Les femmes savantes*, Act IV, Scene III):

> Je viens vous annoncer une grande nouvelle:
> Nous l'avons en dormant, madame, échappé belle,
> Un monde près de nous a passé tout du long;
> Est chu tout au travers de notre tourbillon,
> Et s'il eût en chemin rencontré notre terre,
> Elle eût été brisée en morceaux comme verre.

('I have come to tell you a great piece of news. We have, Madam, while sleeping, had a narrow escape. A world has passed by us, has fallen across our vortex, and if it had on its way met our Earth, it would have broken it into pieces like glass.')

NEWTON

The Renaissance view of life and of the world, which can be summed up by the word *mutability*, was created by personalities of heroic stamina and required the leadership of such personalities for its preservation, for indeed, it is not easy to live in a world where the only divinity is Fortuna and nothing is certain beyond measurement and probability. As Freud contends, neuroses originate from the failure, due to inferior biological endowment combined with stunted psychic growth, to face the burden of the human condition in a world that owes us nothing.

Some contemporary thinkers were frightened, for the relativism and decentralization of the Renaissance found expression not only in astronomy but in political theory; furthermore, the impact of thinkers such as Machiavelli was compounded by the geographical discoveries that gave birth to the doctrine of ethical relativism. In England the herald of reaction against Renaissance thought was the theologian Richard Hooker who imagined that a new conservative position could be justified by appealing to nature's laws linked with an absolute reason and an obedience of man to absolute ethics. In the *Laws of Ecclesiastical Polity* (1593-97), he examined the views current at his time:

> Now if nature should intermit her course, and leave altogether, thought it were but for a while the observation of her own laws; if those principal and mother elements of the world, whereof all things in this lower world are made, should lose the qualities which now they have; if the frame of that heavenly arch erected over our heads should loosen and dissolve itself; if celestial spheres should forget their wonted motions, and by irregular volubility turn themselves any way as it might happen; if the prince of the lights of heaven, which now as a giant doth run his unwearied course, should as it were through a languishing faintness begin to stand and to rest himself; if the moon should wander from her beaten way, the times and seasons of the year blend themselves by disordered and confused mixture, the winds breathe out their last gasp, the clouds yield no rain, the earth be defeated of heavenly influence, the fruits of the earth pine away as children at the withered breasts of their mother no longer able to yield them relief: what would become of man himself, whom these things now do all serve? See we not plainly that obedience of creatures unto the law of nature is the stay of the whole world?

He proposed the comforting solution that was accepted by Newton and the scientists who followed him:

> But howsoever these swervings are now and then incident into the course of nature, nevertheless so constantly the laws of nature are by natural agents observed, that no man denieth but those things which nature worketh are wrought, either always

> or for the most part, after one and the same manner.

Helène Metzger has shown that Newton developed his theory under the influence of this spirit of reaction. She is certainly right when she judges the overall effect of Newton's work which *devait vite devenir une aliée de cette piét*J *bienséante et bien pensante* [13]; but she has not analyzed in detail what caused Newton to arrive at his conservative conclusions nor what is their technical significance for science. Her pacemaking investigations were cut short by the gas chamber at Auschwitz.

One of the precursors of Velikovsky as to the general thesis of the catastrophic past of the earth, to whom he refers in his work, was William Whiston (1667-1752). In 1964, seven years after the first edition of *Principia*, Whiston, then a fellow of Cambridge University, became a devoted pupil of Newton, and two years later submitted to his master the manuscript of a book entitled *New Theory of the Earth*. The book was intended to replace the then popular *Theory of the Earth* (1681) by Thomas Burnet, and dealt with a theme with which Newton had been concerned for more than a score of years. This book contended that the cataclysm described in the Old Testament as universal Deluge was caused by the impact of a comet at the end of the third millennium B.C., and that up to the Deluge the solar year had the duration of 360 days only, yet the new calendar of 365 days had to wait to be introduced by Nabonassar (in 747 B.C.). These contentions were based mainly on historical evidence, whereas astronomical considerations were the main ground for suggesting that comets may become planets:

> Yet comets by passing through the planetary regions in all planets and directions... seem fit to cause vast mutations in the planets, particularly in bringing on them deluges and conflagrations, according as the planets pass through the atmosphere...Tho'indeed they do withal seem at present chaos or worlds in confusion, but capable of change to orbits nearer circular, and then settling into a state of order and of becoming fit for habitation like the planets; but these conjectures are left to further enquiry, when it pleases the

> divine providence to afford us more light about them [14].

Newton was so impressed by Whiston's work that from that moment he established a close scientific relation with him. The book was highly praised also by other contemporaries, John Locke among them. Two years later the Savillian Professor of Astronomy at Oxford, John Keill (1671-1721), dedicated a book to the evaluation of Whiston's hypotheses in comparison to those of Burnet, in which he expressed the following judgments:

> ...Yet I cannot but acknowledge that Mr Whiston, the ingenious author of the new *Theory of the Earth*, has made great discoveries and proceeded on more philosophical principles than all the theorists before him have done. In his theory there are some coincidents which make it indeed probable, that a comet at the time of the Deluge passed by the Earth [15].

Keill approved also of the contention that before this upheaval the solar year consisted of 360 days, divided into 12 lunar months of 30 days.

In 1701 Whiston was appointed as a temporary substitute for Newton at Cambridge, and in 1703, when Newton resigned permanently from the Lucasian Chair of Mathematics, he recommended Whiston as uniquely worthy to be his successor. By 1713, when the second edition of the *Principia* was published, Newton's feelings towards Whiston had changed radically. When in 1720 the astronomer Edmond Halley (1656-1742) and others proposed Whiston as a member of the Royal Society, Newton threatened that, should the members vote for Whiston's admission, he would resign from the presidency of the Society. Whiston, who was deeply devoted to Newton, suggested that his candidacy not be pressed; he felt that the aging Newton was so violently disturbed by the issue that he might die [16]. Halley who one year and a half before the publication of Whiston's *New Theory of the Earth* had read a paper before the Royal Society in which he had explained the Deluge by the impact of a comet, but had not printed it 'lest by some unguarded expression he might incur the censure of the sacred order,' reacted to Newton's gesture by publishing with thirty years of delay a memoir in the acts of the society [17]. Historians of science gloss over this incident, which is vital for the understanding of the evolution of Newton's thought. After 1710, when Whiston was dismissed from his teaching position because of heresy and then formally brought to trial before the body of bishops of the Church of England, he assumed more radical positions and came to disagree with Newton who was becoming more and more conservative.

Whiston's contention was that the creation story told in Genesis should not be interpreted literally, but as referring to a process of progressive creation through several cosmic stages. Newton, who was at first sympathetic to Whiston's religious and scientific views, came to be shocked by his radicalism, and turned towards a fundamentalist position. The concluding words of *Opticks* indicate that Newton, like others of his contemporaries felt that, if the traditional views of cosmic order were abandoned, the foundations of morality would be undermined [18]. Furthermore, Newton felt that Whiston's hypotheses would end by eliminating what he considered the chief argument for the existence of God, the argument from design, namely, the wise adaptation of the present frame of nature to the needs of living creatures, especially man. In *Opticks* he rebutted Whiston in these terms:

> For it became who created them [the celestial bodies] to set them in order. And if he did so, it's unphilosophical to seem for any other origin of the world, or to pretend that it might arise out of a chaos by the mere laws of nature; though being once formed, it may continue by those laws for many ages. For while comets move in very excentrick orbs in all manner of positions, blind fate could never make all the planets move one and the same way in orbs, concentrick, some inconsiderable irregularities excepted, which may have arisen from the mutual actions of comets and planets upon one another, and which will be apt to increase, till this system wants a reformation. Such

> a wonderful uniformity in the planetary system must be allowed the effect of choice [19].

Whereas the first edition of the *Principia* (1687) is essentially rationalistic in spirit and follows a positivistic method, theological preoccupations dominate the second edition (1713). Newton is bent on proving that the machinery of the world is such a perfectly contrived system that it cannot be the result of 'mechanical cause,' but must be the result of an intelligent and consistent plan. In order to support further the story of Genesis that the world was created by a single act, he argued also that the world is stable and has remained unchanged since creation. But he could not prove this point, since he admitted that, according to his own theory, the gravitational pull among the several members of the solar system would tend to modify their orbits; hence, he begged the question and claimed that God in his providence must intervene from time to time to reset the clockwork of the heavens to its original state. This point of Newton's doctrine is well known, for it was the object of sarcastic comments by Newton's great rival in the mathematical field, Leibniz (1646-1716). As the letter observed, Newton cast God not only as a clockmaker, and a poor one at that, but also as a clock-repairman [20].

Jean-Baptiste Biot (1774-1862), the chosen pupil of Laplace, agreed with his teacher in considering the second edition of the *Principia* as highly objectionable. He argued that Newton had ceased to be a creative thinker in 1695 and suggested that this was the result of his mental illness of eighteen months duration [21]. But in truth Newton was hampered by religious preoccupations and not by mental deterioration. The only external evidence that Biot submits for a psychic collapse is Newton's 'infantile' antics in his dealings with Whiston in 1714. In my opinion, the proof that Newton had become fixated on the religious problem, but had not lost any of his intellectual flexibility, is that the few additions that appear in the third edition of the *Principia* (1726), disclose that he came to believe that God reveals himself not in the appearance of things but in the ways of mankind [22].

Scholars have failed to notice that the refutation of Whiston's doctrine was of major concern to Newton. In the *Principia*, he maintained that comets, far from being a disruptive element, contribute to the providential preservation of the original order: since a certain amount of the water of the Earth is steadily consumed by chemical combinations, the seas would not be preserved in their original state unless new water was provided by the exhalations of comets. The notion of the providential purpose of comets was further expanded in Newton's time: the comets exist also for the purpose of supplying new fuel to the Sun which otherwise would gradually consume itself. One of the important popularizers of Newton's ideas stresses that comets can perform these providential functions, but at the same time are providentially prevented from striking the Earth:

In the next place, the reason why the planes of their [comets'] motions are not in the plane of the ecliptic, or any of the planetary orbits, is extremely evident; for had this been the case, it would have been impossible for the Earth to be out of the way of the comets' tails. Nay, the possibility of an immediate encounter or shock of the body, of a comet would have been too frequent; and considering how great is the velocity of a comet at such a time, the collision of two such bodies must necessarily be destructive of each other; nor perhaps could the inhabitants of planets long survive frequent immersions in the tails of comets, as they would be liable to in such a situation. Not to mention anything of the irregularities and confusion that must happen in the motion of planets and comets, if their orbits were all disposed in the same plane [23].

The writer follows here the reasoning of Newton, who argued that the providential order of the universe required that the comets have beneficial characteristics. In reality, the planes of the orbits of some comets are at a small angle with the plane of the ecliptic, and the chance of collision exists.

Biographies of Newton usually dismiss in a few lines his book *The Chronology of the Ancient Kingdoms Amended* (1728), to which he dedicated the last years of his life. They consider it the product of an irrelevant side activity; yet its purpose is clearly that of refuting Whiston's hypotheses. Newton argues that evidence for the years of 365 days is as old as the year 887 B.C., and that even though this year was 'scarcely brought into common use' before this date, it was as old as the first astronomical observation of the Egyptians. However, these would have started only quite late, in 1034 B.C. The main purpose of the book is to contend that there was hardly any reliable history before the First Olympic Games in 776 B.C. In the first page the point is made that the ancient legends and traditions (the basis of Whiston's argument for a cataclysm caused by a comet) are not a reliable source of information.

Newton believed that his cosmology, which he had summed up in the famous General Scholium of the second edition of the *Principia*, could not be accepted unless Whiston was refuted. For this reason, about three months after the appearance of the second edition, he wrote an essay (that lies unpublished at the British Museum) in which he answered the criticism advanced by William Lloyd (1627-1717), an intimate friend of Whiston, on the ground that the oldest calendars of the ancients are based on a solar year of 360 days. From what is known about this document it can be said that Newton gave a lame answer [24]. He argued that if a calendar of 360 days had been in use without a system of intercalation for the five extra days, the official beginning of the seasons would have moved around the full year in a period of 70 years; since there is no trace of this 70 year cycle, this calendar cannot have existed. But the argument of Whiston and Lloyd was exactly that the solar year was about 360 days long and that therefore no intercalation was needed. Newton was begging the question by assuming that the solar year must have always consisted of 365 days.

In the works of Newton the doctrine of the eternal stability of the solar system is clearly presented as an assumption based not on scientific data but on faith in a providential order. But the flood of popularizations that made Newtonianism the basic doctrine of the eighteenth century claimed that Newton had provided scientific mathematical proof of the marvellous order that he accepted on faith. Carl L. Backer, who has examined this development in *The Heavenly City of Eighteenth Century Philosophers* (1932), concludes that the thinkers of the Enlightenment, while they believed themselves to be anti-Christian or even irreligious, were, in the name of Newton's mechanics (though not his religion), returning to the tenets of medieval theology along with Newton. Not since the thirteenth century had there been such as alliance between faith and reason. It was again possible to lift up one's eyes to the changeless movements of the sky - signs of divine perfection and eternal laws. As Becker remarks, Newtonianism was an immediate success with the educated public, because 'the desire to correspond with the general harmony springs perennial in the human breast'[25].

Every good textbook of history points out that Newton's astronomy precipitated a religious revolution. Newton was perfectly aware that he had expounded the religious view that was called 'natural religion agreeing with revealed.' The new religion was called theism and its Nicene Creed was the General Scholium of the *Principia*:

> The six primary planets are revolved about the Sun in circles concentric with the Sun, and with motions directed towards the same parts, and almost in the same place. Ten moons are revolved about the Earth, Jupiter, and Saturn, in circles concentric with them, with the same direction of motion, and nearly in the planes of the orbits of those planets; but it is not to be conceived that mere mechanical causes could give birth to so many regular motions, since the comets range over all parts of the heavens in very eccentric orbits; for by that kind of motion they pass easily through the orbs of the planets, and with great rapidity; and in their aphelions, where they move the slowest, and are detained the longest, they recede to the greatest distances from each other, and hence suffer the least disturbance from their mutual attractions. This most beautiful system of the Sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being.

In the popularizations of Newton theism became deism, and the letter evolved into the mechanistic atheism of La Mettrie (1709-51) and D'Holbach (1723-89). All these views of religion had in common the belief in the perfect regularity of the universe, expressed by the analogy of the mechanical clock. 'The ideal of a clockwork universe was the great contribution of the seventeenth century to the eighteenth-century age of reason.’[26]

There is no doubt that several of our contemporary natural scientists would object that these are metaphysical preoccupations that do not concern an observational science like modern astronomy. But there are no more hardened metaphysicians than those who believe that they do not have any metaphysics, and this can be proved by a timely example.

Venus is the planet closest to the Earth and has a size very similar to that of the Earth, so that it is a sort of twin sister of the Earth. Hence, those who agreed with Newton in believing in the regularity of nature presumed that Venus must rotate in about 24 hours and must be encircled by a moon similar to our Moon. In the eighteenth century a number of astronomers claimed to have seen and tracked this moon; after the solar transit of 1769 Lambert (one of those who advanced the nebular hypotheses) computed the orbit of this moon and its size (28/27 that of our Moon). The subsequent progress in the construction of telescopes made it impossible for astronomers of following generations to see what was not there. According to Newton, Venus has a period of rotation similar to that of Earth, 23 hours [27]. Jacques Cassini revised the figure to 23 hours 20,’ and by the end of the eighteenth century the accepted figure was 23 hrs. 21’ 20". One more century of observations made the figure of 23 hrs. 21’ acceptable, but in 1877 G. V. Schiaparelli concluded that Venus rotates very slowly, probably once in a Cytherean year. Still, many astronomers published reports of decades of observation that proved the correctness of the Newtonian view that Venus rotates in about 24 hours. In spite of the further support provided by the absence of Doppler effect and of polar flattening, Schiaparelli’s view that if Venus rotates, it rotates very slowly, was not accepted by many astronomers until 1963.

Whereas it took two and a half centuries for astronomers to realize that they had been looking into the telescope with the eyes of their mind, the philosopher David Hume (1711-76) recognized the epistemological problem involved in the study of Venus. He presents a Newtonian who declares ‘Is not Venus another Earth, where we observe the same phenomena?’ And to this Hume in his imaginary dialogue counterposes, by appealing to the authority of Galileo, ‘When nature has so extremely diversified her manner of operation in this small globe, can we imagine that she incessantly copies herself throughout so immense a universe?’[28]

The case of the rotation of Venus is a minor example of the intellectual confusion that results when scientists accept all the astronomical doctrines of Newton without discriminating between what is mystical and what is scientific in the modern sense of the term.

In a brilliant and penetrating essay on ‘Newton the Man,’ written for the *Royal Society Newton Tercentenary Celebrations* (Cambridge, 1947), Lord Keynes declared:

> In the eighteenth century and since, Newton came to be thought of as the first and the greatest of modern-age scientists, a rationalist, one who taught us to think on the lines of cold and untutored reason. I do not see him in this light.

The main contention of the essay is that Newton had ‘a foot in the Middle Ages and a foot treading a path for modern science.’ This contention had been advanced earlier by other scholars, but this time it met with the approval of outstanding historians of science, because Keynes had gained access to the unpublished manuscripts of Newton.

In the case of Newton we meet with the unique occurrence that for three centuries his admirers have fought battle after battle in order to prevent the publication of about nine-tenths of his scholarly work. Whiston was one of the first to clamour for the publication of Newton’s manuscripts, since he wanted to have an opportunity to refute his historical theories. Only recently have the efforts to lift the curtain begun to be successful.

If all the manuscripts were published, what had been claimed by some scholars and was granted by Newton himself in some of his letters, would become evident: that science was not his main interest and that he conceived of it as an auxiliary to theology, as *ancilla theologiae*. That he was unusually successful in his scientific endeavours does not disprove that his main aim was to reconcile astronomy with religion. Newton believed that the astronomical revolution linked with the names of Copernicus and Galileo had destroyed the foundations of religious belief and that it was necessary to return to the medieval world view. He was a biblical fundamentalist who tried to prove, among other points, that the Bible contains prophecies of future history. His interest in science was a by-product of his effort to prove that even science does not conflict with biblical religion, conceived by him as the medieval synthesis of biblical religion with Platonic-Aristotelian cosmology.

The voluminous unpublished works of Newton deal with many topics from alchemy to politics, but theology has the lion's share, followed next by ancient history. These unpublished works cannot be dismissed as occasional efforts. To them he dedicated more time than to his scientific writings. They are just as accurately argued and well finished. All his writings constitute a unified stream of thought of which the scientific production was only one aspect.

Recently, Frank E. Manuel in *Isaac Newton, Historian* (Cambridge, 1963), has informed us of the contents of Newton's unpublished historical manuscripts. Manuel has made clear that at the time they were written they dealt with topics that were intensely debated among scholars. But he has not grasped that their purpose was to refute the historical researches of the Renaissance and those of Whiston in particular. Their main object was to discredit all the historical evidence presented for changes in the solar system. For instance, he tried to prove that in Mesopotamia astronomical science did not begin before the era of Nabonassar (747 N.C.).

In substance, Newton was trying to refute the kind of historical evidence that has been brought again to public attention by Velikovsky. It is rather amusing that in the effort to prove that the observation of the heavenly bodies began only at a very late date, he argued that accepted chronology must be lowered and anticipated the conclusions reached by Velikovsky in *Ages in Chaos*. Like Velikovsky, he claimed that Greek chronology must be shortened by four hundred years, eliminating what today we call the Dark Ages of Greece. Like Velikovsky, he claimed that some dynasties of Egypt have been duplicated in chronological schemes. A main contention of Velikovsky is that the Pharaoh Shishak of the Book of Kings, a contemporary of the successor of King Solomon of Israel, is the same person as Thutmosis III of the XVIII Dynasty. Newton, using a similar line of argument, identifies Shishak with the Pharaoh called Sesostris by the Greek. In giving an account of Sesostris, Greek historian confused the deeds of Thutmosis III with those of Sesostris III of the XII Dynasty. It may be noted that Velikovsky, after a ten year struggle with the committees that administer the carbon 14 tests of archaeological material, has finally succeeded in obtaining at least some tests to prove or disprove his theory and Newton's. These few tests support the contention that the currently accepted dates of Egyptian history must be substantially lowered.

All the pursuits of Newton in theology, history, and science had one purpose. I. Bernard Cohen, the foremost authority on Newton in the United States, concludes (*Franklin and Newton*, Philadelphia, 1956, p.66): 'Of course, Newton had one real secret, and concerning it he did his best to keep the world in ignorance.' The secret is that he intended to uphold the theology and the cosmology of Maimonides. Cohen agrees with Keynes that this medieval synthesis of biblical religion with the philosophy of Plato and Aristotle, constituted the ideal of Newton. He kept it a secret because he wanted to influence scientific thought without putting the admirers of the new scientific method on the alert. Velikovsky, too, has recognized in *Worlds in Collision* that through Newton he is fighting Maimonides. Maimonides expressly declares that in accepting the story of creation he disagrees with Aristotle, but that he agrees with Aristotle that the cosmos, once created, is permanent and indestructible.

In order to reconcile the cosmology of Aristotle with the text of the Old Testament, Maimonides asserted that all the passages that have been understood as referring to cosmic upheavals and to changes in planetary motions, must be understood as metaphors, not as factual accounts. Velikovsky reports that Maimonides re-examined a long series of biblical texts, establishing thereby a new trend in exegesis. Newton pursued the same line of argument as Maimonides in his exegesis of Greek texts and of what was then known of Oriental documents. In his scientific writings Newton tried to prove that natural science does not contradict this exegesis and corresponding theology.

LAPLACE

Among those few who had more keenly critical minds than Voltaire and the other so-called *philosophes,* the metaphysics of Newton created an opposite reaction. By questioning it, his contemporaries, Berkeley (1685-1753) and Hume, established scientific empiricism and laid the foundations for our contemporary scientific method. Just as the leading philosophers of England (soon followed by Hegel, 1770-1831) pierced Newton's metaphysical fog, so the leading scientists of France refused to climb the bandwagon of popular Newtonianism and kept in mind the distinction between what Newton had proved and what he had not proved. Historians usually ascribe the reserve of the Academie des Sciences towards Newton to an obscurantist clinging to Cartesian tradition; but these strictures of the French scientists gave the impetus to the studies of Laplace, the greatest genius in mathematical astronomy since Newton. With the emergence of Laplace, gravitational celestial mechanics was more firmly established and the role of providence in sustaining the immutable order was abrogated.

Laplace (1749-1827) was cited throughout the nineteenth century and also has been quoted by opponents of Velikovsky as having provided the mathematical proof that the solar system, and hence nature, is built like a mechanical clock. But this is only one side of his total view. In the *Exposition du système du monde* he uses two pages to argue that mankind should learn to accept without obsessive fear the likelihood that a comet may strike the Earth [29]. In his other major work, *Theorie analytique des probabilités,* he insists that the motions of the Earth are not unalterable, being subject to several unpredictable forces, among which is the impact of meteorites [30]. He realized that the resistance to accepting the alterability of the sky springs also from the fear that thereby moral law may be destroyed. For this reason he continues the discussion of this topic by delving into psychology and arguing along lines similar to those of Hume's ethics, that a feeling of sympathy among men can exist without traditional metaphysics [31]. It is worth noting that his treatment of psychology touches upon the importance of childhood memories and upon the role of unconscious thinking [32].

Laplace observed that from his mathematical formulas it was possible to draw the conclusion that 'nature has arranged everything in the sky to insure the permanence of the planetary system, with the same purpose that it seems to have adopted on Earth for the preservation of individuals and the perpetuation of species' [33], but added that such a conclusion was wrong, even though 'we are naturally inclined to believe that the order by which things seem to renew themselves on Earth has existed at all times and will exist forever'[34]. In reality, the stability of the present order 'is disturbed by various causes that can be ascertained by careful analysis, but which are impossible to frame within a calculation'[35]. He summed up his views in the words: *Le ciel même, malgré l'ordre de ses mouvements, n'est pas inaltérable* [36]. He warned specifically that in his mathematical formulas about the solar system he had not taken comets into account, stating just as specifically, that the motion of the Earth might be affected by meteorites, and one should therefore study the historical evidence, even though this evidence covers only a few millennia.

Laplace stressed that the human race is beset by a great fear that a comet may upset the Earth, a fear that manifested itself dramatically after Lexell's comet in 1770 had passed at only 2,400,000 km from the Earth. Shortly thereafter Lalande published a list of the comets that had passed closest to the Earth [37]. Men should be free from this fear, Laplace argued, for the probability of one striking the Earth within the span of a human life is slim, even though the probability of such an impact occurring in the course of centuries is very great (*très grande*)[38]. He proceeded to describe the possible effects of a collision with a comet, painting a picture that is in close agreement with that outlined by Velikovsky. Much in the geology of the Earth and in human history could be explained by assuming that such an impact had taken place. However, if this is true, it must also be assumed that the colliding comet had a mass similar to that of the Earth [39]. Velikovsky conjectures that this comet was Venus, which had the required mass.

Laplace summed up his hypothesis in these words:

> The axis and the movement of rotation would be changed. The seas would abandon their ancient positions, in order to precipitate themselves toward the new equator; a great portion of the human race and the animals would be drowned in the universal deluge, or destroyed by the violent shock imparted to the terrestrial globe; entire species would be annihilated; all monuments of human industry overthrown; such are the disasters which the shock of a comet would produce, if its mass were comparable to that of the earth.
>
> We see then, in effect, why the ocean has receded from the high mountains, upon which it has left incontestable marks of its sojourn. We see how the animals and plants of the south have been able to exist in the climate of the north, where their remains and imprints have been discovered; finally, it explains the newness of the human civilization, certain monuments of which do not go further back than five thousand years. The human race reduced to a small number of individuals, and to the most deplorable state, solely occupied for a length of time with the care of its own preservation, must have lost entirely the remembrance of the sciences and the arts; and when progress of civilization made these wants felt anew, it was necessary to begin again, as if man had been newly placed upon the earth.

Laplace also wondered whether heavenly bodies might not be affected by forces other than gravitation, such as electric and magnetic forces [40]. He did not exclude such a possibility, even though according to available calculations their effect was not noticeable. Yet, when Velikovsky stated that the members of the solar system have strong electric charges and that these affect their motions, some astronomers objected that this had been proved impossible by Laplace. The first empirical evidence of the present effect of electromagnetic forces on the motion of the Earth is now available.

Scientific literature never mentions the Laplace statements listed above. He won immediate fame for having provided the mathematical proof of the stability of the solar system that was missing in Newton, despite the fact that he had emphatically warned against such an interpretation of his conclusions.

The interpretation of Laplace's theories was influenced by a minor point he made. He felt the need to refute Newton's argument that the fact that all the planets and their satellites rotate counterclockwise is proof of divine providence [41]. After calculating the statistical near-impossibility that such rotation may be a chance arrangement, he concluded that it must be the result of a common mechanical phenomenon [42]. Hence, he proposed the nebular hypothesis which had already occurred independently to the theologian Emanuel Swedenborg(1688-1772), to the philosopher Kant, and to the astronomer Johann Heinrich Lambert (1728-77). But Laplace did not yet know of the satellites that revolve clockwise. He would have been pleased by the evidence submitted in 1963 which suggests that Venus rotates clockwise. The uniform direction of the rotation and revolution of the planets and their satellites, far from being a key point of his view, was considered by him to be a stumbling block to his probabilistic view of the universe.

The following quotation indicates to what distortions Laplace's theories were subjected by the interpreters:

> We are naturally led to ponder on the great truth of the stability and permanence of the solar system as demonstrated by the discoveries of Lagrange and Laplace... The arrangement, therefore, upon which the stability of the solar system depends, must have been the result of design, the contrivance of that infinite skill which knew how to provide for the permanence of His work. How the comets, whose motions are not regulated by such laws, and which move in so many different directions, may

> in the future interfere with the order of the system, can only be conjectured. They have not interfered with it in the past, owing no doubt to the smallness of their density; and we cannot doubt that the same wisdom which has established so great a harmony in the movement of the planetary system, that the inequalities which necessarily arise from their mutual action arrive at a maximum, and then disappear, will also have made provision for the future stability of the system [43].

Since Laplace was concerned with eliminating providential order, he proved (within the limits of the formal rigour that was considered sufficient by mathematicians of his age) that the mutual gravitational influence of the planets cannot disrupt the system [44]. But this is an empirical, not a metaphysical, conclusion which is valid only if other factors are excluded, that is, if it is assumed that the solar system is isolated in the universe, that the Sun does not suffer alteration, and that no other matter and no other forces beside gravitation and inertia are present in the space where the Sun and the planets move.

Interpreting Laplace as supporting the theological assumptions of Newton has destroyed the scientific achievements of the Renaissance. We are back at scholasticism, and Aristotle is again *il maestro di color che sanno* on an issue that Galileo considered central to the new thought. In the First Day in the *Dialogue on the Great World Systems*, which is concerned with the refutation of the concept of the immutability of the heavens, the great astronomer formulated his creed in these unequivocal terms:

> I cannot without great wonder, nay more, disbelief, hear it being attributed to natural bodies as a great honour and perfection that they are impassible, immutable, inalterable, etc.: as, conversely, I hear it esteemed a great imperfection to be alterable, generable, mutable, etc. It is my opinion that the Earth is very noble and admirable by reason of the many and different alterations, mutations, generations, etc., which incessantly occur in it... I say the same concerning the Moon, Jupiter, and all

> the other globes of the Universe... These men who so extol incorruptibility, inalterability, etc., speak thus, I believe, out of the great desire they have to live long and for fear of death...[45].

Galileo is in precise agreement with Dewey's argument and with Velikovsky's psychological assumption.

Laplace was interpreted to meet the psychological need to believe in the eternal stability of the solar system. The following quotations from *An Analytical View of Sir Isaac Newton's Principia* by H. P. Brougham and E. J. Routh are a good example of a general tendency.

> The other changes which take place in the orbits and motions of the heavenly bodies, were found by these great geometricians [Laplace and Legendre] to follow a law of periodicity which assures the eternal stability of the system.
>
> These changes in the heavenly paths and motions oscillate, as it were, round a middle point, from which they never depart on either hand, beyond a certain distance; so that at the end of thousands of years the whole system in each separate case (each body having its own secular period) returns to the exact position in which it was when these vast successions of ages began to roll [46].

The religious tone of the presentation is obvious. Laplace is construed to be saying that heavenly bodies can have only two types of movements: cyclical movements and uniform rectilinear movements; that is, movements that are equivalent with a state of rest. It is a full return, with some added sophistication, to the Aristotelian doctrine that the heavenly bodies can have only circular motions, motions reconcilable with immobility.

FEAR AND TREMBLING

When one examines the reviews of *Worlds in Collision* written by some one hundred luminaries of our age, he observes that the civil liberty aspects of the affair (the effort to prevent the printing, the academic pressure exercised to keep reviewers in line, and the refusals to publish corrections of misstatements) recede in the face of the frightening realization that the experts to whom is entrusted the human inheritance of scientific thought, our most precious possession, can be the victims of collective hysteria. Scientist after scientist declared that the edifice of science was threatened with destruction by a book which, to hear a number of them, is full of transparent contradictions, written by a 'complete ignoramus' who ranks with the proponents of the flat-earth hypothesis. The atmosphere of panic was somewhat better justified by the opposite contention advanced by a minority of reviewers, that Velikovsky is a hoaxer so unusually well-informed in all technical details and so deft in the subtleties of scientific thinking, that the normal professional expert cannot detect the flaws of his arguments, although these must exist.

The emotional upheaval was such that the *New York Times Book Review* ten years later, in reviewing the literary events of a decade, dwelt upon the fate of 'a book which most contemporary scientists regarded as a publishing catastrophe. It stirred up all sorts of vituperation, especially among astronomers who, it may be recalled, behaved as though they had been stung by a hornet from outer space.'[47]. One should peruse the literature of the hundred years that followed Copernicus's work, to assemble an equivalent collection of bizarre and ridiculous arguments used in the refutation of a theory. To cite one of the best publicized instances: a popular argument against Copernicus was that if the Earth moved, human beings would be thrown into space; similarly, the mimeographed memorandum distributed by the Harvard Observatory, and later several other astronomers, contended that if the Earth's rotation had been arrested, as Velikovsky suggested, human beings would have been projected into space along with all objects not anchored to the Earth [48]. This argument completely ignores the possibility of gentle deceleration and attributes gravitational effect, apparently, to the constancy of the Earth's rotation. The natural scientists who gave Velikovsky's evidence the benefit of objective examination were few. Some reviewers, after boasting that they had not read the book, delivered themselves of Catilinarian orations against the crime of Velikovsky.

In spite of the variety of emotional expressions, the greatest number of reviews written by natural scientists, when reduced to the scientifically significant points, repeat monotonously the same general arguments. They appeal to the ‘laws of nature’ without any further specifications, and keep iterating the names of Newton and Laplace, as if they were an incantation, without referring to any specific passage or section of their works. The stereotype is varied only by the late President of the American Astronomical Society, Otto Struve, who in a review entitled ‘Copernicus, Who Was He ?’ (New York *Herald Tribune Book Review*, April 2, 1950), declared that the trouble was that Velikovsky had never heard of Copernicus and was refuted by the Copernican doctrine.

The psychological assumption that gave Velikovsky his original subjective stimulus to investigate ancient traditions, namely that mankind lives in subconscious fear of cosmic cataclysms, could explain the panic and the emotional irrationality of many reviewers. A valuable clue to the cause of such a reaction is given by the professor of philosophy at St Louis University [49] who, while associating himself with the efforts of the scientists to suppress the book, complained that they did not fully realize the enormity of the crime committed by the publishing industry, for the book destroyed the foundation of Judeo-Christian beliefs. The article concluded that the Catholic Church should come to the rescue by placing the book on the *Index*. But, after the painful experience with Galileo, the Catholic Church has accumulated more wisdom in scientific epistemology than that revealed by our scientific community.

The Cardinal Bellarmine of this case was Professor Harlow Shapley who was indefatigable in his campaign, started before the publication of the book, to alarm the scientific world of the impending catastrophe. How similar are the two personalities! Cardinal Bellarmine was the epitome of the bureaucratic personality and Shapley has devoted his life to the new Leviathan of scientific bureaucracy. The spirit of the new bureaucracy was revealed by the A.A.A.S. meeting (Dec.30, 1950) held in response to Velikovsky’s book. At that meeting it was proposed that henceforth any publication that presents new scientific hypotheses should not be allowed to be printed without the *Imprimatur* of a proper professional body [50].

Every bureaucratic organization that wants to be accountable only to itself attempts to base its power on a transcendental absolute, and Velikovsky was threatening the transcendental absolute of the church of scientism. The reaction against Velikovsky's book confirms once more the common observation that the great mass of natural scientists has not yet assimilated the implications of the great scientific transformation that started at the end of the last century (on the foundations laid by Berkeley, Hume, and Hegel), and clings to scientism, the crude mechanical determinism of the eighteenth century, with insufficient awareness of all the knowledge that has been accumulated in two hundred years on the problem of human perception [51]. What has happened is that when science was still operating on scholastic premises, there were developed mechanical clocks. Since early clocks were connected with astronomy and often took the form of orreries, they influenced the interpretation of the cosmological revolution brought about by Copernicus, Bruno, and Galileo. The recent book, *The Myth of Metaphor* (New Haven, 1962), by the philosopher Colin Murray Turbayne, who explicitly appeals to the arguments of Berkeley and Hume, examines the pervading influence of the metaphor of the mechanical clock and observes, in the Introduction, that as a result of it there has been 'founded a church, more powerful than that founded by Peter and Paul, whose dogmas are now so entrenched that anyone who tries to re-allocate the facts is guilty of more than heresy; he is opposing scientific truth.'

In the Velikovsky-Shapley correpondence of 1946, when Velikovsky offered to submit to crucial tests before publishing his book, Shapley took a position similar to that of Bellarmine: one should not test Velikovsky's hypotheses about the physical characteristics of Venus, such as high temperature and atmosphere of hydrocarbon gases, unless he first agreed to frame them within the proper scheme of metaphysical presuppositions. What Shapley had in mind was the dogma of the absolute stability of the solar system [52]. Velikovsky forced the scientists to become well aware that proof of this postulate does not exist.

Scores of reviews were remarkable for the violence of expression and the jejune poverty of the contents. Often columns of denunciation were not followed by a single argument. The case of Harrison Brown is a good example of those who proclaimed that they had peremptory arguments galore, but did not submit a single one. Only a few scientists of note showed a spirit of scholarly cooperation by providing friendly criticism and additional information. Among them were W. S. Adams, G. Atwater, V. A. Bailey, V. Bargmann, A. Einstein, A. Goldsmith, H. H. Hess, H. S. Jones, J. S. Miller, P. L. Mercanton, C. W. van der Merwe, L. Motz, and S. K. Vsekhsviatsky. In contrast with the rational attitude of these men, several other great names affixed their signatures to statements that competent scholars know to be incorrect.

In order to prove the eternal stability of the solar system, scholar after scholar insisted that records document that planetary motions and eclipses have conformed to the present pattern from the origin of writing at the beginning of the third millennium B.C. But this is known not to be so: records proving such assertions do not exist for the period preceding the year 747 B.C. The aforementioned claim is so manifestly incorrect that, when it appeared for the first time in the *New York Times Book Review* (April 2, 1950), Velikovsky for once obtained the satisfaction of a retraction, but the assertion continued to appear in scholarly publications. The most serious effort to prove the basic postulate of Velikovsky's opponents was that of the astronomer John Q. Stewart of Princeton University, who debating with Velikovsky in the pages of *Harper's Magazine* (June, 1951), argued that Venus could not have entered into orbit after the creation of the solar system because this would contradict Bode's Law. What this so-called law amounts to is a mnemonic formula which gives with rough approximation the planets' distances from the Sun, and which has no basis in gravitational theory.

The almost childish misrepresentations of the available scientific evidence can be explained by the circumstance that many scholars associated Velikovsky's book with their worst personal fears. Astronomers saw the book as a defence of astrology; professors linked it with the McCarthy investigations; a professor at Southern Methodist University declared that it would subvert our traditional way of life more radically than would communism and prostitution combined; and J. B. S. Haldane saw it as fitting into the plans of the American warmongers to start an atomic war [53].

Leaders in science accused Velikovsky of encouraging belief in sorcery, witchcraft, and demonic possession. Since, however, a good number of his postulates, especially those listed as crucial in the final pages of *Worlds in Collision*, have been confirmed by subsequent discoveries, the new strategy of retreat is the assertion, heard with increasing frequency, that these predictions were lucky guesses: it follows that Velikovsky has gambled and won the longest shot in history. It could therefore be argued that the accusation of witchcraft stands.

On the issue of what constitutes or does not constitute superstitious thinking, natural scientists have had their signals crossed for a long time. ‘A true son of the Enlightenment,’ the great naturalist Buffon (1707-88), in 1749 opened his monumental *Histoire naturelle, générale et particulière*, the most comprehensive effort since Aristotle to gather in one body all scientific knowledge, with a condemnation of Whiston [54]. This ferocious onslaught put the tombstone on Whiston’s reputation, whereas up to that point it had been Newton’s view of the history of the solar system that had been on the defensive among scholars [55]. Since he believed that the mechanism of planetary motions is so well contrived that its origin could not be ascribed to a series of accidental events, Buffon suggested that it came into existence as the result of the impact of a comet on the Sun; for this reason he could not object to Whiston on mechanical grounds, but resorted to theological arguments. After having presented a mocking summary of his hypotheses, Buffon declared:

> I shall make only one remark upon this system, of which I have given a faithful abridgement. Whenever men are so presumptuous as to attempt a physical explanation of theological truths, whenever they allow themselves to interpret the

> sacred text by views that are purely human;... they must necessarily involve themselves in obscurity, and tumble into a chaos of confusion like the author of this whimsical system, which notwithstanding all its absurdities has been received with great applause [56].

Whiston was ridiculed for quoting the Old Testament in matters of astronomy and at the same time, condemned for not having taken literally the story of creation in Genesis: ‘He says that the common notion of the work of six days is absolutely false, and that Moses’ description is not an exact and philosophical account of the origin of the universe.’ On the first point Buffon declared that the true naturalist must leave the interpretation of the Scriptures to the theologians, and on the second point he agreed with Newton that the solar system is so exquisitely designed to operate ‘in the most perfect manner’ that it cannot have changed since its creation. Modern interpreters of the thought of Buffon are perplexed because he appears to be a rank mechanical materialist, whereas he put at the head of the fourth volume a letter to the Faculty of Theology of Paris that begins with this profession: ‘I declare that I do not have any intention of contradicting the text of the Scriptures, that I firmly believe all that they report about creation, both in relation to time sequence and to factual circumstances’ [57]. In his writings he delved at great length into problems of scientific method in order to maintain that hypotheses must be built solely on the painstaking gathering of facts, monuments, experiences: but apparently, the narratives of mankind’s history do not fit into any of these categories, whereas Newton’s adaptation of the creation story of Genesis does.

Buffon’s intellectual confusion persists among our contemporary scientists: Kirtley F. Mather [58], Edward U. Condon [59], and J. B. S. Haldane [60] alleged Velikovsky was a rationalist and an enemy of religious faith; many, among them Otto Struve, accused him of trying to subvert science for the sake of religious superstition and biblical fundamentalism. Obviously, *odium theologale* is not a monopoly of the so-called dark ages.

Frank Manuel came close to the truth in his book, *The Eighteenth Century Confronts the Gods* (Cambridge, 1959), where he acknowledged that Newton was deeply involved in controversies about the significance of ancient mythology (pp.85-128). Newton championed euhemerism, the theory that myths were based upon the lives of historical personages, for by this doctrine he hoped to discredit the references to astronomical and other natural events in myths - aspects of mythology so frequently cited by his opponents. Manuel has elegantly summarized (pp.210-27) the ideas of a prominent antagonist of Newton whose views Velikovsky has revived: Nicolas-Antoine Boulanger (1722-59). Author of the entry 'Deluge' for the *Encyclopédie*, Boulanger also wrote *L'Antiquité dévoilée par ses usages, ou examen critique des principales opinions, cérémonies et institutions religieuses et politiques des différents peuples de la terre* (Amsterdam, 1766). In this work he analyzed the cosmogonies and mythologies of several farspread peoples of the Earth, such as Germans, Greeks, Jews, Arabs, Hindus, Chinese, Japanese, Peruvians, Mexicans, and Caribs, concluding that rites, ceremonials, and myths reflect the fact that the human race was subjected to a series of cosmic convulsions for which he also considered the geological and paleontological evidence. He argued that these catastrophes shaped the human mind, causing among other things a deepseated psychological trauma:

> We still tremble today as a consequence of the deluge and our institutions still pass on to us the fears and the apocalyptic ideas of our first fathers. Terror survives from race to race... The child will dread in perpetuity what frightens his ancestors. (III, 316)

Boulanger explained by these fears the human tendency to ideological intolerance, and his hypothesis seems to be confirmed by the reactions of the academy to Velikovsky's work:

> We shall there see the origin of the terrors which throughout the ages have alarmed the minds of men always possessed by ideas of the devastation of the world. There we shall see generated the destructive

> fanaticism, the enthusiasm which leads men to commit the greatest excesses against themselves and against their fellows, the spirit of persecution and intolerance which under the name of zeal makes man believe that he has the right to torment those who do not adore with him the same celestial monarch, or who do not have the same opinion as he does about His essence or His cult. (III, 348-49)

When the ‘Velikovsky affair’ is considered in the light of the history of science it loses its puzzling qualities. Velikovsky saw what other scholars were not able to see because he relied on pieces of evidence that they had chosen to neglect, namely the accumulated records of human experience. Natural scientists who scorn these records put themselves in the position of the early astronomers who held that no truly respectable scholar should resort to the telescope. In only thirteen years a number of fundamental discoveries, predicted by Velikovsky, have demonstrated the value of his method. And one could have predicted that the academic world would react to his thesis with a most unscholarly fury, even with personal vindictiveness: the record shows that astronomers hold to a peculiar dogma akin to the biblical story of Creation, that the solar system has remained unchanged since it was created eons ago, and their assumption has of necessity determined the views of geologists and historical biologists. This dogma, being basically of theological and not scientific nature, is grounded itself on fear, as Galileo and Laplace have pointed out. The evidence is that the dogma is groundless but the fear real. This was the principal reason for the prolonged emotional outburst in which almost the entire scientific community of the 1950’s took part, an outburst of what Soren Kierkegaard termed ‘fear and trembling.’

It is now time for a sober and factual reconsideration; William James properly called ‘tough minded’ those who can face reality and who do not believe *a priori* in uniformity and regularity. The scholars, the learned societies, the professional journals which violated, in some cases quite outrageously, the canons of proper scholarly procedure in evaluating Velikovsky’s hypotheses, should undo the foolishness of the past by promoting a systematic study of what the records of antiquity can contribute to the natural sciences. Newton himself, by his extensive investigations of ancient accounts and records, recognized that his contention that the solar system has no history stands or falls on the historical record. The crux of the matter is not the validity of Velikovsky's particular historical interpretations, but whether an entire body of scientific evidence can be rejected on dogmatic premises.

Notes (References cited in "The Inconstant Heavens")

1. The position of Galileo on the question of magnetism is summarized in the following way by Herbert Butterfield, *The Origins of Modern Science* (New York, 1960), 142: ‘Galileo at one time was prepared to adopt the more general theories of Gilbert in a vague kind of way, though he did not pretend that he had understood magnetism or the mode of its operation in the universe. He regretted that Gilbert had been so much a mere experimenter and had failed to mathematize magnetic phenomena in which we have seen to be the Galileian manner.’

2. *Op. cit.*, 158.

3. *Principia*, Ed. by Florian Cajori (Berkeley, 1946), 525. This peculiar explanation is already presented in the first edition of the *Principia*, 505: *Ascendit fumus in camino impulsu aeris cui innatat.*

4. *De natura deorum* II, 45, 115. The source of this passage is Posidonius. Whereas the cosmology of Cicero has received great attention and its sources have been traced, the cosmology of Ovid, which is an even richer source of information on ancient scientific theories, has been neglected; but the gap has now been partly filled by Walter Spöerri, *Späthellenistische Berichte uber die Welt* (Basel, 1959).

5. *Op. cit.*, II, 21, 56 (Transl. Hubert M. Poteat).

6. Hermann Diels, *Die Fragmente der Vorsokratiker*, 6th ed. (Berlin, 1952), II, 387-88 (Transl, Edward S. Robinson in Werner Jaeger, *The Theology of Early Greek Philosophers* (Oxford, 1947), 187.)

7. Freud’s essay has the untranslatable title *‘Uber die Weltanschaung,’* Gesammelte Werke (London, 1946), 176. It is Lecture XXXV in *New Introductory Lectures on Psychoanalysis.*

8. *Of Learned Ignorance*, Transl. by Germain Heron (New Haven, 1954), Bk. II ch. XI-XII, 107-118.

9. Johannes Funck, *Chronologia cum commentariis chronologicis ab initio mundi* (Nuernberg, 1545).

10. *Opera latine conscripta*, Ed. by F. Fiorentino (Napoli, 1879), I, 1, 367.

11. Op cit., I, 1, 372.

12. *Cf.* A. Corsano, *Il pensiero di Giordano Bruno nel suo svolgimento storico* (Firenze, 1940), 249-64.

13. *Attraction universelle et religion naturelle chez quelques commentateurs anglais de Newton* (Paris, 1938), 4.

14. Quoted from William Whiston, *Astronomical Principles of Religion Natural and Reveal'd* (London, 1717), 23. John C. Greene, when he was writing *The Death of Adam* (Ames, 1959) and was my colleague at the University of Chicago, called to my attention, before the publication of *Worlds in Collision*, the crucial significance of Whiston's writings in the development of scientific thought.

15. *An Examination of Dr Burnet's Theory of the Earth with Remarks on Mr Whiston's New Theory of the Earth* (Oxford, 1698), 177-224.

16. William Whiston, *Memoirs of the Life and Writings of Mr William Whiston* (London, 1760),I, 293.

17. *Philosophical Transactions* XXXIII (1724-25), 118-25.

18. 2nd ed. (London, 1718), 381.

19. *Op. cit.*, 4th ed. (London, 1730), 378.

20. *Letter to the Princess of Wales*, November 1715, in *Correspondence Leibnitz-Clarke présentée d'après les manuscrits originaux*, Ed. by Andre Robinet (Paris, 1957), 22.

21. 'Newton, Isaac,' *Biographie universelle, ancienne et moderne*, Published by L. G. Michaud (Paris, 1821), 127-94;*cf. Journal des savants*, April 1836, 216.

22. *Cf.* 'An Historical and Explanatory Appendix' by Cajori to his edition of the *Principia*.

23. Bernard Le Boyier Fontenelle, *Conversation on the Plurality of the Worlds*, Transl. from French, 2nd ed. (London, 1767), 466.

24. Quoted in *Gentleman's Magazine*, XXX (1755), January, p.3.

25. (New Haven, 1932), 63.

26. Butterfield, *Op. cit.*, 118.

27. *Principia*, 534.

28. *Loc. cit.*

29. *Oeuvres complètes* (Paris, 1884), VI, 234.

30. VII, p. cxx.

31. VII, p. cxxiv.

32. VII, p. cxxx.

33. VI, 478.

34. VII, p. cxx.

35. VII, p. 121.

36. *Ibid.*

37. VI, 235.

38. VI, 234.

39. *Ibid.* (The following translation by Kenneth Heuer, The End of the World, New York, 1953).

40. VI, 347.

41. VI, 479.

42. *A Philosophical Essay on Probabilities*, Transl. by F. W. Truscott and F. L. Emory (New York, 1951), Part II Ch. IX, 97.

43. David Brewster, *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton* (Edinburgh, 1855), Vol. 1, 359-60.

44. Several reviewers stated or intimated that the Newtonian theory is absolutely confirmed by the ephemerides. But, as every student of astronomy is taught, the Newtonian theory, in spite of the contributions of Laplace, is only nearly confirmed. The discrepancy between the predictions and the events may be explained by the inadequacy of our mathematical equipment in matters of three-body or n-body problems, or by the inadequacy of the theory, or by the possibility (which is extremely rarely mentioned in the texts of celestial mechanics) that a third factor may be at work besides gravitation and inertia.

45. *Dialogue on the Great World Systems*, Ed. by Giorgio de Santillana (Chicago, 1953), 68-9.

46. (London, 1855), 122, 124.

47. Russell Lyne, 'What are Best-sellers Made of?,' November 27, 1959.

48. C. Payne-Gaposchkin, *The Reporter*, March 14, 1950; F. K. Edmondson, Indianapolis *Star*, April 9, 1950.

49. Thomas P.McTighe, *Best Sellers*, August 15, 1950.

50. *Science*, April 30, 1951.

51. Most leaders of science, except for the very top layer, reveal themselves as being naive realists without any knowledge of

scientific epistemology. An expression of this is that some of them declared that Velikovsky's earlier activity in neurology and psychiatry disqualifies him from discussing questions of cosmology. However, it was just from an interest in neurology and psychiatry that Kant moved to his investigation of the phenomenology of space and time, which is the foundation of non-Euclidian geometry and Einsteinian physics; *Cf.* F. S. C. Northrop, 'Natural Science and the Critical Philosophy of Kant,' *The Heritage of Kant*, Ed. by G. P. Whitney and David F. Bowers (New York, 1962), 37-62. The fruitfulness of Kant's background is indicated by the circumstance that, in his very first essay published in 1753, he declared: 'A science of all the possible kinds of space would undoubtedly be the highest enterprise which a finite understanding could undertake in the world of geometry,' and continued by considering the possibility of conceiving a space of more than three dimensions.

52. Shapley, *Flights from Chaos* (New York, 1930), 56-7, declares that the Earth has 'a quiet predictable behavior' and that 'not many catastrophes happen to the Earth, except those of its own making, like floods, earthquakes, and sudden continental shifts.' According to him the destruction caused by the impact of a small comet in the Tunguska uninhabited area of Siberia on June 30, 1908, was a unique event in history. On this occurrence, *Cf.* V. G. Fesenkov, *Meteorika*, XX(1961), 27-31.

In the introduction to *Of Stars and Men* (Boston, 1958), 2, Shapley sums up his philosophy in these terms:

"It is a good world for many of us. Nature is reasonably benign, and good will is a common human trait. There is widespread beauty, pleasing symmetry, collaboration, lawfulness, progress - all qualities that appeal to man-the-thinker if not always to man-the-animal. When not oppressed by hunger or cold or manmade indignities, we are inclined to contentment, sometimes to lightheartedness."

Like other militants, he seems to have identified dialectical materialism with the optimistic mechanical materialism of the eighteenth century, which rehashed the position of the most dogmatic among the scholastics. Such a position would have been too extreme even for the more critical of the scholastics, such as the nominalists. It would have been too extreme even for Plato and Aristotle. It occurs only in the more literary passages of Plato, as *Gorgias* 508 A:

Friendship, orderliness, harmony, and justice hold together heaven and earth, and Gods and men, and because of this the whole is called an order *(kosmos)* and not disconnected chaos. *Cf.* G. P. Maguire, 'Plato's Theory of Natural Law,' *Yale*

Classical Studies, X (1947), 178, John Wild, Plato's *Modern Enemies and the Theory of Natural Law* (Chicago, 1957), 117, observes how these passages of Plato inspired *The Laws of Ecclesiastical Policy* by the Anglican theologian Richard Hooker, a work which, as I have indicated, framed the foundations of the Newtonian ideology of the eighteenth century. But Plato deals at length with the astronomical changes and related physical disasters that have befallen the human race.

53. William A. Irwin, *Journal of Near Eastern Studies*, April 1952; Haldane, *New Statesman and Nation*, November 11, 1950.

54. *Oeuvres complètes* (Paris, 1858), I, 96-100.

55. The last time that Whiston's view was given serious consideration was in 1754 when the Berlin Academy of Science offered a prize for an essay on the question: 'Whether the Earth since its origin has undergone a change in its period of rotation, and whence this fact could be established.' Kant submitted an essay for this competition (*Werke*, Ed. by Ernst Cassirer, Berlin, 1912, I, 189-96); but, since he was an ardent Newtonian, he refused to answer the question as it was stated: 'One could investigate the question historically by considering the documents of the most ancient period of the ancient world that concern the length of the year and the intercalations....But in my proposal I shall not try to gain light with the help of history. I find these documents so obscure and so little trustworthy in the information that they could provide on the question before us that the theory that would have to be built on them in order to make them agree with the foundations of

nature, would sound too much like an artificial construction.' He then proceeded to outline the nebular hypothesis which implies the stability of the solar system.

56. Transl. by William Smellie (London, 1791,)I,108.

57. *Oeuvres philosophiques de Buffon*, Ed. by Jean Piveteau (Paris, 1954), p. XVI.

58. *American Scientist*, Summer, 1950.

59. 'Velikovsky's Catastrophes,' *New Republic*, April 24, 1950.

60. *Loc. cit.*

4. CUNEIFORM ASTRONOMICAL RECORDS AND CELESTIAL INSTABILITY

by Livio C. Stecchini

To prove that there are ancient records which document that in recent times the earth underwent a cataclysm of extraterrestrial origin which is precisely described and should be taken into account as an empirical datum by those whose task is to construct astronomical and cosmological theories, I shall quote the opinion of a recognized major authority on Babylonian and biblical astronomy, chronology, and mythology, Father Franz Xavier Kugler (1862-1929).

Kugler had a strictly scientific bent of mind. He started his academic career as a university lecturer of chemistry, but, after the death of Joseph Epping (1835-94), a fellow member of the Jesuit order and the founder of the study of cuneiform astronomical texts, Kugler decided to take over and continue his work and to this end became an outstanding expert on ancient astronomy and cuneiform philology. Most of his life was dedicated to the interpretation of cuneiform texts dealing with astronomy and with the related topics of chronology and mythology; the main characteristic of his method was a mathematical rigour for which he is considered still unsurpassed today.

In the latter part of his life he applied the knowledge developed in the field of cuneiform documents to the solution of related problems of biblical interpretation. His greatest contribution to the study of ancient astronomy was his approach, by which he built only from the most painstaking interpretation of specific texts and thereby cleared the field of *a priori* presuppositions and hasty generalizations.

The decipherment of cuneiform materials had produced from the very beginning an overwhelming mass of novel data which compelled thoughtful scholars to question most of the accepted notions about the development of civilization in ancient times. However, this wealth of revolutionary evidence drove a number of highly competent specialists of cuneiform philology to raise too many general questions at the same time and, in their enthusiasm for the new data before their eyes, to commit themselves to general theories without adequate empirical backing. It is true that many of these general theories were presented as merely tentative, with the purpose of stressing that most of our assumptions need to be totally revised; but the concrete result was that the debate shifted to controversies about generalities, obscuring thereby the more meaningful aspect that cuneiform texts provide a new exact historical documentation, more reliable than most of those that had been hitherto available.

Kugler insisted that one should suspend judgment and concentrate on the careful study of specific groups of documents. For this reason, only at the end of his life did he feel ready to come forth with a general theory, and less than two years before his death, he published a rather slim book entitled *Sybillinischer Sternkampf und Phaëthon in naturgeschichtlicher Beleuchtung*, 'The Sybilline Battle of the Stars and Phaethon Seen as Natural History,'(Munster, 1927).

He who rested his fame on tomes which, in spite of their intrinsic clarity, are comprehensible only to the few who can understand both mathematical astronomy and cuneiform philology, issued this book as part of a series called *Zeitgemässige Beiträge*, ('Essays of Current Interest'), because, as he explains, he felt that he had a message that should affect contemporary society, since it had a great meaning for the history of culture. Kugler well understood that great innovating ideas can be made to prevail by presenting them to a public wider than the narrow specialists, who have a tendency to become prisoners of the general conceptions they have learned together with the technical routines that they have spent their lives to master. But even though Kugler intended to address himself to the general public, he could not help following his usual method, which consisted in proving a general point by concentrating on the exact technical interpretations of a few texts.

Werner Jaeger was fond of repeating to us students that the most important rule he had learned from the great Wilamowitz, was that in philology a few univocal texts have more compelling force than one hundred ambiguous ones. The trouble with this method is that it leads to the formulation of conclusions meaningful only for the wise who can understand that the revision of the interpretation of a single text may automatically imply the revision of a host of similar ones. What Kugler submitted was intended to be dynamite that should have shaken the entire field of ancient chronology and historical astronomy, but the fuse was not lit because the general public did not understand what was implied, and those who were competent to understand the implications were not psychologically ready to draw the inevitable conclusions.

The 'pressing warning' that Kugler wanted to communicate to the public was summed up by him as:

> the momentous doctrine that ancient traditions, even when they are dressed as myth and saga, cannot be dismissed lightly as fantastic, or worse, meaningless fabrications. It is particularly proper to avoid this pitfall when dealing with serious reports, especially those of religious nature such as those that occur in large number in the Old Testament.

He applied this general theory to the interpretations of the ancient texts that deal with the Battle of the Stars. He observed that these texts have been dismissed by scholars as:

> completely nonsensical and that nobody has succeeded in explaining them as a meaningful allegory, if it is not possible to interpret them as references to true cosmic occurrences... I have to confess that in my first occasional attempts I did not succeed any better. But many years of experience with the decipherment of cuneiform documents that concern the astronomical and astromythological conceptions of the Babylonians have taught me that, in the system of ideas of the Easterners and of the ancient Orientals in

> particular, there is much that seems nonsensical to us Occidentals, but is in reality within the realm of factual foundations and sound logic.

When in 1966 I published a first version of the present essay, I stressed that pronunciamentos such as the two just quoted, were intended to sum up an entire life of research on ancient astronomical documents. It was the intention of Kugler that they should be taken as statements of fundamental importance for the understanding and the gathering of actual empirical data of astronomy (which is relevant to natural science).

After this brief, but final and comprehensive publication of Kugler was rescued from oblivion, it was quoted by several supporters of Velikovsky. Yet it has been ignored by his opponents, which is regrettable since I heartily desire to hear their interpretation of the astronomical records submitted by Kugler.

My essay of 1966 stimulated a writer friendly to Velikovsky's theories, Malcolm Lowery, to dedicate a learned article to the contents of Kugler's book. This article is a valuable contribution. First published in England, it was then published again in the United States in a revised form [1]. It is remarkable that the latter version of Lowery's article (which is the one I shall quote), in spite of its effort to summarize what Kugler intended to convey, had to dedicate 25 compact pages to Kugler's 52 pages. In spite of this, Lowery missed several points made by Kugler. This is not to be taken as a reflection upon Lowery's learning, which is of the highest level: for instance, he has translated well some Greek texts of astromythology which have challenged even the professional classicists. The root of the problem is that, although Kugler meant to address himself to the general public, he knew that he was uttering momentous statements and therefore tried to document every single step: for this reason, in many cases, instead of presenting an argument in his own words, he limited himself to citing the text of ancient documents. The result is a booklet that is comprehensible only to those who are familiar with his previous publications of an extremely specialized nature.

Kugler published his booklet when he was sixty-five years old, because what he intended to issue was actually a manifesto announcing a new line of solutions for problems which had been debated since scholars first began to read the astronomical clay tablets found in Mesopotamia. Kugler had wrestled with these problems all through his scholarly life. A manifesto is a declaration of opinions and of related objectives to be pursued. In his manifesto Kugler was considering what had developed in the study of ancient astronomy in the preceding half century, and was setting aims for future research to be pursued by the next generation.

Unfortunately Kugler's manifesto was ignored by the generation that immediately followed it. This is not a unique case. Thomas S. Kuhn (*The Copernican Revolution*, Cambridge, Mass., 1957, pp. 185-6) relates that Copernicus had been 'widely recognized as one of Europe's leading astronomers' for twenty years, before he published his revolutionary book on point of death (A.D. 1543):

Many advanced astronomical tests written during the fifty years after Copernicus' death referred to him as a 'second Ptolemy' or 'the outstanding artificer of our age;' increasingly these books borrowed data, computations, and diagrams. Authors who applauded his erudition, borrowed his diagrams, or quoted his determination of the distance from the earth to the moon, usually either ignored the earth's motion or dismissed it as absurd.

Today, if what Kugler stated in his booklet was put into the hands of a writer with some journalistic talent, it would be the source of a runaway bestseller. It would be expedient that this writer reserve to himself the copyright to the film version, because Hollywood would be most likely to make a bid for it. But Kugler belonged to a different generation and a different world: he spent most of his life within the walls of Jesuit training institutions, carrying on, as a practical sideline to his reading of Sumerian and Assyrian tablets, the teaching of mathematics to his brothers of the Order.

The pivotal idea in Kugler's book is that the myth of Phaeton, one of the best known but also oddest Greek myths, was based on an actual physical occurrence which can be dated historically around 1500 B.C. According to Kugler it was at this time that there appeared in the sky a body which was more brilliant than the light of the sun and finally made an impact on the earth: ‘There really were at one time simultaneous catastrophes of fire and flood.’

The myth narrates that Phaeton (The Shining One) borrowed and drove the chariot of the Sun, but was forced by the steeds that were pulling it to drive it off course through the sky and finally to drive it disastrously close to the surface of the earth. The gods had to put an end to the calamity. Phaeton was struck by a bolt of lightning and fell to earth dead. Kugler concentrates upon this myth in order to establish the principle that, if such a ‘highly fantastic’ story must be taken as scientific truth wrapped ‘in the veil of poetry,’ there are other ancient myths which must be understood as having a similar basis.

Before Kugler many scholars had recognized that the myth of Phaeton refers to an event of physical nature, but they had tried to explain it as an ordinary recurring phenomenon. Some had maintained that it describes the fiery glow of particularly brilliant sunsets, and some, as the coming out of Venus as the morning star. Lowery has translated in full from the original German the pages in which Kugler lists these interpretations, in order to show how forceful Kugler was in scorning them as preposterous. This is a quotation from Lowery’s translation:

> So simple, ordinary and peaceful a phenomenon as the evening sky could not provide the basis for a legend which patently describes complicated extraordinary and violent natural events. And yet neither, on the hand, could the appearance of Venus as the morning star awaken the idea of a universal catastrophe - even in the wildest imagination.

According to Kugler, the reality behind the myth, is that the earth was enveloped by a stream of meteorites, a stream of ‘enormous width’ and containing meteorites of such ‘giant’ size that they could cause ‘great fires and violent flood waves.’ He also indicated that the impact must have been preceded by the appearance in the sky of a body larger and more brilliant than the sun. He left the definition of this body open for reasons that I shall explain later.

According to Kugler, the fire of Phaeton which according to the Greeks had its main impact on Africa (some poets claimed that it caused the Africans to turn black), refers to the same event which in Greek mythology is called the Flood of Deucalion (the name by which the Greeks called the man who supposedly survived it and repopulated the land). Having identified the Fire of Phaeton and the Flood of Deucalion, Kugler proceeded to document that ancient chronologists had assigned specific dates to these two events, such as 610 years before the founding of Rome or the 67th year of Moses. Actually, Greek chronologists state that the period for which we have certain dates begins with this event. They date as contemporary the Flood of Deucalion or Ogyges in Greece, the Fire of Phaeton in Africa, and the Plagues of Egypt. Kugler left out of his account of the ancient information the detail that the foundation of Athens, that is, the city of Athena (who was the planet Venus), was made contemporary with these events. In the chronology set up by the Greek historian Ephorus (fourth century B.C.) the cataclysm took place in the year 1528/7 B.C.[2]. This chronology was accepted in the chronological studies of Eratosthenes (third century B.C.) which in turn were incorporated into those of Castor of Rhodes (first century B.C.). Varro quotes Castor as his source for the information that at the time of the Flood of Ogyges ‘so great a miracle happened in the star of Venus, as never was seen before nor in aftertimes: for the colour, the size, the figure and the course of it were changed. Adrastus of Cyzicus and Dion of Naples, famous mathematicians, said that this occurred in the reign of Ogyges’ [3].

Kugler concluded his quotations of the chronological texts with these words: ‘Even though we do not get the notion of ascribing certain chronological value to these dates and of accepting the old chronological tables based on them (e.g. Petavius, *de doctrina temporum*), we do not have any right to deny that these traditions have a core of historical truth.’ Like Velikovsky, Kugler studies both the ancient writers of chronology and the chronological investigations of Renaissance scholars. Velikovsky quotes a number of

Renaissance writers who stress that ancient sources make the cataclysm contemporary with the appearance of the comet Typhon, and observe that, although this was called a comet, it had a circular shape. These Renaissance writers quote, among others, a passage of Pliny (II, XXIII, 91-92) from which one can gather that it had been disputed whether Typhon was a comet or a planet. The passage reads:

Some comets move like planets, but others remain stationary ... A terrible comet was seen by the people of Ethiopia and Egypt, to which Typhon the king of that period gave his name. It had the nature of a fire, twisted like a spiral, but it was dismal in appearance. Rather than a comet it was some sort of conglomeration of fire. Occasionally both planets and comets spread out a coma.

Wilhelm Gundel, a specialist in Hellenistic astromythology, in his review of Kugler's book sharply rebuked Kugler for not mentioning that all the texts similar to those examined by Kugler ascribed the catastrophe to a comet, and specifically to the comet Typhon [4]. Gundel denied to Kugler the merit of originality by remarking:

> Kugler arrives at the conclusion that the saga of Phaethon has as its historical core the appearance of a comet that was followed by a partial world fire and a flood. In support of this Kugler provides a complete detailed analysis of the saga. I can observe that this interpretation has been already offered several times in antiquity. Probably it is based on an old Pythagorean theory of comets. The first references to it are in Plato and Aristotle, but it is presented in detail by later commentators.

It would seem that Kugler refrained from using the term *comet* because he was puzzled by the role of Venus and because the texts mention a globular body similar in apparent size and brightness to the sun. He used the term 'sun-like meteor' which sounds strange except to those who are familiar with ancient terminology. Aristotle, in order to defend the immutability of the heavens, distinguishes astronomy from meteorology and defines the latter as the study of 'the appearance in the sky of burning flames and of shooting stars and of what some call torches and horns' (*Meteor*. I 341 B). It is significant that, after having described the general topic of meteorology, Aristotle begins the treatment of it by refuting those who say that 'the comet is one of the planets' (342 B).

Gundel's criticism is not justified, because even though it is clear from Kugler's explanation of the ancient accounts that he was suggesting answers in terms of the appearance of a comet and of the impact of the comet's tail, he refrained from committing himself because he was puzzled by the role assigned to Venus in the entire event.

Having dealt with the myth of Phaeton, Kugler, in order to prove further that ancient texts that touch upon heavenly occurrences and are dismissed as fantasy or gibberish contain precise scientific information, picks as a test case the last lines of the Fifth Book of the *Sybilline Oracles*. He chose these lines (512-31) because F. W. Blass, the editor of the text of the *Sibylline Oracles*, had referred to them as 'the insane finale' of the Fifth Book, and the historian of ancient science, Edmund Hoppe, had declared that, no matter from which angle they are examined, they prove 'entirely nonsensical.'

Kugler concluded that to him, as an expert on ancient astronomy, these lines have a clear meaning, since they contain 'an elegant dressing of real natural events according to a fully unified plan' [5].

The lines purport to describe the circumstances of the coming end of the world; they were written in the century before the birth of Christ by Greek-speaking inhabitants of Egypt, when the ancient world was agitated by the Messianic expectation of a cosmic upheaval. But the lines give an account that is so exact and technical that it must be something more than a mere mystical vision of coming destruction. Such precise astronomical details are given that, calculating by the position of the constellations around 100 B.C., the crisis began in September and reached a climax in seven months and 2.7 days, after the 7th or the 8th of April. Velikovsky has concluded on the basis of the agreement of Egyptian, Hebrew, Athenian, and Aztec traditions that the earth was hit by the tail of a comet on

April 13. According to Kugler, the crisis described as the Battle of the Stars began with the appearance in the eastern sky of a body as bright as the sun and similar in apparent diameter to the sun and the moon. The light of the sun was replaced by long streams of flame crossing each other.

After the mention of these streams of flame that replaced the sun as a source of light, there follows the line, ‘the Morning Star fought the battle riding on the back of Leo.’ Kugler observed that this association of Venus with Leo must have had a momentous meaning for the ancients, since the several goddesses that represent Venus, such as the Phrygian Cybele, the Greek Great Mother, the Carthaginian Coelestis was portrayed as riding a lion while holding a spear in her hands. In Babylonian mythology Venus as Evening Star was a goddess of love and motherhood; but as Morning Star she was a divinity of war, leader of the army of the stars, associated with the lion ‘as a symbol of a power that overthrows everything.’

The Battle of the Stars ends when the attacker is defeated, falling into the ocean and setting the entire earth on fire. Kugler explained these events by bringing to bear another prophecy of the same book of the *Sibylline Oracles* (line 206-13) where, after mentioning the same positions of the stars, warning is given to the Indians and the Ethiopians to beware of a coming ‘great heavenly fire on earth and a new nature from the fighting stars, when the entire land of the Ethiopians will be destroyed in fire and wailing.’ The emphasis on Ethiopia is comprehensible when one considers that these texts were written in Lower Egypt.

Kugler concluded that the details of the world disaster prophesied in the *Sibylline Oracles* are materials taken over from the reports of past events, which among the Greeks were presented as the story of Phaeton.

Lowery has stated that in dealing with the Sybilline oracle Kugler retreated from his former position that some major catastrophe of extraterrestrial origin took place at the middle of the second millennium B.C., because Kugler analyzes the oracle according to the normal movement of the heavenly bodies in the year 100 B.C. In spite of his diligence and familiarity with the Greek originals, Lowery has missed the drift of Kugler's argument. First of all, it is a good guess to assume that this oracle was written in the first century B.C., the age in which the Mediterranean countries were most agitated by expectations of a messianic end of this world [6]. In the second place, Kugler wanted to indicate that the writers of the oracle were so preoccupied with solid astronomical facts that they described the successive phases of the episode of Phaeton according to what they knew about the position of the heavenly bodies in the several months of the year. It is his contention that the writers of this oracle, far from being maniacs breathing gibberish, were trying to make their prediction (based on a past historical occurrence) credible by framing it in an accurate astronomical timetable. Kugler left no doubt that he was not thinking of an ordinary movement of the heavens according to the yearly unfolding of the seasons, when he put emphasis on the line of the oracle that reads, 'the Morning Star fought the battle, riding on the back of Leo,' and linked this line with the fact that, in several ancient cults of the planet Venus, the goddess was portrayed as riding on a lion.

Followers of Velikovsky may find fault with Kugler for having left the role of Venus hang loosely as an unexplained item. They do not understand that Kugler did not intend to compile a treatise of cosmology : he was broadcasting a manifesto on how texts of astromythology should be interpreted. Perhaps one can explain his approach by referring to his first academic position as a teacher of chemistry : by testing two pieces chipped out of a mountain, he proved that there was an entire gold mine to be dug out.

Lowery criticizes Kugler for not having raised the issue of catastrophism versus uniformitarianism; but Kugler was not trying to construct an astronomical theory : he was stating less and stating more, in that he was arguing that there was an entire world of astronomical knowledge to be explored. In any case, Kugler was more clearminded on the theoretical aspects of the problem than Lowery has proved to be. The latter regrets that at the end of his presentation Kugler took a stand against 'catastrophism;' that is, he dismissed as without historical significance all those passages of Greek philosophers, from Plato in his late writings to the Roman Stoics, in which mention is made of universal destructions by fire and flood, despite the fact that these passages take some elements from the myth of Phaeton.

Kugler was scientifically correct, but in a peculiar sense : these ancient writers failed to see the episode of Phaeton as a unique event. This group of philosophers was fathering modern uniformitarianism, because they were fitting the historical tradition of 'catastrophes' into a cyclical pattern of phenomena recurring at fixed intervals of time, past and future, according to an absolutely unchangeable and predictable order of the heavenly cosmos. It was *their* way of moving from a disorderly universe, now often admitted, to *an orderly progression of disorders*, which was a first step towards dropping disorders entirely and leaving the history of science with simple orderly progression of the ages.

PANBABYLONIANISM

Since Kugler's booklet on the myth of Phaeton has been ignored, his reputation rests on his monumental work *Sternkunde und Sterndienst in Babel*, 'Astronomical Science and Astronomical Observations at Babylon.' The first volume was published in 1907 and the second volume in 1909 ; supplements were issued up to 1914. The contents consist essentially in the edition, interpretation, and numerical analysis of cuneiform astronomical records. Even today it is quoted as an invaluable source of data; but those who draw from it do not mention that it was written in order to solve problems of astromythology. The two published volumes were intended to be followed by a third volume dealing with mythology; but this volume was not issued for reasons that I shall explain.

In the period that goes from the beginning of our century to the First World War, the field of ancient studies was agitated by debates about the value of a theory to which there was given the misleading name of Panbabylonianism. In order to explain how their theory came to be formulated, one would have to review the entire history of the decipherment of cuneiform languages, but here I shall limit myself to a few points. The reading of the clay tablets that were excavated in Mesopotamia after 1842 provoked a revolution in biblical studies, since it was found that many of the accounts of the Old Testament had close parallels in cuneiform narratives. A typical example is the story of the Deluge and of the Ark. To explain these parallels was a complex task which was rendered even more arduous by the circumstance that the Old Testament is sacred literature to Jews and Christians (divine revelation to the more conservative ones). The problem became extremely difficult and at the same time of utmost importance when it was realized that episodes which are common to the Old Testament and to cuneiform literature occur in the mythologies of the most diverse areas of the globe. The case of the Deluge story is the best known one. To this day Scholars have not yet agreed on an explanation for these astounding parallels. Velikovsky's hypotheses constitute an effort to arrive at the solution of the problem, which obviously is central to the understanding of the development of any civilization and of civilization in general.

The decipherment of the cuneiform signs (particularly of the original Sumerian ones) had relied in part on the study of mathematics; documents dealing with measurements had been particularly useful. In the process it was found that, at the time the Sumerians were developing the art of writing, they had already established a scientific system of measures linking length, volume, and weight; the very fact that these units were sexagesimal indicates their connection with time units. Even before one began to read cuneiform tablets, it had been surmised that the measures of the ancient world derived from Mesopotamia. A highlight in the growth of cuneiform studies was a paper submitted by C. F. Lehmann-Haupt to the International Congress of Orientalist held at Stockholm in 1889; 'The Old Babylonian System of Volume and Weight as the Foundation of the Ancient System of Weight, Coinage, and Volume.' Since the notion that a single system of measures spread through the world by *diffusion* from Mesopotamia was then generally accepted, it was reasonable to infer that scientific thinking spread from the same area by *diffusion*.

Friedrich Delitzsch (1850-1922) thought of applying these notions of *diffusion* in the mathematical field to the solution of the problems of the similarities between the mythologies of the world. This scholar who was one of the most powerful minds in the field of cuneiform studies, developed a comprehensive theory which centres on two main contentions. The first is the common elements of mythologies. The second is that very early in Mesopotamia there was developed an advanced astronomical science which was carried by *diffusion* to the rest of the world in the form of mythological stories. In substance mythology would have been used as a medium for *coding* astronomical information. According to this interpretation the mythological dress would have helped in *remembering*. (According to Velikovsky's interpretation the memory of some astronomical occurrences would have been clothed in a mythical dress because a direct recollection was too traumatic.)

The reason why the Panbabylonists were hurrying to formulate a comprehensive theory, even before all the available evidence was gathered, was that cuneiform scholars were under pressure to answer to statements made by students of the Old Testament; this category included a broad range of writers, from biblical scholars to religious zealots. The discovery of the similarities between Old Testament narratives and cuneiform accounts had caused a commotion among interpreters of the Bible, whether scholarly or not; much of what was published was irrational or irresponsible, and there was some outright exploitation of the interest of the general public. The excavation of the Tower of Babel which was then being planned by German archaeologists, seemed to be symbolic of the situation; in Germany one spoke jokingly of *Babel und Bibel*, a phrase which in English was expanded into 'Babel, Bible, and babble.' The German scholars, who were the world leaders in developing the new field of cuneiform studies, felt they had the responsibility to come out with some clear-cut formulation that could put an end to this confusion of tongues.

Delitzsch and his many supporters among the experts on cuneiform philology would have been on solid ground if they had stuck to their own area and investigated the assumed high level of early Mesopotamian astronomy. Instead they over-extended themselves in a sort of imperialist enthusiasm for their own discipline. For instance, they engaged in an unnecessary, and in my opinion misguided, campaign to belittle the achievements of Egyptian mathematics and astronomy. They rushed to explain the great riddle of the similarities among the mythologies of the world.

Panbabylonianism became so well established among German scholars that in 1902 Delitzsch was asked by them to present his ideas in two solemn public lectures in the presence of the Emperor. The latter was so impressed that he asked Delitzsch to repeat them for the Emperor and his court. The text of these lectures was immediately translated into English: *Babel and Bible, Two lectures Delivered before the Members of the Deutsche Orient-Gesellschaft in the Presence of the Emperor,* (New York and London, 1903). In England too the Panbabylonist theory received so much public attention that the London Times of February 25,1903, printed a letter in which Wilhelm II answered those who wondered whether he had performed his imperial duty of upholding the Christian faith.

THE ERA OF NABONASSAR

Kugler at first was sympathetic to Panbabyloniaism, but later rejected it, because he became convinced that any serious astronomy could not have existed in Mesopotamia before the era of Nabonassar.

Late Mesopotamian and Hellenistic astronomers reckon the years by a chronological system called ‘era of Nabonassar,’ which begins on February 26, 747 B.C. This era gets it name by the circumstance that, in the initial centuries, the years are counted according to a list of the years of reign of the Kings of Babylon; the first of the kings included in the list, is Nabonassar. At the time of Nabonassar, Babylon was under foreign rule and the power of its king was only nominal; in any case, as Kugler observed, no significant political event occurred during the reign of Nabonassar. Nevertheless, starting with the reign of Nabonassar there began to be kept a yearly record of outstanding political events, known as the *Babylonian Chronicle*. Since Ptolemy calculated the years by the era of Nabonassar, it continued to be used by astronomers until the Julian era was adopted as the scientific era during the Renaissance.

The common explanation for the adoption of the era of Nabonassar, which is still repeated today in standard textbooks, is that at that time in Mesopotamia there was introduced a new luni-solar calendar, which gradually was adopted in the neighbouring countries, including Greece. But Kugler realized that the introduction of this calendar was not the cause, but the result of whatever caused the adoption of the new era.

In the very first pages of the introduction to his *Sternkunde*, Kugler states that only with the beginning of the era of Nabonassar did Babylonian and Assyrian astronomers feel the urge ‘to ascertain and record the heavenly motions according to space and time by measurement and number.’ Before this era the astronomers of Mesopotamia would have been only ‘stargazers’ (the German word *Sterngucker* has a humorous connotation which may be rendered by ‘starpeeper’) who were ‘exceptionally inclined to fantasy’ (*ausserördentlich phantasiereich*). This is indeed a strange claim, but Kugler dedicated the entire body of his *Sternkunde* to justifying it by facts and figures. In the supplements to it there is a chapter entitled triumphantly, ‘Positive Proofs for the Absence of a Scientific Astronomy before the Eighth Century B. C.’

The proofs are basically of two types. First, after the beginning of the era of Nabonassar, the astronomers of Mesopotamia, for a period that lasted about two centuries, worked laboriously to ascertain some basic pieces of numerical information without which any rational study of the heavens is impossible, as, for instance, the exact day of the spring equinox. Second, the earlier astronomers of this group developed elaborate calculations which begin with basic figures set through a rough approximation. For instance, computations of the appositions and conjunctions of the sun and the moon, made for the purpose of calculating the beginning of the new moon, would have been based on a value of the longest day which is in excess by more than ten minutes. Since some of these data could have been obtained by a minimum of diligent observation, he concluded that these astronomers liked to play with numbers and enjoyed calculations that had little to do with reality. Still he had to admit that at times one comes across figures of breathtaking accuracy.

According to Kugler there are two specific pieces of proof that astronomy began to be based on exact calculations in the era of Nabonassar. The first is that, because the list of eclipses available to Hellenistic scholars begins with the year 721 B.C., one can infer that Mesopotamian astronomers had not kept a record of eclipses before this date; any serious study of the heavens would start with such a record. Kugler was not aware of the fact, called to our attention by Velikovsky, that the Chinese list of eclipses begins at the same point of time. The second is that before the age of Nabonassar the Mesopotamian calendar appears to have been based on irregular lengths of the year and month; obviously the establishment of a reliable calendar is a prerequisite even of elementary astronomy.

Kugler fails to provide a consistent evaluation of the method of pre-Nabonassar astronomers: at times he describes them as totally oblivious of numerical data and at other times as occasionally careless. At the beginning (p. 25) of the second volume of the *Sternkunde* he hedged the statement he had made at the beginning of the first volume, by declaring that the collecting of observational data ‘at least was not administered systematically.’

Kugler tried to establish why at the time of Nabonassar there would have been a striking change in the attitude towards astronomical records. At first he suggested that ‘perhaps Nabonassar promoted it;’ but later he recognized that Nabonassar contributed only a name to the dating system. He concluded that observers must have been influenced by some momentous astronomical occurrence. Kugler could not trace anything more significant than that, at the time, Jupiter, Venus, and Mars were in conjunction. On December 12, 747 B.C. Venus and Jupiter were at a distance of 1’30" and on February 26, 746 B.C. Mars and Jupiter were at a distance of 23". In reality these conjunctions do not provide an explanation for a total reform in the art of astronomy. If they prove anything, they give some support to Velikovsky’s hypothesis that Venus, having been originally ejected from Jupiter, came to interfere with the orbit of Mars on February 26, 747 B.C. According to astrophysics, if there was a near collision, the present orbits, retrojected to the assumed time of the near collision, should indicate proximity.

Kugler had his doubts about the meaning of the era of Nabonassar, but these were assuaged by the statement of the Byzantine chronologist Syncellus that, ‘Beginning with Nabonassar the Chaldeans made precise the times of the movements of the heavenly bodies.' What Kugler did not consider is that Syncellus drew on the Greek chronologists that I mentioned in the first chapter of this essay. These chronologists indicate that whatever change took place in the methods of measurement was not limited to Mesopotamia.

In my doctoral dissertation I studied the role of Pheidon, King of Argos, in Greek chronology [7]. Greek chronologists divide their system of dates, which begins with the Flood of Deucalion, into a first period called *mythikon* (period of the myths) and a second period called *historikon*. The dividing line is the date of Pheidon of Argos which was originally set in 748/7 B.C.[8]. Other dates of early Greek history, such as the supposed date of the First Olympiad (776 B.C.), were calculated from this assumed date of Pheidon, who would have interfered with the Olympic Games (*Cf.* Herodotus VI, 127). According to Greek tradition Pheidon of Argos would have invented measures of lengths, volume, and weight; but this tradition puzzled the same Greeks who reported it, since, as they say, 'measures existed even earlier.'

However, I proved to the satisfaction of my academic readers that Pheidon was an imaginary character whose name is derived from the verb *pheidomai* 'to reduce.' The earliest texts do not speak of Pheidon, which in Greek is a nickname for one who gives scanty measures, but of *pheidonia metra*, 'reduced measures.' Since in successive investigations I established that the basic units of length, volume, and weight were not changed from the Mycenean age, the only units that could have been changed would be time units.

Greek historians report that the first basis for a yearly record of events was the list of the priestesses of the Temple of Hera outside Argos. Excavations show that this temple may well have been founded in the eighth century B.C. One point can be accepted as proven, namely, that Greek chronologists set a break in the calculation of time at the middle of the eighth century B.C., independently of anything that may have happened in Mesopotamia, and that this break was connected with the units of measurement.

Possibly similar developments had occurred independently in Rome. The foundation of Rome is dated by the earliest annalist, Fabius Pictor, in 748 B.C. The foundation of Rome was ascribed to an imaginary character called Romulus after the name of the city, Rome. Romulus was followed by another imaginary character called Numa; this name is derived from an Italian modification of the Greek word *nomos*, ‘norm, standard.’ We are told that Numa was the second founder of Rome; his birthday was April 21, which was the supposed date of the foundation of Rome by Romulus. Numa was the first to establish a calendar ‘according to exactness’ [9]: he would have calculated a luni-solar calendar according to the correct length of the solar year and the lunar month. Before him the Romans would have used erroneous figures for the length of the year and month. Finally, it must be observed that, up to the second century B.C., the Roman year began on March 1, and hence we say September, October, November, December. The beginning of the era of Nabonassar has been calculated as beginning on February 26, 747 B.C., at a point which, as Kugler related, had no particular significance in the Babylonian calendar and which does not mark any turning point in the unfolding of the seasons.

Kugler probably did not know that Newton too had argued, on the basis of the Greek and Latin authors available to him, that the science of astronomy began with the era of Nabonassar. The purpose of Newton was to silence those who disputed the stability of the solar system since creation. Newton’s contention that astronomical science was a late historical development, was challenged by a scholar who anticipated some of the views of the Panbabylonists, Nicolas Fréret (1688-1749), the first permanent secretary of the Academie des Inscriptions. Fréret, who is properly described as *l’un des savants les plus illustres que la France ait produit* [10], in a series of monumental studies published in the acts of this academy, foresaw the immense advances that could be made in the study of ancient history by combining linguistics, mythology, chronology, geography, astronomy, and history of science in general, taking into account the information that was beginning to be available concerning the civilization of Mesopotamia, Persia, India and China. He realized that with this material there could be obtained conclusions that not only are revolutionary, but also particularly reliable. This point is summed up in his essay, *Réflexions sur l'etude des anciennes histoires et sur le degré de certitude de leurs preuves*. He saw that the data of ancient history were in conflict with the theory of Newton. He challenged Newton's views about mythology and ancient science by which the latter tried to dismiss the evidence for changes in the solar system before the era of Nabonassar. A number of scholars of the time wrote heatedly for and against his *Défense de la chronologie fondée sur les monuments, contre le système chronologique de Newton* (Paris, 1758). The strongest argument, however, against Newton's contention that the ancient evidence on astronomical events is unreliable, is contained in Fréret's essay on ancient geodesy, in which he maintained not only that the length of circumference of the earth was well known in early times but also that the Egyptians knew the length of their country almost to the cubit [11]. In 1816, Jean-Antoine Letronne (1787-1848), after reviewing the entire Academie des Inscriptions concluded that, given the precision of the Egyptian methods of geodetic surveying the declaration of Fréret 'is verified or at least ceases to be too exaggerated'[12].

In 1972, I published the figures used by the Egyptians in calculating the length of their country at the beginning of the dynastic period and showed that they calculated the size of the earth according to a polar flattening of 1/297.75 [13]. At present, I have ready for publication the Mesopotamian figures for the size of the earth, which are based on a polar flattening of 1/298.666. There are accounts that concern the discrepancy between the two sets of figures. In our own age, before the launching of satellites, it was believed that the flattening is 1/297.1. With the help of satellites it has been established that the earth flattening is 1/298.25. Using this figure and an equatorial radius of 6,378,140 metres, it has been calculated how each area of the globe is above or below the level indicated by a geometrically perfect spheroid. It happens that Egypt and Mesopotamia are among the few areas in which the actual sea level agrees with the spheroid of reference. Even before the figures of our space age were published, on purely empirical grounds I had reached the conclusion that the ancient calculations of distances within Egypt agree best of all with a flattening of 1/298.3.

In conclusion, Kugler was right in documenting that a new age in the reporting of astronomical data began with the era of Nabonassar, but the aberrant astronomical data reported for the earlier period cannot be explained by a lack of interest in precise measurements.

VENUS IN CUNEIFORM ASTRONOMY

Kugler's criticism, which concentrated on the specific issue of the era of Nabonassar, had a sobering effect on some leading members of the Panbabylonist school. Hugo Winckler (1863-1913) and Alfred Jeremias (1864-1935) withdrew from the emotion laden debates about the value of the biblical testimony. In 1907 they began to publish a series of monographs aimed at refuting Kugler. This Series was entitled *Im Kampfe um den Alten Orient; Wehr-und Streitschriften,*'On the Field of Battle about the Ancient Orient; Writings of Defence and Attack;' but in spite of their flamboyant heading, these monographs concentrated on what their authors knew well, cuneiform philology. General questions of comparative mythology were introduced only as far as it was necessary to interpret cuneiform texts.

In their counteroffensive Winckler and Jeremias tried to prove their case by focusing the attention on one specific item : 'the entire manner in which Venus is handled by mythology.' They observed that all the astromythologies they considered reveal consistently three features: there is a paramount concern with Venus which is described as the Queen of Heaven; the planets are listed as four, whereas Venus is grouped together with the sun and the moon; mention is made of the phases of Venus. In their opinion the last feature must have been the determining one: Venus was grouped with the sun and the moon because it has phases like the moon and was the object of particular attention because of these phases. Only advanced astronomers would have been able to observe the phases of Venus. Hence, it should be inferred that an advanced level of astronomy was reached so early in Mesopotamia as to have an echo in the mythology of distant countries.

The phases of Venus became the kingpin of Panbabylonist theory. Winckler stated that one should not be surprised at discovering that the astronomers of Mesopotamia were acquainted with them since unquestionably these astronomers had seen four satellites of Jupiter, 'which are much more difficult to observe than the phases of Venus.'

At this point Kugler felt that he could score a crushing victory over his opponents. In March of 1909 he published in *Anthropos*, an international magazine of anthropological and ethnographic studies, an article entitled *'Auf den Trümmern des Panbabylonysmus,'* ('On the Wreckage of Panbabylonism'). The following year he expanded it into a book [14]. His main contention was that to assume a knowledge of the phases of Venus was a patent absurdity. He remarked sarcastically (p. 58 of the book) :'The phases of Venus! If this discovery is authentic, then, oh Galileo Galilei, your fame is turning pale.' According to Kugler the Panbabylonist should have refrained from any further publication until they were ready to submit a special excursus on the physiology of the eyes of the Babylonians.

In reality Kugler was treading on slippery ground, because when in 1611 Galileo announced the discovery of the phases of Venus, some of his contemporaries immediately remarked that they seem to have been known to the ancient Greeks (I have mentioned what Sir Walter Raleigh wrote in 1616). The contemporaries of Galileo who were familiar with classical literature wondered whether Greek mythology hinted at the four satellites of Jupiter, which Galileo saw in 1610 with a telescope that enlarged thirty times. For this reason the four satellites were given the name of four mythological figures closely associated with Zeus: Io, Europa, Ganymede, and Callisto.

For that matter, the contemporaries of Galileo did not know that in Babylonian mythology the god Marduk is accompanied by four dogs. They did not know that the planet Jupiter is portrayed with satellites in the art of the Near East. Kugler did not deny that the Babylonians were acquainted with the satellites of Jupiter, but he dismissed this point as unimportant (p. 61): 'Only this is true: in most rare cases and under most favourable conditions one could have observed the satellites of Jupiter - in any case they could have been seen only for a few minutes.' They would not have been seen well enough to permit listing their appearances in astronomical tables, and only such a listing could be a proof of scientific astronomy.

On the central issue of the special treatment of Venus, Kugler granted readily that this planet forms a ‘triad’ with the sun and the moon. He even submitted pictures from Babylonian monuments in which Venus is grouped with the sun and the moon. But, according to Kugler, all of this can be explained by the elementary fact that occasionally Venus is bright enough to cause a pointer to cast a shadow, as the sun and the moon do, and often is bright enough to be seen during daylight. In reality, neither the Panbabylonists nor Kugler could account for the cuneiform texts in which Venus is referred to by phrases such as the ‘diamond that shines like the sun’ or ‘lordly miraculous apparition in the middle of the sky.’

The very title of the book that Kugler published in 1910 indicates how confident he was that he had succeeded in laughing his opponents out of the scene of cuneiform studies. But their ranks received reinforcement in the person of a young recruit, Ernst Friedrich Weidner (born 1891), who was not only like them a master of cuneiform languages (he was respected as an authority throughout the following half century of his life), but was also well versed in astronomy and mathematics. Winckler and Jeremias, like other distinguished Panbabylonists such as F. E. Peiser, had declared that they were philologists whose task was merely the deciphering of the texts and that they intended to leave the task of solving the problems of astronomy to experts of that discipline.

The arguments lined up by Weidner hit Kugler so hard that in reacting he lost his balance. He stated that the texts that mention that a star was seen as being near the ‘right’ or ‘left’ crescent of Venus, really referred to the crescent of the moon (waxing or waning moon) behind which Venus was concealed at the moment; then, a short time later, he printed a special sheet in order to withdraw this interpretation. The debate between Kugler and Weidner had become so heated that their publications were dated not only by the year, but also by the month and the day.

In March 1914 Weidner published a monograph entitled *Alter und Bedeutung der babylonischen Astronomie und Astrallehre* (‘Antiquity and Import of Babylonian Astronomy and Astrological Conceptions’), which was intended to be a refutation of Kugler’s main contention, as stated in the Preface. Weidner felt so sure of himself that, in spite of his young age, soon after, in 1915, he issued the first instalment of a comprehensive manual of Babylonian astronomy [15].

In the mentioned monograph Weidner saved his best argument for the last pages where he refuted Kugler on the interpretation of texts which mentioned the ‘crescent’ of Venus. The very last sentence of the book reads: ‘Henceforth nobody will try to shake the solid fact that the Babylonians were acquainted with the phases of Venus.’ But this forceful and positive statement is followed, at the bottom of the page, by the following elusive footnote: ‘One may also mention that well-known staffers of astronomical observatories have assured me that, in the clear sky of the Orient, it is definitely possible to follow the phases of Venus with the naked eye.’

The quarrel between Kugler and the Panbabylonists had reached a dead end. Kugler could not deny that the phases of Venus and the satellites of Jupiter had been observed; but his opponents could not explain how this feat had been accomplished. It was pointless for them to cite alleged expert opinions, unless they could produce living individuals who had actually seen such features of the heavens with the unaided eye. Both sides had declared that they were interested in establishing the textual record and that they did not intend any personal rancor, but in fact their exchanges had deteriorated into unconstructive vituperation. Kugler, years later, expressed regret for the asperity of his attacks on the Panbabylonists. Both Kugler and his opponents took advantage of the pause forced upon them by World War I to drop the matter entirely. However, although silence about what had been aired in the controversy may have been advantageous in terms of academic respectability, it did not contribute to the advancement of knowledge.

ON THE WRECKAGE OF PANBABYLONIANISM

Since the ‘Panbabylonists’ were the innovators and Kugler proved that some of their contentions were incorrect, their silence was interpreted by the academic community as a confession of defeat. But Kugler too had been forced into a corner, and kept silent after 1914. Scholars who chose to avoid thorny problems on their way to achieving academic prestige acted as if the ‘Panbabylonists’ had been totally refuted. Yet, even assuming that Kugler had made a ‘wreck’ of Panbabylonism, one should ask whether in this wreck there were pieces of valuable salvage.

A distorted view of the status of the controversy was created by the circumstance that Delitzsch, in 1920, at the age of seventy, two years before his death, aimed a Parthian shaft at his religious opponents, in which he reiterated and broadened some of the original positions of Panbabylonism. The claim that many of the most striking accounts of the Old Testament must be interpreted as astronomical information and that this information was derived from Mesopotamian scientific astronomy was presented in the context of a book entitled *Die grosse Taüschung*; The title ‘The Great Fraud’ refers to Old Testament religion. This book stirred a furor in Jewish and Christian religious groups and aroused all sorts of suspicion in less committed circles. Delitzsch even felt compelled to write an article in the popular press, in which he reviewed his life in order to prove that he had not been motivated by antisemitism [16].

A standard German encyclopedia, *Brockhaus Enzyklopädie*, in the edition of 1972, in the entry ‘Panbabylonismus’ states the following: ‘Today Panbabylonism survives only as a subject of historical interest, because in a one-sided manner it reduces the history of religion to diffusionism.’ This evaluation may be justifiable in relation to Delitzsch, but not in relation to the other ‘Panbabylonists’ who tried to avoid theological topics and concentrated on the interpretation of cuneiform records.

In 1914 they withdrew from the battle because they did not know how to respond to Kugler’s documentation of the ‘gross errors’ in early Babylonian records. Weidner tried to answer by pointing out that there are errors of a few degrees in Ptolemy’s list of the positions of fixed stars [17]; but this is a poor way of defending the high scientific level of early Mesopotamian astronomy. He might have made his point, if he had had the courage to infer from the records that Mesopotamian astronomers made use of some means of optical enlargement. But the Panbabylonists were intimidated by Kugler's statement of 1910 that, 'At the start one must relegate to the realm of illusions the assumption that the Babylonians were already acquainted with the telescope.'

They appeared ridiculous when they ascribed unusually good eyesight to the Babylonians. There is a consensus among those who deal with measurements, that the human eye cannot perceive intervals of less than a minute. It has been argued that this practical reason explains why the degree was divided into 60 minutes. An object which, because of its size and distance, subtends an arc of less than a minute of degree is perceived as a point without any recognizable shape. The apparent diameter of Venus varies from less than 10" to 63" when she is closest to the earth (inferior conjunction); but at the latter point she shows us her dark side (being between the Sun and earth like a new moon), so that she is hard to observe even with a telescope. For an amateur astronomer the best time to observe Venus is about a month before and after inferior conjunction, when she appears as a thin crescent. The four satellites of Jupiter per se would be in the range of visible objects, since they have a brightness of stars of the fourth or fifth magnitude, but what is decisive is their angular distance from the body of Jupiter. We perceive as one light two stars that are less than 3 minutes apart.

Supporters of Velikovsky could argue that the phases of Venus were seen because there was a time when Venus came closer to the earth. In this spirit Lynn E. Rose, with the help of mathematicians and astrophysicists, has been conducting investigations aimed at establishing what may have been the orbits of the earth, Mars, and Venus before the age of Nabonassar [18]. He has gone so far as to consider the possibility that there had been a period of time in which Venus was an outer planet and Mars an inner planet. But, even if these investigations were to arrive at a wellgrounded conclusion, they could not solve all the problems raised by the Panbabylonists.

There has been a general neglect of one problem which in my opinion should be the first one to be asked in dealing with ancient astromythologies : how could Jupiter have been conceived as ruler of the gods, when the planet Jupiter, although by far the largest of the planets, appears to the naked eye as a not particularly brilliant point. However, with an enlarging tool of modest power one can see that Jupiter surpasses all other planets in apparent diameter; this diameter varies between 30" and 50". I do not claim that the apparent diameter of Jupiter is the only explanation for the role assigned to Jupiter by mythology, but I suggest that it may be a part of the explanation.

Since the great debates of the period that preceded World War I scholars of ancient astronomy have avoided difficult problems. Father Johann Schaumberger in 1935 published an addition to Kugler's *Sternkunde* based upon the notes that Kugler had left unpublished at his death. Upon noticing that Kugler did not reply to Weidner's statement of 1914 about the phases of Venus, he supposed that Weidner had been refuted by implication [19]. The argument of Weidner was that cuneiform documents refer to the left and right 'horn' of Venus, using a Sumerian symbol which is used to refer to the shape of the waxing or waning moon. Schaumberger observed that there have been found texts in which the same symbol is used in relation to Mars; since the phases of Mars undoubtedly cannot be observed with the unaided eye, the symbol should not be understood as referring to a moonlike shape. He left out of consideration that Mars when in quadrature (that is, just before and after its closest approach to the earth) shows a contour similar to that of the moon in second and third quarter, and that this face was first noticed in 1636 by Francesco Fontana with the help of a poor telescope.

The total evidence suggests to me that the astronomers of Mesopotamia made use of some sort of enlarging device [20]. But, even if one chooses to let the investigation of this possibility hang suspended in limbo, it remains that the astronomers of Mesopotamia were acquainted with the phases of Venus and Mars and with four satellites of Jupiter, and must have had some notion about the huge size of Jupiter. The question whether Mesopotamian astronomy had an influence on the astromythology of other countries may also be ignored for the time being. The essential point is that the early astronomers of Mesopotamia cannot be dismissed as fantasts who had no concern with empirical reality and lacked scientific spirit; here the Panbabylonists were right.

But, on his side, Kugler was right in pointing out that in the early cuneiform records there occur figures which seem to be gross errors, and that after the beginning of the era of Nabonassar Babylonian astronomers were conducting investigations aimed at ascertaining basic data without which any scientific study of the heavens is impossible. It must have occurred to Kugler that the explanation of these discrepancies may have been some shift in the heavenly motion in the period preceding the era of Nabonassar.

It is a fact that after 1914 Kugler suspended the publication of his major work which had given him a world wide reputation. From the beginning he had announced that the first two volumes, which dealt with observational data, would be followed by a third volume dealing with mythology and cosmological concepts. This third volume was never published, and one must understand that the booklet of 1927 on the myth of Phaeton, in a real, if limited, sense, replaced it. The message of this booklet is not so much that the myth of Phaeton refers to a cosmic catastrophe which took place at the middle of the second millennium B.C., but that in general astromythologies are based on astronomical occurrences. Kugler would have granted to Velikovsky that it is perfectly legitimate to use mythological materials as a source of information about astronomical events.

In substance Kugler accepted one of the major contentions of the Panbabylonists. It may not be true that Mesopotamia was the center of diffusion of astromythologies, but the Panbabylonists were right in pointing out that in Mesopotamia one comes across data which are superior as sources of astronomical information. The information is not only couched in the form of mythological stories, but also in the form of numerical records.

The cuneiform astronomical tablets dating before the era of Nabonassar must be taken at face value. It is no longer possible to speak of careless measurements. Since the publication of Kugler's writings these tablets have been almost completely neglected, with the result that only a fraction of what is available has been published. The collections of cuneiform astronomical tablets that are stored in some museums have been gathered from the excavation of entire astronomical libraries of Mesopotamia. The wealth of material that is available is such that it should occupy scores of scholars for several generations. But the effort would be well justified, because these tablets contain more than general accounts of the events, such as those studied by Velikovsky; they contain exact quantitative data on the basis of which it will be possible to establish on empirical, not metaphysical, foundations the history of the solar system.

Notes (References cited in "Cuneiform Astronomical Records and Celestial Instability")

1. The article first appeared under the title ‘F. X. Kugler - Almost a Catastrophist,’ in the second *Newsletter* of the Interdisciplinary Study Group, now *I. S. G. Review*. It appeared in revised form under the title ‘Father Kugler’s Falling Star,’ in *Kronos*, II (1977), No 4.

2. Felix Jacoby, *Das Marmor Parium* (Berlin, 1904), 136-37.

3. Augustine, *City of God*, XXI,8.

4. *Gnomon*,1927,449-51.

5. The Greek text of this particular oracle with an English translation and commentary, has been now provided by Lowery in *Appendix I* to his mentioned article. It must be noticed that, although the academic world has generally ignored Kugler’s book, when Alfred Kurfess, *Sybillinische Weissagungen* (Berlin, 1951), published an authoritative translation with commentary upon the entire body of *Sybilline Oracles*, in relation to this particular oracle he followed Kugler’s interpretation.

6. Lowery objects that Kugler was arbitrary in choosing the date of 100 B.C. for the composition of this oracle. Kugler would have just chosen a point of time in which the sky fitted the text of the oracle, although the book called the *Sybilline Oracles* most likely was put together in the second century A.D. but the date of the gathering of the oracles in a collection has no relation with the date of composition of this particular oracle.

7. *The Origin of Money in Greece* (Harvard, 1946).

8. Jacoby, *Op. cit.* 93, 158.

9. Plutarch, *Life of Numa*.

10. *Grand Dictionnaire Universel*, ed. by Pierre Larousse (Paris, 1866-90), VIII 818, s.v. 'Nicolas Fréret.'

11. *Mémoires, Académie des Inscriptions*, XXIV (1756), 507-522.

12. *Recherches critiques, historiques et géographiques sur les fragments d'Héron d'Alexandrie* (Paris, 1851), 133.

13. *Noted on the Relation of Ancient Measures to the Great Pyramid*, published as Appendix to Peter Tompkins, *Secrets of the Great Pyramid* (New York, 1971).

14. *In Bannkreis Babels: Panbabylonistische Konstructionen und religionsgeschichtliche Tatsachen* (Munster,1910).

15. *Handbuch der babylonischen Astronomie*, Vol. I (Leipzig, 1915).

16. 'Mein Lebenslauf,' *Reclams Universum*, 36 (1920), Heft 47, 241-46.

17. *Alter und Bedetung*, 13.

18 A good sample of these investigations is provided by Lynn E. Rose and Raymond C. Vaughan, 'Velikovsky and the Sequence of Planetary Orbits,' *Pensée* IV (1974), No. 3, 27-34. *Cf.* also *Velikovsky Reconsidered*, by the Editors of *Pensée* (Garden City, 1976), 100-133.

19. *Ergänzungsheft* 3, 302.

20. One of the few Orientalists who pays attention to this problem is H. W. F. Saggs, *The Greatness that was Babylon* (New York, 1962), 432. But Saggs assumes that the solution must of necessity be the discovery of lenses in excavations. Saggs indicates that some lenses were found. Sir Flinders Petrie too was always on the lookout for lenses in his excavations in Egypt, and reported that once he found an object that might have been a lens. I must observe that a simple glass container of the right shape, filled with water, can perform the function of a lens. Furthermore, the written and archeological evidence

suggests that in the ancient world enlargement was obtained by the use of mirrors. Mirrors provide simple and powerful enlarging devices.

5. ASTRONOMICAL THEORY AND HISTORICAL DATA

by Livio C. Stecchini

> Jupiter: 'Ah Venus, Venus! Is it possible that you will ever consider our condition even once, and yours in particular? Do you think that what humans imagine about us is true, that he among us who is old is always old, that he who is young is always young, that he who is a boy is always a boy, and thus we eternally continue as we were when first taken into heaven; and that just as paintings and portraits of ourselves on earth are always seen unchanged, so likewise here our vital complexion does not change again and again?'

> GIORDANO BRUNO, *Spaccio della bestia trionfante*,
> First Dialogue, first Part. Translation by Arthur D. Imerti. (New Brunswick, 1964),98.

In the September 1963 issue of the *American Behavioral Scientist*, my essay, 'The Inconstant Heavens,' dealt with the Velikovsky controversy only tangentially and intended to limit itself to a mere gathering of its historical antecedents. The substance of what I said was that the doctrine of the eternal stability of the solar system since its creation eons ago is a theological dogma for which there has never been presented scientific evidence and that, hence, it must be concluded that the 'contention that the solar system has no history stands or falls on the historical evidence.' Yet my essay, in spite of its antiquarian intent and tone, happened to touch a most sensitive point, since it dealt with a controversy about the nature of science that has been fought for more than two thousand years.

In his last treatise, the *Laws*, Plato declares that the most dangerous and subversive doctrinaires are those who deny the eternal regularity of the heavenly bodies. According to him, no intellectual, political, or moral order can exist unless it is believed that the stars (in Greek the terms refer to the heavenly bodies in general) 'behave always in the same way according to rules of action established long ago, at some distant time beyond human understanding, and that these rules are not altered up and down, so that the stars at times change nature and now and then act in a different way with wandering and change of orbits.' (*Epinomis* 982 C.) Although Plato here states his general principle, his choice of words intimates that he had concretely in mind the contention which Aristotle too (*Meteor*, 1343A) tries to refute, that a planet may become a comet or a comet may become a planet.

On the basis of this view of astronomy Plato states that there are two conceptions of science, one that we may call *noumenic* and the other that we may call *phenomenic*. According to the first, the physical order is the manifestation of an ordering mind, a *nous*; he sums it up in these words (X 903 C): 'the ruler of the universe has ordered all things with a view to the excellence and preservation of the whole.' The essential proof of this is the system of heavenly motions.

The opposite view, which was represented by Democritus's theory of atoms and celestial bodies in collision, is summed up by Plato in these terms (X 889 B):

> They say that fire and water and earth and air, all exist by nature and chance, and none of them by art, and that as to the bodies that come next in order - Earth, and Sun, and Moon, and Stars - they have been created by means of these absolutely inanimate entities... After this fashion and this manner the whole heaven has been created, and all that is in heaven, as well as all animals and plants, and all the changes of seasons, having had their

> origin not by mind, not from any god or art, but, as
> I was saying, by nature and chance.

For those who uphold this second view of science, Plato recommends (X 909 A) that they be imprisoned for five years in a House of Better Judgment to be brainwashed and that, if they do not change their minds within that period, they be put to death.

This recommendation was not lost to history, for, in fact, Giordano Bruno was subjected to such treatment for seven years and, when it was seen that in spite of the repeated tortures he would not agree even to a partial recantation, he was finally put to death. It must be kept in mind that in the famous passage (*De immenso*, VI, 19; Op. lat. I,2,229) in which Bruno sums up his cosmology with the motto *veritas temporis filia* (a motto that was later adopted by Galileo), he refers to the mentioned passage of Aristotle about comets and takes his stand with the opponents of Aristotle. In the work entitled *Spaccio della bestia trionfante* (which means 'The Expulsion of the Triumphant Beast,' that is, Platonic and Aristotelian cosmology) Bruno propounds an interpretation of ancient astromythology that is similar to that followed by Velikovsky.

The reactions to the publication of Velikovsky's books prove that those who agree with Plato are still with us. The case of the curator Gordon Atwater, who was summarily dismissed without trial from his position as Chairman of the Astronomy Department of the American Museum of Natural History and prevented from ever practising his art, indicates that the supporters of the perfection of the solar system went as far as they could in the use of repressive measures and missed only the help of the secular arm of the state.

Animistic thinking will always be with the human race and, therefore, the battle for the defence of phenomenic science will never be ended. This is well documented by a letter that the editor of the *Bulletin of Atomic Scientists*, Eugene Rabinowitch, wrote (September 9, 1964) to professor H. H. Hess, in which he tried to justify the attack of his magazine against the contributors to the *American Behavioral Scientist*. In this letter he condemns Velikovsky, while boasting, as other scientists of his faction have done, of having never studied any of his writings, and dismisses those who advocate a free discussion on the value of Velikovsky's hypotheses as being 'behavioural scientists' who do not understand the nature of science. The fact that Rabinovitch claims a monopoly on the definition of what is an abomination, indicates which kind of science he is upholding.

Behaviouralism is a movement which aims at introducing the scientific method propounded by Galileo, the phenomenic method, in the area of the so-called social sciences, an area infested with dogmatic, theological, metaphysical, and rhetorical thinking. Against the behaviouralists, Rabinowitch resorts to arguments *ad hominem*, imputing to them malice and obscure ulterior motives; it is a variant on the old Platonic accusation, repeated today even by many social scientists, that the use of the behavioural approach destroys necessary human certainties and subverts moral values. One could have expected from Rabinovitch, at least for the sake of rhetoric, a statement to the effect that, having examined the arguments of his opponents, he found reasons for not accepting them. But he felt the need to state that his condemnation is based on major premises and not on the study of the evidence. The alternative to such medieval scholasticism would have been to accept the method of phenomenic science.

The editors of *ABS* well know that, by dealing with the attitude of some scientists toward Velikovsky's hypotheses, they were risking the wrath of well-entrenched academic power organizations. What they wondered was whether raising this issue was worth the trouble in relation to their general aims of scientific enlightenment. The results prove that, in publishing the special issue, they made a wise decision, in that they struck at the roots of the opposing position.

NEW METHODS AND DISCIPLINARY BOUNDARIES

Since this year marks the fifth centenary of the death of Nicolas of Cusa and the fourth centenary of the birth of Galileo, it is timely to remind the reader that the preservation of the scientific method established by them requires eternal vigilance. The same need for eternal vigilance has been underlined by an international magazine written in several languages and published in Italy, *Civiltá delle Macchine*, which is concerned with the problem of the role of science in contemporary society. In celebration of the fourth centenary of Galileo, this magazine came out with a special issue (May-June 1964) dedicated to the problem of scientific method. In presenting the special issue the editors stated on the first page:

> Precisely today, because the progress of science seems to shine with particular brilliance, there is a tendency to neglect some obscure forces that affect scientific progress from the inside and the outside. If it is easy to identify, at least historically, the external obstacles to scientific research (the case of Galileo is just an obstreperous example of it), one often forgets that some resistances come from the inside of science itself...
>
> To the obstacles that are often set by the closed-mind attitude of the humanists there is added, with more harmful consequences, the immobilism resulting from *a priori* and absolutist tenets held by some of the very people whose task is to cultivate science. This problem is treated with breadth and profundity of analysis in the article by Bruno de Finetti, who reminds us that scientific thought is 'unitary and in perpetual renewal, not fragmentary and final.'

The main article is by Professor Bruno de Finetti of the Instituto Matematico of University of Rome, a specialist in probability theory whose main contribution to scholarship has been the analysis of the interplay of mathematical method with psychological attitudes in the structure of quantitative science.

The editorial of the magazine [1], under the title 'Truth in Expansion,' remarks that modern science was born by proclaiming the independence of science from theology and metaphysics, but that this claim of science to be a complete and autonomous source of knowledge 'has two enemies that are never tired and never defeated: on one side, there is dogmatism, which may come from inside science itself, that pretends to give absolute value to what has been already acquired to such a point as to make difficult or even impossible the introduction of new concepts, and on the other side there is scepticism which pretends to limit the cognitive aspect of science to a series of unrelated hypotheses.'

In order to illustrate this point, Professor de Finetti, in his article 'Brakes on the Path of Science' [2], gives a good deal of attention to the Velikovsky case. In his opinion, the refusal of the large majority of the academic community to discuss objectively how much is acceptable about Velikovsky's hypotheses, in the light of the present state of the empirical evidence, imparts 'one great teaching above all others,' namely, that the professionalization and departmentalization of the several branches of science have become an obstacle to the necessary continuous renewal of science itself.

Scientists forget that the division of science into disciplines exists for the sake of science and come to think that science exists for the preservation of the boundaries of the several disciplines and the related academic organizational structures. In de Finetti's opinion, the uproar against Velikovsky resulted from his trying to relate the art of interpreting historical memories and documents to astronomical and physical research. What was felt as a threat was the possibility, for instance, that the space probes might help to solve problems in the field of the history of ancient civilizations. Scholars refused to discuss the merits and demerits of Velikovsky's studies, because they were concerned with a larger issue, the fact that he challenged 'the right of their fossilized brains to rest in peace' with the skills and problems already established. The defence of this vested interest in the preservation of disciplinary boundaries may transform 'each clan of specialists and the great clan of scientists in general into a sort of despotic and irresponsible mafia.'

Here we are reminded of one of the distinctive contribution to behavioural science made by Harold D. Lasswell, who has demonstrated that the conflict for money, power, and prestige among different skills, and in particular for the preservation of old skills against new skills, can be as explosive in society as the class struggle is according to Karl Marx.

AGAINST HISTORICAL SCIENCE

Professor de Finetti makes us realize that the ideologists who planned the opposition to Velikovsky, even before his first book was published, were successful in their efforts to mobilize the academic community because they were raising what politicians call a bread-and-butter issue, the fear of natural scientists that they might be compelled to learn something about historical evidence. The ideological issue of denying that the solar system has a history becomes intertwined with the issue of denying the significance of historical evidence.

As I demonstrated, the scientific evidence for the non-historicity of the solar system does not exist: if this evidence existed, the opponents of Velikovsky could simply point to it and the debate would be closed. But, since this evidence does not exist, the supporters of the stability of the solar system have been forced to carry the battle into the field of history itself. They are engaged in the strange manoeuvre of denying the historicity of the solar system by denying the value of historical science. This is clearly indicated by the fact that, in the campaign against Velikovsky of fourteen years ago, at the meeting of the American Philosophical Society which was intended to dispose of the issue forever, the performer was the astronomer Cecilia Payne-Gaposchkin, who did not discuss astronomy, but made a mockery of historical science.

Rule number one of this discipline is that one must quote the texts correctly and she demonstrated *ad abundantiam* how this rule can be violated. Similarly, the renewed onslaught by the *Bulletin of the Atomic Scientists* was concentrated on the field of historical science. In the field of physical science the supporters of the Newtonian theology of the solar system not only cannot find proofs, but find themselves confronted with a steadily increasing number of discoveries (many of them predicted by Velikovsky) which flatly contradict it. The space probes have an effect on this theology that is as devastating as that exercised by the telescope on the similar theology defended by the opponents of Galileo.

Therefore these dogmatists are forced into the position of de-fending scepticism. As de Finetti observes, they are forced to deny the unitary character of science. In the area of natural science they have to claim that astrophysical data, such as magnetic fields, radio noises, hot temperature and geological data, such as Worzel layer, tektites, the recent origin of at least some oil deposits, the results of paleomagnetic analysis, are isolated phenomena. In the field of historical science they have to prove that this discipline is not science and cannot provide reliable data of any sort. This is the reason why Margolis in the *Bulletin of the Atomic Scientists* followed in the footsteps of Madame Payne-Gaposchkin in presenting an outrageous caricature of historical documentation. He showed his contempt by stating that in a few hours of study of Egyptology he could contradict an interpretation laboriously arrived at by Velikovsky and supported by the authority of William F. Albright. Margolis trampled on the most precious tenets of historical research: he misquoted passage after passage, referred to statements that did not exist, submitted erroneous translations, and subverted the most elementary rules of linguistics.

But his quarrel is not with Velikovsky, not with me, not with the *American Behavioral Scientist*s; it is a quarrel with an entire scientific tradition that dates from the revival of scientific learning in the Renaissance. In my essay, having assumed that any person who enters into discussions of scientific method is familiar with at least the main work of Galileo, I limited myself to quoting the complementary opinions expressed in less known works of other major figures of science. But, since there has been an effort to muddy the waters, I am willing to rest my case on this passage in which Galileo expressed, with superb lucidity of thought and expression, the epistemological conflict between his spokesman and his Aristotelian opponent:

> *Salviatus:* But to give Simplicius yet fuller satisfaction, and to reclaim him, if possible, from his errors, I affirm that we have in our age new occurrences and observations and such that I doubt not in the least that, if Aristotle were here today, they would make him change his opinion. This may be easily gathered from the very way he argues, for when he writes that he esteems the heavens unalterable because no new thing was

> seen to be born there, or any old one to be dissolved, he seems to imply that, if he were to see any such accident, he would then hold the contrary and put observation before natural reason (as indeed is right); for, had he not made any reckoning of the senses, he would not have then argued immutability from not seeing any change.
>
> *Simplicius:* Aristotle deduced his principal argument *a priori*, showing the necessity of the unalterability of heaven by natural, manifest, and clear principles, and then established it *a posteriori* by sense and the traditions of the ancients [3].

The astronomical question, whether the solar system is unalterable, cannot be settled *a priori*, but must be settled *a posteriori*, by examining 'the traditions of the ancients.' Galileo stated that astronomical theories about the structure of the solar system must stand or fall on the historical record. I have shown that even Newton, although he did not like what he found in the historical records, granted as much. One cannot defend Newton's cosmology without defending also the conclusions of his historical studies. Hence, the astronomer who wants to pronounce himself today on the mechanics of the solar system cannot ignore the historical documentation and must depend on the result of historical scholarship.

The writer of the *Bulletin* tries to reduce a controversy on the nature of scientific method to arguments ad hominem. He asserts that Velikovsky is a person of dubious morality, a peddler of hokum, and hence those who advocate investigations in the same direction are equally tarnished. Similarly, Eugene Rabinowitch, on the one side, in his letter to Professor Hess explaining the editorial policy of the *Bulletin*, accuses the 'behavioural scientists' of unconfessed invidious intents, and, on the other side, in his letter (June 23, 1964) to the editor of ABS, asserts that historical evidence is 'inevitably tentative and often controversial matter.'

Indeed, any phenomenic science, any science which is not based on noumenic premises dogmatically accepted, is bound to be 'inevitably tentative and often controversial matter.' If one reads the record of the trial of Galileo, one sees that this was the main argument against him. This appears to be the reason why he chose to sign a recantation; he granted that to those who were asking for absolute certainty his science was of no avail.

History (unless one believes in a dogmatic and scholastic Marxism which today is outmoded even in the Soviet Union [4]) is an empirical science, a behavioural science, indeed, *cum pace Rabinowitchi*. As such it cannot produce the apodictic certainty to which the *Bulletin*, with Plato, would like to restrict the name of science; but it can be shown that history can produce a body of information that is specific and positively significant, even in the area of celestial phenomena. Historical science, properly used, achieves the same results as any other science. The only limit that is specific to this discipline is that it depends on the records of the past that happen to be preserved and it cannot manufacture them if by chance they have been destroyed. Hence, the problem is the factual one of assessing how many and which kind of documents are available. In the following pages I shall address myself to this problem, relying on the opinion of scholars other than Velikovsky and stressing the significance of documents that do not constitute the major element of his argumentation.

Notes (References cited in "Astronomical Theory and Historical Data")

1. Page 17. The editorial is signed by the Director, Francesco d'Arcais.

2. Pages 19-24.

3. Dialogue on the Great World System, ed. by Giorgio de Santillana (Chicago: U. of Chicago Press, 1953), p.59.

4. The likelihood of recent shifts in the structure of the solar system, with resulting catastrophes upon earth, has been discussed over the past three years in the general science magazine, *Nauka i Zhizn'* (*Science and Life*). The articles quote both physical and historical evidence, similar in kind to, and at times identical with, material adduced by Velikovsky.

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