Mitra, Prabir

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Prabir Mitra (India)

EXPLANATIONS IN THE HISTORY OF SCIENCE: A STUDY OF THE INTERPRETATION OF HERMETIC INFLUENCE ON THE SIXTEENTH AND SEVENTEENTH CENTURY SCIENCE

The magical cult of Hermes Trismegistus, although known to the historian of ideas as an important component of Renaissance thought, was generally not visualised as a source of influence on science by the historian of scientific thought. In the early sixties publications appeared linking the scientific works of Giordano Bruno with hermeticism.[1] By the end of the sixties empirical historical evidence appeared to prove that savants like Paracelsus, Van Helmont, Robert Fludd etc. were not only decisively under the influence of hermetic ideas, but some of their scientific discoveries could be considered a product of these ideas.[2] An analysis of Newton's alchemical works appeared, which attempted to demonstrate the influence of the most basic concept of hermeticism – the spirit of nature or the „Spiritus" theory – on Newton's other ideas.[3] By the beginning of the seventies a debate on the issue was already building up and in 1971 a compilation of essays was published which contained among other things the most clear-cut exposition of the basic problems involved in the issue.[4] From a philosophical angle it would have been possible to overlook the debate but for a number of reasons specified below. The discussion itself was largely on philosophical rather than technical issues related to the historiography of the 16th and 17th century science, and hermeticism almost became an excuse for questioning the notions of scientific rationality, which the foundations of history of science had conveniently incorporated for a long time without much critical thought.

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[1] Yates (15).
[2] Yates (16), Pagel (11).
[3] McGuire, Rattansi.
[4] Teich, Young.

Again, the contemporary philosophy of science has displayed a remarkable knowledge of and erudition about the history of science. Models are proposed on selective historical examples and competitive methodological plans are compared through historical case studies. In all these activities the philosopher takes for granted the current level of historical knowledge. He neither critically examines the historian's labour in culling out the "facts", the selection or rejection of such "facts", nor studies the philosophical problems associated with the explanation of these "facts". By this act the philosopher virtually attributes an immutable "hardness" to the process behind the history of science—to its "facts", and to its reconstructions. The hermetic debate, by challenging this immutability of factual and logical continuity in the history of science, and by raising querries about accepted models of rational thought, has more than deserved philosophical attention.

Finally, a little realised implication of the debate is that, using hermeticism as a case, a number of historians have challenged the use of a logically formulated criterion of demarcation for segregating the rational–irrational or the scientific and non-scientific in the history of science. A number of historians like Pagel, Debus, Rattansi, have argued that, viewed in its proper context, against the backdrop of the Renaissance scientific thought and in the works of Paracelsus, Van Helmont etc., hermeticism and science lose their rational–irrational antithetical relationship and come into a complex, inseparable logical unity.[5] This delicate unity is broken by the historian, who in order to reconstruct the continuity of rational ideas, abstracts stray observations or theories from its original context. In the process the historian uses an *ad hoc* criterion of demarcation which has neither a historical validity nor a timeless normative validity. The dilemma could have been resolved by purporting a logical empiricist type dichotomy between the context of discovery and justification, but for the fact that with laboriously compiled empirical evidence and complex interpretation, Pagel and Rattansi try to establish that justification, of scientific ideas in the case of Paracelsus etc., uses as many explicit hermetic premises as probably were implicit in the context of discovery. They argue that the prevailing view of the history of science—the "rational reconstruction" on the basis of an explicit or implicit demarcation criterion—is characterised by its circularity and produces a continuity of philosophically questionable kind. These historians therefore suggest a more complex, and what we shall call here, a structuralist view of science for its reconstruction. Even the most ardent critic of this view, Mary Hesse,[6] grudgingly concedes that a rational demarcation criterion can hardly be abstracted by an actual examination of the history of science, and in absence of absolute norms history must be demarcated by an *ad hoc* criterion. Although the debate on hermeticism

[5] Rattansi, Debus.

[6] Hesse.

uncovered a serious lacuna in our understanding of explanations and reconstructions in the history of science, little followed subsequently to clarify these questions.

The present paper hopes to reopen the issue by critically examining the basic premises of Renaissance hermeticism, its historical context and then reconstructing the philosophical questions underlying the debate. The nature of historical explanation and the process by which the historian prepares a line of continuity is subjected to investigation and it is proposed that the combination produces a four-fold diversity within the conceptual structure of the history of science: between the logico-methodological and contingent--empirical explanation, on the one hand, and horizontal spatial continuity and vertical continuity in time, on the other. Finally, issues like whether the historian can become mentally a contemporary of the savant studied, an aspect of the structuralist-contextualist prescription, are briefly dealt with in the last part of the paper. The paper is divided into the following sections:

I. Basic premises of Renaissance hermeticism.
II. Hermeticism and science in the 16th and 17th centuries.
III. Explanation and continuity in the history of science.
IV. Some peripheral assumptions of the structuralist view on the history of science.

I

What is identified as Renaissance hermeticism is a body of gnostic texts on diverse arcane subjects, such as occult virtues of physical objects, astrology, alchemy, magic, cabala, making of talismans, nature philosophy, creation of the universe and spiritual cures of human predicaments in general. Inconsistent and mutually contradictory in nature, these texts were in the Renaissance widely believed to have been authored at a very ancient period by the mythical Egyptian priest Hermes Trismegistus. Later scholars, starting with Isaac Casaubon in 1614, doubted the antiquity of these texts, and at the present level of historical scholarship today their variegated character and contradictions are attributed to the absorption of many streams of ideas into the main currents of the hermetic thought, through the works of many unknown authors living in considerably different times.[7]

There does not appear to be any coherent philosophical system common to the texts. Two mutually intermingling components of ideas, mainly philosophical-religious and magical-religious ideas exist, into which the works have been tentatively compartmentalised.[8] The classification is not very rigorous. The two main philosophical works of the tradition, by Asclepius

[7] On the redating of the hermetic texts, see Yates (15), pp. 2–3 and p. 170.
[8] Ref. Yates (15), Ch. I.

and the *Corpus Hermeticum*, which are today dated to have been compiled around one hundred and three hundred A.D., respectively, freely use magical symbolism, planet images, decan images, and almost the same variety of mysticism which we see in the texts of "natural" and "demonic" magic of the tradition. Nevertheless, the distinction could be useful for understanding of the basic structure of Renaissance hermeticism. Written in the traditional form of revealed knowledge, through the encounter with the divine spirit– *Nous* or *Mens*– or in the form of dialogue between the illuminated and the non-illuminated, the philosophical texts narrate the hermetic version of the origin of the cosmic system, the creation of man, his fall from grace, and the possibility of spiritual redemption through the *gnosis*. Nature, through the continuity of creation myth, is assumed to be animate, uniformly permeated with divine substance– the "world soul" or the "intellect"– and alive. The soul links the sphere of cosmic hierarchy to the terrestrial one, and an *affluvia* is believed to perpetually run through the soul of all beings across the spectrum of nature. Thus the "spirit" or "soul" formed a kind of chain linking everything with everything else in nature. The concept of matter varies from an ethical one to a simple aesthetic one. Matter is a container for the soul, restrictive in nature, and transcendence consists in abstaining from the "punishments" of the matter. Ethically, matter within the framework of this concept is baser in dignity than the soul, and through the possession of the soul the material world is uplifted. Again, matter is simply a receptacle for form, wherein nature "imprints" various transitory forms. Matter combines and recombines, life arises, and the dissolution of the composite structure is not death but the release of the soul in its elemental structure. In an interesting passage in the *Corpus Hermeticum*, Hermes discourses with his son Tat on matter being energy– "energies of God".[9] Matter therefore, in a sense is "mortal" as well as "immortal". This form of dialectical logic appears repeatedly throughout the entire *Hermetica*. Things are "mobile" and "stable", "mortal" and "immortal", "finite" and "eternal", and the one which occupies a special place in the philosophy is also the "cause of all". The laws of cosmic operations are basically astrological in nature, ruled by stars, zodiacs, and the seven planets are "seven governors". Relationship between the upper and the terrestrial world, man and cosmos, man and earth, takes various analogical forms in the *Corpus Hermeticum*, and in the later period hermetic writings are dealing with such notions as microcosm–macrocosm, earth and tree, etc. Earth, too, is variously seen as the mother of all things, womb, egg, etc. This analogical relationship becomes the cornerstone of the hermetic search– the search for invisible formal and symbolic parallelism– in later hermeticism, from which the basic magical manipulability of the hermetic world derives. The Renaissance provided a further impetus into the hermetic

[9] For exact quotation from the *Corpus Hermeticum* Ref. Yates (15), p. 34.

main currents through the contributions of Marsillio Ficino (1433–1499) on the use of talismans to reinforce the medical practice of the period, and through Pico della Mirandola's (1463–1494) powerful synthesis of Hebrew cabala.[10]

Although the hermetic tradition repeatedly stressed the importance of knowledge of the external world, this knowledge in the hermetic nature philosophy did not relate to the contemporary empirical knowledge or to the accepted conceptual schema of the Aristotelian-scholastic tradition. It also did not relate in any way to the rising trend of mathematisation of nature in the Renaissance. Instead, it sought its base in a completely different body of literature. Thus Ficino's writings on medicine and talismans show a remarkable similarity with the cosmological structure of *Picatrix*,[11] perhaps the most comprehensive treatise on magic available in the 16th century. The world again uniformly animated is structured into a tripartite division: *intellectus, spiritus* and *materia*– the intellect, soul and the body of the cosmic system. The soul of the world embodies within itself the "seminal reasons" corresponding to numerical values which exist in species in the matter. The mediating substance between the corporeal matter and the soul of the world is a very fine subtle substance– very fine heat or very fine air– *spiritus mundi*, through which the influence of stars is transmitted to the corporeal world. Starting with this conceptual apparatus, Ficino develops a complex world of planet images, stones, animals, food, scent, colour and orphic hymns associated with the *spiritus* of a particular planet whose influence is to be comprehended through the interaction of various cosmic components, *corpus mundi*, *anima mundi*, *mens*, etc., and captured through sympathetic use of talisman. Ficino himself imagines that his work is an extension of the ideas of Plotinus, and quotes from Plotinus. In its basic formulations, Ficino's work does not differ very much from the Neo-Platonic position on nature represented by Plotinus. Plotinus' "contemplation", *intuitis*, "reason principle", etc., representing an image within every corporeal object, roughly correspond to Ficino's formulation. Nevertheless, the knowledge of external world in this type of schema becomes the study of mystique essence, secret properties, seminal reasons, etc., through revealed or directly intuited knowledge, as opposed to the empirical or logical knowledge. This contradiction of the Neo-Platonic mysticism was felt by many contemporaries of Ficino, who like Reuchlin (1455–1522) being inspired by Nicholas of Cusa, on the one hand, wrote eulogies on observational knowledge based on measurement and, on the other, in philosophical writings argued in favour of knowledge by revelation over that of logic and reason.

It is possible that this rising bifurcation between observational knowledge

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[10] Walker.

[11] Ficino never cites *Picatrix*, nevertheless considering the similarities, Walker (14), Yates (15), have concluded *Picatrix* to be the most probable source for Ficino.

and the gnostic world-view in the Renaissance was responsible for turning several branches of Neo-Platonic gnostic speculative trends into more distinctly revivalist channels in search for valid and authoritative explanations. Ficino's search in hermetic literature for true enrichment of the quality of medicinal practice of his time should probably be seen against this background. Reuchlin, too, was concerned with the revival of the Greek, Pythagorean, Platonic, Hebrew and Cabalistic ideas. Pico della Mirandola, a contemporary of Ficino, is believed to have added a new dimension to the Renaissance hermeticism through his syntheses of hermeticism and cabala. In his basic formulations, Pico accepts the Ficinian cosmic hierarchy and its schema of unification of the corporeal and the cosmic through the *spiritus*, but adds a double layer of mysticism to it by superimposing the cabalistic version of letters–combinatory mysticism or the understanding of magic arrangement of sacred Hebrew words according to the principle of which the entire external world is believed to have been created by God. The same structure of tripartite division is also accepted by Cornelius Agrippa of Nettesheym (1487–1535),[12] albeit the vocabulary is different and more modern. Agrippa's world is divided into elemental, celestial and intellectual. The "virtue" of the world descends through intellectual to celestial to elemental and can be caught by magic manipulation of the receptors at the level of the elemental world. The virtue of the elemental world can be understood by systematic study of medicine and natural philosophy, the celestial world by mathematics and astrology and intellectual world by the study of religion. Agrippa believed that magic combined within itself the knowledge of all things and all these sciences. In its basic formulation, the hierarchy and structure of the hermetic universe as expounded by Agrippa is somewhat similar to the accepted medieval cosmic system. The generally accepted medieval cosmic system was a synthesis of Ptolemic into Christian hierarchy, perhaps accomplished through the writings of Pseudo-Dionysius (5th century), Moses Maimonides (1135–1204), Albert Magnus (1193–1280), etc. Beyond the spheres of fixed stars there were the divine spheres. Outermost of the divine sphere was the realm of God, and then a hierarchy of heavenly intelligences, circles of seraphim, cherubim, thrones, circles of dominations, virtues and powers, principalities, archangels and angels. Inscribed within the circle of the fixed stars were planets in the Ptolemic order, with the earth at the centre, surrounded by the spheres of water, air, and fire. Nevertheless, the Agrippan world in terms of the elemental relationship was poles apart from the accepted Ptolemic world-view.

The distinctive character of the hermetic world, which separated it from the accepted scientific world of the medieval period, can now be isolated. In its conception of the external world, its conception of man, and its projected relationship between man and nature, the hermetic world differs

[12] For an analysis of hermetic element in Agrippa see Yates (15), Ch. III.

radically from that of science. The animate external world is structured between higher and lower, "divine" and "elemental", mediated through a universal substance. This way of segregation of the material world can only be based on a preconceived moral order and not on the representative physical character of the world. The divine is also linked to the elemental through the components of universal animation – the universal world-soul. The character of the celestial representation in the corporeal world is sometimes in a discernible symbolic form. Thus the character of stars is visibly imprinted on physical bodies, such as stones, plants, etc., and the nature of search is therefore to identify symbolically imprinted bodies. In the midst of this elemental world, man, placed there by his fall from grace, is the only being which can elevate himself to the level of the divine, by directly intuiting the knowledge, manipulating it and completely aligning himself with the cosmic powers. What is aimed at is a "deification of man through the *gnosis*". The interaction of the human mind with nature is therefore purposeful and action-oriented, as opposed to the impersonal perspective of the emerging mathematico-mechanical tendencies of the Renaissance. The knowledge of the external world in this nexus of relationships acquires its own peculiar distortions. Planets become symbols of a certain passion or emotion. The geometricised cosmic space comprising 360° is divided into 36 segments of 10° each, and each segment is ruled by a decan. Physical bodies become earthly representatives of some heavenly bodies. Light rays become the vehicles of transmission of virtue into the material universe, and later a device for formation of divine images within the inner psyche of the human mind – the "hieroglyphs of the divine"[13] as Bruno called them. The knowledge of mathematics is considered useful for making flying crabs, moving and speaking statues and is considered indispensable for an aspiring magician. This knowledge of mathematics breaks down into long tables for angel summoning, and chapter after chapter deal with secret virtues and sacred groupings of numbers. Geometry becomes the game of magic squares, sacred triangles and other more complex combinations of figures. One doubts if the emotionally charged relationship between man and nature in hermeticism could have ever produced a tradition of detached enquiry, observation, experimentation, mathematisation and study of measurable variables in a universal, observational language.

Even at the points where hermetic tradition joins issue with Renaissance science, and even at the points where its conclusions are subsequently proved to be correct, the logic of justification remains logically indistinct and totally outside the circle of scientific justification. It has been for example pointed out that the hermetic discourses emphasised the movement of the earth much earlier than even Copernicus put forward his theory. In *Corpus Hermeticum* there is a set of dialogues between Hermes and

[13] Yates (15), p. 309.

his son Tat which confirms the opinion. Tat is here being introducted to the mysteries of the world by his father Hermes who propounds the idea of mobility of everything including the earth. The earth alone in this view is "stable" as well as "mobile". Because, Hermes explains that, the earth is the "mother of all things", and how could it give birth to anything if it were not mobile. Without mobility there is no generation of new things.[14] Almost similar kinds of dialectical, closed arguments are used in every scientific issue, composition of matter, definition of life, etc.

Question can now be legitimately asked as to what this mysterious internal world of hermeticism has to do with science? To seek an answer we have to briefly go back to Giordano Bruno, because Bruno formed the first fortuituous meeting points of science and hermeticism, and it is through the analysis of the complex science and complex character of Bruno that hermeticism first entered the history of sciences. The subsequent search for undercurrents of hermetic thought in the Renaissance science– in the alchemical literature, in the works of Paracelsus, Van Helmont, Robert Fludd, Newton and the Rosicrucians, and even the issue of the structuralist interpretation of history– will have to be reviewed from this starting point.

II

In the history of scientific thought Giordano Bruno (1548–1600) is generally regarded as one of the early converts of the Copernican heliocentric idea and a fervent propagator of the concept of infinite universe. This infinitisation or the opening up of the essentially finite Copernican world, Bruno himself as well as several historians regard as an advancement over the Copernican system and an invaluable contribution towards the making of the modern world picture. Despite this, Bruno is generally not regarded as a scientific or intellectual heir of Copernicus. His cosmological views were neither a product of abstract mathematisation of space, nor based on exact astronomical observations. Nor was his interest exclusively confined to scientific subjects. The corpus of work Bruno left behind at his death leaves no doubt that Bruno can hardly be regarded as a scientist in the modern sense, but as a man who had a certain remarkable "premonition of modern physical thought"[15] he would perhaps always claim a place in the history of scientific thought. That such a remarkable premonition was not a product of any scientific enquiry would perhaps always remain a puzzle for the historian of science.

Bruno was preceded by Lucretius, Diogenes Laertius, Nicholas of Cusa and Leonard Diggs in his conception of the infinite universe. It is entirely conjectural if Bruno was familiar with the works of Leonard Diggs, first

[14] Yates (15), p. 34.

[15] Singer.

published in the year 1576 by his son Thomas Diggs, seven years before Bruno landed in England, but it is well known that Bruno was profoundly influenced by the views of Lucretius and Nicholas of Cusa. A copy of Lucretius "accompanied Bruno all through his tempestuous wandering life" and his Latin verses are redolent of Lucretian lines. Besides this Bruno's views of cosmic metabolism, minima and discrete continuum are believed to be extensions of Lucretian ideas. The influence of Cusa can be more directly perceived in Bruno's arguments. Bruno uses the same arguments and nearly the same words in his proof of the infinite universe, and like Cusa accepts the doctrine of the eternity of universe. Like Cusanus again Bruno assumes that the other celestial bodies are inhabited and that the inhabitants are in conformity with the conditions of their habitat. In his conception of matter again Bruno, like Cusanus, used numerical and geometrical analogies to illustrate his view. Bruno often applies analogy and symbolism based on the Trinity, which recalls to mind Cusa's similar use. It is generally known that Nicholas of Cusa often used the ancient doctrine of dialectics and reconciliation of opposites in an original and creative way, quite differently than the scholastics.[16] Bruno, too, often employs the doctrine of dialectics and his approach to it is similar to that of Cusa. Bruno's admiration for Cusa is indeed great and he perpetually quotes Cusanus: his works are replete with laudatory references.[17]

It cannot be argued that Bruno synthesised the diverse views of Lucretius and Cusa into a common system. Centuries separated Cusanus and Lucretius, and their views have nothing in common with each other except perhaps the idea of infinite universe. Bruno merely gathered together from both of them arguments and doctrines which were useful for his purpose. Indeed Bruno was no synthesiser in the scientific sense. It becomes clear if we examine the other convergent influence to see that he was torn between disparate influences of very contradictory kind. Bruno was greatly influenced by Raymon Lull. Much of his early work is either an exposition or an extension of the rather obscure, mystic, mnemonic system of Lull, and his later works are replete with praises of fellow Lullians, like Charles de Borelles (1470–1533), who was not only a follower of Lull, but shared with Bruno his belief in Wisdom Litera, microcosm–macrocosm theory, and symbolism based on the Trinity. Bruno, whenever it suited him, like Borelles and Cusa, quotes the Pseudo-Dionysian dialectics. Pseudo--Dionysius was commented upon by St. Thomas (1225–1274), Albert Magnus (1193–1280), Cusanus and Ficino. All these commentators were cited by

[16] Similarities between the views of Bruno and Cusa, and Bruno and Lucretius, on issues such as eternity of universe, maxima and minima etc., have been discussed in detail in Singer, Ch. III.

[17] Several laudatory references on Cusa and his work appear in Bruno: "Remarkably talented man", "Cusan speaketh divinely" (Singer, p. 307), "Cusan has known and understood much" (Singer, p. 307), etc.

Bruno to strengthen his arguments. Bruno also cites cabala and orphic theologians and quotes Agrippa. The appeal of Renaissance Epicureanism and Lucretianism was strong on his mind and he quotes Palingenio and Girolamo Fracastore (1478?– 1533). Bruno never uses Christian symbolism but the Wisdom Literature appeals to him greatly. He praises David of Divant for his universal pantheism. Like all other nature philosophers of his age Bruno was also fascinated by Neo-Platonism and often cited the Jewish statesman and poet Solomon Ibn Gabriel (1021–1058) and Aviceborn. The views of eternity and essential unity of the world of Averroes (1126–1198) also appeared in Bruno's works. Although no student of astronomical tables, he greatly praised the learned Dane Tycho Brahe, who by his "wise talent hath discovered many things" and also cites Cornelius Gemma and Elyseus Roeslin. He was also a great admirer of Bernadino Telesio (1509–1588), the founder of the scientific academy of Cosenza.[18]

It is not difficult to see that a man's mind shaped under these disparate influences would be fraught with enormous contradictions. It is obvious that a prolific and impressionable thinker like Bruno would have at some level incorporated generally mystical and intuitive arguments of many of his mentors. Yet it is a surprise that no one examined Bruno to unearth a substratum of hermetic thought in his corpus before Francis Yates published her study. Yates' volume came almost ten years after the most thorough study of Bruno's life, namely the work published in the English language by Dorothy Singers in the early fifties. Both books bear many similarities including primary and secondary sources of information. Indeed a passage by passage comparison would almost show duplicacy, notwithstanding a fundamental difference. Singer's Bruno is a scientist, a man with a "remarkable premonition" of the modern thought, and one who ultimately laid down his life courageously defending his science. By a totally unexpected and imaginative twist of interpretation, however, Yates' Bruno turns out to be an out and out magician, deeply seeped in hermetic occultism, convincingly modifying his scientific views in order to seek royal favours and even getting entangled in secret international missions of dubious kind. If Singer's Bruno is a scholar and a martyr, then Yates' Bruno is a mystic manipulator in his private and public life. A terrible transformation of the *enfant terrible* of Science.

Yates first studies the structure of hermetic texts and goes on to study the various medieval adaptations of hermetic thought in Ficino, Pico, Agrippa, Paligenio, etc. Almost all of these had influence on Bruno and were quoted by him. She then goes on to unearth hermetic elemets in Bruno's thought by two methods, a direct comparison of the syntactic structure of the *Corpus Hermeticum* with some of Bruno's works, and by direct comparison of Bruno's arguments with the hermetic arguments. Gradually and dexterously

[18] For a more detailed treatment Ref. Singer, Ch. III.

she locates hermetic ideas, allusions, and even many direct references, in almost all the major works of Bruno, e.g., *Cena de le Ceneri, De le Causa Principio et Uno, The Infinite Universe, Spaccio della Bestia Trionfante, De Umbris Idearm*, etc. Through these types of comparisons Yates relates Bruno's entire corpus of scientific thought: his heliocentric conception, his conception of maxima–minima, his thoughts on the plurality of the universe, his outburst against the Oxford pedants, his studies on mysterious properties of geometrical figures, his entire work in Germany, to show Bruno's passionate and mysterious affiliation with hermeticism. Even ordinary references on special properties of animals, flowers, plants, which Bruno sometimes makes (*Spaccio*), or his incantation to the sun (*Cantus Ciraeus*) Yates is able to successfully connect with the main body of hermetic literature. In his division of 36 decan images, and in his planet images Yates finds the germs of Agrippa's conception and on Bruno's cosmic division she discovers a Ficinian hermetic stamp. Through an entirely new set of historical evidence she demonstrates that Bruno's controversial Oxford lecture was in a very large part plagiarised from Ficino,[19] without any reference being made, and a part of his work (*Spaccio*) was almost verbatim lifted from Asclepius, again without any acknowledgement.[20] Yates even sees the origin of the infinite universe idea in the *Hermetica*. The arguments are too numerous to be included here in detail, but the implication is important that Bruno's scientific premonitions rose from his almost near total commitment to hermeticism, and the other diverse influences, Cusa and Lucretius notwithstanding, were probably merely used to strengthen this commitment wherever possible to do so.

Studies that followed on the subject of hermeticism and science further strengthened the connection. Walter Pagel had already published his study of Paracelsus some years back.[21] The influence of Neo-Platonic and various kinds of gnostic thought on Paracelsus was an accepted conclusion. That the uniformly animated Paracelsian world used microcosm–macrocosm theory, doctrine of signature, principle of sympathy and antipathy, for interpreting empirical-observational data was well known. The influence of Ficino, Reuchlin, etc., on Paracelsus had been demonstrated through some historical evidence. The demonstration that all this leads to an influence of hermetic ideas was only a step ahead. Allen Debus further developed the finer structure of the Paracelsian hermetic universe and Pagel took up the case of van Helmont.[22] Every textbook in the history of chemistry notes that Jean Baptiste van Helmont (1579–1644), discovered gas. Pagel notes that his harmless entry in textbooks as a record item is true but not the whole

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[19] Yates (15), p. 208–209.
[20] Yates (15), p. 212–214.
[21] Pagel (10).
[22] Pagel (11), Debus.

truth. It is true that Helmont conducted experiments by heating coal in a closed chamber and by carefully observing the vaporous substance that forms, he distinguished it from air and water vapour. Helmont called the substance gas. Yet gas for him was an integral component of matter, that every substance received as a divine gift at the time of its creation. In the animistic–vitalistic universe of Helmont, gas was virtually the power within matter by which the matter lived. It conferred on the matter the ability to exist in several possible states and forms. When gas was liberated from the matter, it was as if the matter was spiritualised or the spirit materialised. The entire conception of gaseous substance in Helmont's writings is presented within the problematic of interaction of spirit and matter, almost an extension of the perennial Aristotelian polemics on entelecha. Viewed in the context of Helmont's other animistic and hermetic ideas such as *magnale* or *blas*, which in Helmont's works paralleled the Platonic conception of *anima mundi*, Helmont's gas assumes quite a different meaning from that attributed to it in modern chemistry. How fair is therefore the historian, Pagel asks, who for the sake of working out a continuity of ideas, on the one hand, equates Helmont's concept with the modern one, and on the other hand, carefully weeds out the Helmontian justification, as it happens to conflict with the modern notion of scientific rationality. Pagel develops the idea further by examining Helmont's model of scientific method.

The line of argument on the continuity issue that was developed by Pagel was pushed to its logical extreme position by Rattansi.[23] Rattansi examined some of the alchemical writings of Newton. Newton's involvment in alchemy, biblical chronology, prophecy, etc., although well known to the historian of science, are usually carefully overlooked as not directly relevant to his scientific activity. Rattansi, on the other hand, begins with the assumption that Newton's alchemical ideas must be having some conceptual relationship with his other scientific ideas. He is not happy with the traditional position taken on the issue, namely that Newton was either looking for chemical and metallurgical information in the alchemical texts or he had a hidden irrational, magical streak within his rational scientific self. Rattansi sought the genesis of the alchemical ideas of Newton in the influence of Cambridge Platonists on him. A number of parallels, like Newton's idea of space in his arguments against the Cartesians, Newton's ontological presuppositions in the *De Gravitatione*, are cited by Rattansi to show the influence of More on Newton. In the post-Principia period, Newton in his *Optiks* also made a somewhat ambiguous distinction between passive laws of motion and a certain potent active principle generating new motion, thereby at least obliquely hinting at the possibility of an animistic world, perhaps on the lines suggested by More. Rattansi believes

[23] Rattansi.

that it was the influence of More that made Newton use the most central notion of hermeticism – the Spiritus theory. Rattansi particularly picks up Newton's use of the *spiritus* idea in connection with his conception of light and tries to establish that Newton at one stage visualised *spiritus* as light itself, and explained activity in matter through particles of light embedded in matter. Rattansi concludes somewhat daringly that Newton, through his implicit animistic leanings, conjured light as a grand vegetative spirit of nature. He therefore goes on to ask, what entitles the historians to reject the hermetic – alchemical component of Newtonian thought, for the sake of creating a rational continuity of ideas.

To the historians of science and Newton's various biographers, the influence of Cambridge Platonists on Newton and his use of the *spiritus* theory have been well known for a long time. Burtt, writing in 1925, traces the influence of More on Newton to Newton's early Grantham School days, where Newton lived together with the Platonist's intense admirers.[24] Burtt quotes from the *General Scholium* to demonstrate the similarity of the Newtonian idea of deity with those of More and goes on to trace the similarity of ideas of space in both men. Again Brewster writing in 1885 and Ball in 1893,[25] both repeatedly cite passages from Newton, where Newton uses *spiritus* hypotheses to explain a large variety of phenomena, e.g., electricity, magnetism, gravity, cohesion, animal sensation, motion, colour of light, reflection and other abstruse phenomena, which the science of his days found difficult to explain. As a matter of fact at one stage of his movement towards ideas later presented in *Principia*, Newton made a somewhat ambiguous use of the concept of ethereal spirit. Newton defined the concept in his famous latter to Oldenberg, in 1675, wherein he also for the first time defined the concept of ether. Newton's description of the ethereal spirit as something "very thinly and subtly diffused through it", "perhaps of an unctuous or gummy, tenacious and springy nature",[26] also immediately recalls to mind the hermetic definition of *spiritus*. Ball and Burtt also cite the Newton's letter to Halley (just before the publication of *Principia*), in which Newton proposes that one of the main advantages of the ethereal spirit hypothesis is that the hypothesis could easily be expressed in mathematical form consistent with derivations from Kepler's planetary laws, if constant or accelerated velocities are assigned to the descending spirits.[27] Although it is impossible to say if Newton's ethereal spirit concept was in a hermetic spiritual line or a more mundane mechanical explanatory construct, it is, however, established beyond doubt that up to

[24] Burtt, p. 256.

[25] On this point, both Ball and Brewster are repeatedly quoted by Burtt. Ref. Burtt, pp. 269, 272, 274.

[26] The content of the letter to Oldenburg occurs in Brewster, I, pp. 390–400, from which Burtt quotes repeatedly, Burtt, pp. 269, 272.

[27] The reference to the letter to Halley occurs in Ball, p. 158 and Burtt, p. 272.

a stage, perhaps up to the publication of *Principia*, Newton was toying with some sort of *spiritus* theory and a belief in universal transmutation. It therefore appears curious that despite this knowledge historians did not propose an explicit connection between Newton's *spiritus* ideas and hermeticism for so many years. Did they or did they not see this connection?

My answer to this would be that the historians did see and deliberately neglected this connection. At least there is enough in the works of Burtt or Koyré to suggest it. To admit this omission as deliberate is to virtually concur with Rattansi that historians owe an explanation on methodology to the charges he formulates extremely lucidly. I shall present Rattansi's arguments in a somewhat simplified form. Citing the case of hermeticism he begins his defence of the study of the subjects which are seemingly trivial or nonsensical in nature, and goes on to claim that the historians of science, in the name of rational reconstruction, have carefully rejected important sources of influence on science which are not consistent with their notion of the supposed rational structure of science. The methodology of historical research of science in his view becomes a circular teleological one. The historian begins his research with a certain notion of rationality in his mind and thereafter selects all such trends of ideas which are consistent with his preconceived notion, instead of historically testing how correct these ideas are. Resulting narration becomes a teleological summary of trends which are continuous with the contemporary science, selected according to what historians think as the special character of the rationality of the modern science. Since the line for drawing a demarcation between science and non-science in the past practice is arrived at by *a priori* considerations, according to Rattansi it has no validity and the resulting teleological narration presents an extremely distorted version of history. An important corollary of Rattansi's critique is that "doing" science in any period involves important metaphysical assumptions which are not easy to ascertain for the historian who sees from the perspective of a different age. Scientific changes occur and new scientific theories develop by a complex interaction of rich substrata of ideas, all of which cannot be captured into a history by a narrow rationalistic reductionism. He therefore suggests that the historian should use a more detailed contextualistic technique of historiography.

More recently Elkana[28] has reformulated almost similar charges against what he calls the inductivist–positivist interpretation in the history of science, through his examination of Leibniz' and Euler's theories. He poses the question sharply: "How does the historian of science know *a priori* what was for Newton, Leibniz, Euler or anybody else directly relevant to science?". He asks for example how was Leibniz' view on the unification of Church related to the concept of monad or force. Is it not the job of the his-

[28] Elkana.

torian of science to seek coherence between various aspects of a scientist's thought? Elkana asks by what demarcation criterion Euler's theory of matter is neglected in most of the textbook accounts and why standard history of mechanics books like Dijksterhuis' or Dugas' books do not mention Hobbes concept of *conatus* or Leibniz' concept of force and monad. Although Elkana, unlike Rattansi, does not suggest a methodology of historical research, his case studies leave no doubt that he has in mind some variant of structuralism, probably not too unlike contextualism.

III

In order to examine the philosophical problems underlying Rattansi and Elkana's questioning of the established continuity of ideas in history of science, we shall have to examine the contextualism *vs.* rational reconstruction debate a little more closely. Although never posed in this form, it is evident from some of the recent debates between historians and philosophers of science, e.g., Lakatos–Kuhn exchanges, that the question has been in an underground sort of way present in the substratum for some time. Also, it retains the trappings of the old debate on individualistic *vs.* holistic interpretation, and the externalist *vs.* internalist controversy in the history of science. Despite this somewhat long covert background, we shall see that if we alter our perspective a little, we find that contextualism and rational reconstruction are not two possible antithetical interpretations in the history of science, but are more or less complementary interpretive possibilities.

Rattansi suggests contextualism because he feels that the rigid straight-jacket of rational reconstruction would not be able to encompass within itself all the modes of complex interactions which produce scientific concepts. The fundamental differences of the contextualist suggestion from the rational reconstruction view are the following:

1. Rattansi suggests that arbitrarily imposed demarcation criterion, used in order to create a rational continuity of ideas, would fracture the structural unity of ideas within a specific historical formation. Since interaction and tension within this structural unity are an essential ingredient for the development of a new perspective, the reductionist view would invariably miss the central point. This structural unity he conceives in a horizontal–spatial or time cross-sectional sense as opposed to the vertical narrative type continuity in time implicit in the reductionist methodology. The historian therefore has to essentially empty his mind of all the demarcation criteria and become in some sense a contemporary of the savant being studied.
2. The exact relationship of hermeticism within the nexus of explanatory formation of the 17th century is not clear from a reading of Rattansi. He does not propose a systematic structural theory on how different explanatory traits are related to each other within a historical formation. But it is obvious that he has a more open multiple-explanatory structure

of scientific interaction in mind, within which several explanatory lines, progressive/degenerating, continuous/discontinuous, primary/subsidiary, interact. For Rattansi continuity is no criterion for exclusiveness of the explanatory trend. Several explanatory lines which are extremely incongruous with the later science, and degenerating even within their own milieu are also used within the explanatory conjuncture. These explanatory lines are in a complex way and perhaps uniquely related to the main explanatory line and should be covered within any authentic historical study. In a peculiar sense therefore Rattansi defends the historiography of discontinuous–subsidiary trends or what we shall later define as degenerating explanatory trends, as a legitimate branch of history of science, as opposed to the accepted historiography of progressive–continuous explanatory trend. Beyond this however, Rattansi neither explores the possibility of integrating the progressive–continuous within the structuralist approach he suggests nor does he think of developing his suggestion into a systematic theory.

3. On the other hand, Rattansi self-consciously differentiates contextualism from Hesse's arguments by formulating a view of history which deals exclusively with the specific, local and contingent nature of influences on science. The key assumption in this is that there is something quite unique in the way a particular scientific concept is formed. There is also a corresponding element of specificity in the social, economic, psychological background, and other material, antecedental factors in the personal history of every scientist. Thus for example Burtt explains Newton's Platonism by the fact that he lived with ardent admirers of More during his Grantham School days. Pagel explains van Helmont's strong bias for intuitive knowledge as opposed ot the rational knowledge, by pointing out Helmont's intense resentment of the Spanish occupation of his country and the consequent domination of the cultural life and the academies by the Jesuits. This resentment seems manifested in a strong, explicitly stated rejection of the logico-formal methods of the Jesuits. History of science abounds in this type of explanation, and in each case contingent historical evidences are marshalled to establish the point. We shall call this type of explanations contingent explanations. Rattansi feels that the historian, whose job is to restore the complex kinship of specific ideas and antecedents which go into the making of a specific set of scientific concepts, would do much better to closely scrutinise the details of the circumstances of concept formation rather than delve exclusively at the level of logic of justification. It must be emphasised that the contingent explanations, (a) depend heavily for proof on the empirical, historical–circumstantial details, (b) have a structure in which the relationship between evidence and conclusion is not of logical necessity.

To summarise the contextualist–structuralist position, we can say that its basic tenets boil down to advising historians to self-empty their minds of demarcation criteria, to become a contemporary of the savant studied,

and to seek horizontal structural unity through unique, contingent explanations of the subsidiary and degenerating trends in the history of science. It must be added that although neither Elkana nor Rattansi develop various ramifications of their ideas, the structuralist view if developed systematically as a historical theory of science has the potential of providing a more authentic alternative to the mono-paradigmatic conception so much prevalent among the philosophers.

This purposeful abridgement of the structuralist position taken by Rattansi may be somewhat of an understatement of his position (he continuously challenges the proponents of the rational reconstruction view to provide absolute norms of reasons which could be used as demarcation criteria) but does not in essence compromise the structuralist position. In absence of such norms the only fair approach for Rattansi would be to use an open-ended relativism, without imposing any external canons to produce a hierarchy of concepts. He therefore denies the possibility of a history which uses a more universal explanation pattern of logical necessity type. This is exactly where Hesse intervences. For Hesse history without an evaluation is a banal affair, and evaluation must invariably use an external criterion. The collapse of inductivism and the failure of contemporary philosophy of science to provide a substitute for it may have generated scepticism and philosophical uncertainties but should not deter the historian from his work. Since history of science is primarily history of scientific theory, it should be recognised that the historian's primary task is to identify all such theories which lead to the contemporary world-view. In this sense Hesse feels that history of science would always be a somewhat forward-looking affair. Secondly, since evaluation for seeking continuity with contemporary science is inevitable, historian must use some criterion for this, timeless or not. Reason being inescapable part of science, whether universally accepted, timeless or not, it must actually appear to us as reasons. A passage from her text reads like this: "Reasons are what appear to us to be reasons, whether or not we can explicitly formulate these, whether or not there is any agreement about their timelessness or normative character".[29]

Hesse's formulation, therefore, provides a weak defence of an absolutely contrary view to contextualism, whose basic tenets can be summarised as following:

1. It is perfectly legitimate for a historian of science to seek a vertical narrative type continuity of "reasonable" trends.
2. The criterion for demarcation of concepts for constructing such continuity is not an absolute, timeless norm, but a certain identifiable fragment of reasons, which can be discovered in the past science.

We call Hesse's formulation a weak defense of rational reconstruction for the following reasons:

[29] Hesse, p. 137.

(a) Hesse does not quite succeed in strongly emphasising and demonstrating that teleological continuity seeking activity is an integral and unique part of methodological structure of history of natural sciences and perhaps cannot be encountered in any other branch of creative or intellectual history. The idea of sequential progress is quite meaningless in the history of ideas or the history of arts, where no strict basis for comparison between different ideas or different works of art exists. Even in social sciences a strict comparison is impossible. In political theory for example, the relationship between empirical evidence and theory is so ambiguous (an antecedent certainty always exists that any evidence can be used for or against the theory), that theories can hardly be said to be an improvement over others, except in a certain aesthetic way, as a matter of style, precision, comprehensiveness, etc. Even in the history of economic thought, where theories have attained a more rigorous quantitative method of expression, generically different types of theories are strictly speaking not comparable and the choice between them is usually ideological or extra-logical. Such, however, is not the case with the theories of natural sciences. The historian of science works with a foreknowledge that a large part of theories have been discarded for one reason or another. Whether the historian begins with inductivist presuppositions, believing in solid factual evidences yielding theories or a much more ambiguous notion of relationship of facts and theories, the historian knows in advance that the explanatory power of the discarded theories is somewhere superseded by the subsequent developments in science. Even more compellingly he has an undeniable social knowledge that the scientists do not work with these discarded theories any more. So whether the historian has a coherent theory of progress or not, he has no option but to recognize the fact that there exists a succession of theories, tried and discarded, working backwards from the present day. This is probably the reason why at least some part of the history of science dealing with the vertical connection of theories in time would always teleologically converge towards present theories.

(b) Hesse does not quite analyse the criterion by which the historian actually works out the continuity of the theories. It is possible that the historian's criterion in seeking vertical continuity is much broader than merely seeking identifiable structures of reason in the science of the past.

(c) Identifiable reasonableness of theories as the demarcation criterion, although not necessarily erroneous, is a very borad concept. Since a large number of things which cannot be included in science appear reasonable, it is necessary to narrow down the criterion a little and identify a more precise concept. The reasonableness, as Hesse calls it, of even archaic scientific entities arises out of the fact that every scientific theory has a formal explanatory structure, which depends on logical necessity as well as contingent facts for its justification. Irrespective of how we see that contingent factual and logical are related within the explanatory structure, on which question

there is no agreement between philosophers, we can say that the formal character arises out of the fact that an explanatory structure always tries to relate the antecedent and the anticipated factual element in a logically necessary cast. All explanatory lines in natural sciences, however, do not have a distinct formal structure. Historical investigations in science are often exclusively confined to the investigation of this formal structure in various ways: clarifying, elaborating, exploring philosophical implications and seeking horizontal and vertical correspondence between different formal structures. The historical explanation that deals exclusively with any of these types of activity we would call here formal explanation, as opposed to the contingent explanations that we have identified before. What Hesse and others have called rational reconstruction can therefore be termed the formal explanation of the progressive explanatory trends in science.

Through the hermetic debate we therefore see two different kinds of explanatory devices often employed in the history of sciences: the contingent explanation of the degenerating trends and the formal explanation of the progressive trends. Before interchanging the components within this bi-polar structure and trying to explore the possibility of other kinds of explanations, it would be necessary to define the terms progressive and degenerating. The choice of terminology may superficially suggest Lakatosian approach to classification, but the terminological convergence is more or less accidental.[30] At several important points the choice shares nothing with Prof. Lakatos' stimulating analysis. Lakatos suggests several normative demarcation criteria for the segregation of progressive and degenerating research programmes or problem-shifts as he calls it. He suggests that where theoretical growth anticipates empirical growth the research could be called progressive and *vice versa*. He contents that better theories replace theories which cannot handle their excess empirical contents. The suggestions are logically neat, it is however not known how historically well-founded they are. Historical examples can be found where a theoretical explanatory structure did not have to go through such rigorous empirical testing, or for that matter any empirical testing at all in order to be rejected. Even within hermetic debate such a counterexample can be found. The *spiritus* theory as has been described had a great explanatory power, through the use of which Paracelsus, More, Newton, would resolve a number of unresolved puzzles of science. It appears that at one stage, especially in Newton, it was also inextricably linked up with the ether hypothesis, which was to continue a much longer explanatory innings than the *spiritus* theory. Newton even thought of giving it a mathematical shape consistent with derivations from Kepler's laws. Yet it never crystallised into a concrete empirical programme, and in the rising trend of mathematico–mechanical interpretation of nature it was discarded almost without ever having been given a fair trial. The

[30] Lakatos.

contingent factual (or empirical) and theoretical (or logical) are also so neatly related within the Lakatosian schema that it is hard to believe it. In fact years of philosophical theorising with examples from the history of science on the question of relation between the observational and theoretical within an explanatory structure has produced little clarity on the question, resulting in the question being almost relegated to the distinguished status of the hen and egg question. Again, Prof. Lakatos, in choosing examples from the history of science, takes for granted a fairly advanced knowledge of history of science, on which his demarcation criterion could be tested. In reality, however, there is nothing stable, constant and neutral about the existing stock of knowledge in the history of science which itself has been arrived at by the use of several sets of philosophical assumptions and demarcation criteria. Hermetic debate could be a conclusive evidence for what philosophers like Aggasi and even Lakatos himself have been trying to point out, namely that different philosophical assumptions could produce entirely different versions of narration and historiography. The point therefore is that historical examples cannot be picked up at random to test normative methodological formulations without examining the assumptions and the alternative historical possibilities within the construction of the historical example itself. Finally, the Lakatosian account is what has been called the mono-theoretic account. Koertge[31] has taken Lewis and Langmuir's electron pair theory as a case study of, for example, Lakatosian examination of Bohr and Prout's research programme, to demonstrate that a mono-theoretic model is not necessarily correct; as we have pointed out already that the contextualist–structuralist view of history has a serious possibility of developing into a multi-theoretic model of science, as opposed to the mono--theoretic paradigmatic view of science. In fact any realistic identification of the progressive and degenerating must operate within a multiple-theory choice framework. We therefore suggest a differentiation which involves a somewhat lesser amount of normative assumptions by identifying with the broad criterion by which the historian reconstructs a coherence.

Baring exceptions, historians of science are not known to have stated how they demarcate the territory of their discipline. Even when they do make a few succinct pronouncements on the subject, the view may appear to the philosopher quite ambiguous. Nor have the historians ever attempted to produce any historical account using such well-developed demarcation criteria as philosophers like Popper or Lakatos have produced. The margin of interaction of these disciplines, despite pious statements, has remained rather limited, and little can actually be cited on an actual demarcation criterion. Looking at the existing histories of science it appears that two main grounds have been used to demarcate. The first we shall call here formal reasons and the second mechanical reasons. As has already been

31 Koertge.

hinted, the formal reason consists of discovering a certain semblance of logico-methodological structure in each archaic structure and marshalling historical evidence to spatially or temporally locate this structure within a certain historical continuum. The identification of the formal structure is a necessary but not a sufficient condition for successful fulfillment of formal reasons and a complete incorporation of the explanatory trend within the historical continuum. Thematic continuity and contingent historical evidence are often required as a supportive argument for the incorporation of the explanatory trend within the narrative, although thematic continuity and reconstruction of the formal structure are in themselves sufficient conditions for inclusion of an explanatory structure. Almost all the existing historical studies on science, with exception of those dealing with the history of a single concept, use a multiple theory choice explanatory structure, and corroborate by means of historical examples that at any specific time horizon there are several explanatory options which spatially interact and can be reconstructed on formal grounds. A more realistic outcome of the multiple theory choice approach is the recognition that not the primary continuous line, but a large part of subsidiary lines are also amenable to formal explanations. Those explanatory trends however, whose continuity the historian can teleologically work out backwards, we shall call the progressive explanatory lines. The second type of demarcation, the mechanical demarcation, as we have called it, is usually attained on purely thematic, observational, sociological (citation etc.), and contingent historical grounds. A number of stray observations on scientific themes, citations of isolated theoretical structures, etc., although not amenable to formal reconstruction are still incorporated into the narration on contingent historical grounds. Some of these are also known to have played an important role in the development of science, and the history of science abounds in this type of examples of continuity. The much used example of this type is alchemy, whose continuity almost every historian assumes on the ground that it provided rich factual inputs for the development of metallurgy and chemistry. We would call the subsidiary explanatory trends and the trends incorporated on mechanical grounds, together, the degenerating explanatory structure at any specific time horizon. We therefore see that a formal explanation of at least some of the degenerating explanatory trends, comprising the subsidiary trends of the formal explanatory structure, is possible.

Theoretically speaking therefore, we see the possibility of four distinctly different types of explanations in the field of history of science. Of these the formal explanation of the progressive trends is the most standardised textbook type of historical narration and what strictly speaking should be called a rational reconstruction. The purely negative type of historiography comprising contingent explanations of only mechanically incorporated observational trends as Rattansi suggests, although interesting in itself, nevertheless is unimaginable as a mainline contribution to the history of science, and

this is probably why Hesse at one place question whether Yates' analysis should at all be considered a contribution to the history of science. It is the existence of a large penumbral zone of the subsidiary explanatory structures, explainable contingently as well as formally, which perhaps has saved the history of science from the possible pitfalls of being either a boring banal affair or an open-ended territory indistinguishable from the history of ideas.

IV

The hermetic case therefore can be broken down into different levels of arguments. Firstly, using hermeticism the historians succeed in emphasising the existence and legitimacy of historiography of a certain horizontal structural unity in science. They then isolate some singular aspect of the hermetic thought– like the *spiritus* theory, signature theory, theory of universal animation, etc., and gather contingent historical evidence to demonstrate that these isolated concepts have been used as explanatory devices on several occasions. Through this contingent connection a limited compatibility of hermeticism with the main currents of scientific thought is advocated. Obviously, since the basic character of hermeticism, as demonstrated by our examination of it, can never be amenable to formal explanatory continuity on methodological grounds, the only continuity that can be advocated is of the mechanical type, justified by contingent historical evidence. As we have tried to demonstrate in the previous section, such type of negative contingent explanations are of limited conceptual value for the history of science. Therefore if the structuralist view of the kind Rattansi tries to develop is to grow into a theory of alternative historiography of science, it would have to integrate meaningfully the possibility of all types of explanation for creating a structural unity and not merely concentrate on isolated cases of mechanical continuity.

There are two additional features of the structuralist view which need to be commented upon here:

(1) Since the positivist–inductivist intellectual apparatus has fallen out of vogue, it has become customary to snigger at the old scissor and paste account of history, and in this respect, Rattansi, Pagel, Elkana are not out of step with the main tendencies of the time. Nevertheless at least one aspect of the contextualist–structuralist prescription at the present level of development has more in common with the old style Positivism than modern theories of history. The superiority of the contextualist method of the history of science is also claimed to be raising out of its more detailed scrutiny of minute historical details. Although none of these historians are so naive as to suggest that a total and unalterable picture would finally emerge out of this meticulous collection of empirical data, it is

implied that the unity prepared with empirical details is superior. It should be realised that if the claim for a total picture is given up, the contextualist view would become even less defensible on this count than the rational reconstruction view. Both types of historiographic pictures would be susceptible to changes, but the internal world of rational reconstruction, depending more on logical necessities, would be less susceptible to fortuitous discoveries. In any case, it is better to recount here the old dictum that no historical account can possibly hope to reproduce isomorphically any historical event. The inertness of the past, its manifoldedness, the limitation of using but a few of the still surviving artifacts, and the limitations of our categories of understanding and communication are all responsible for this. A contingent explanation, therefore, depending more heavily on historical evidence, would suffer more from these imperfections than the formal explanations, which, at least theoretically, have a logically closed character. (2) Another methodological prescription of contextualism is that, in order to reconstruct the horizontal structural unity, the historian has to necessarily empty his mind of all demarcation criteria and become a contemporary of the savant studied. This suggestion seems to have arrived too late in the day. With the fall of inductivist–positivist view of history, the philosophers of history in our century—Croce, Collingwood, Carr, etc.—have been crying aloud that all history is nothing but Contemporary history, and that the supposed neutrality of the historian as an observer of historical events is a pleasant myth with which historians sometimes delude themselves. What is only a polemical view in general history becomes an undebatable certainty in the history of science. The historian of science begins his enquiry with the foreknowledge that the discarded theories have a limited explanatory power compared to the functional ones. In his investigation he seeks and restructures these limitations of the discarded theories, invariable by comparison with theories that followed. To expect a neutrality from the historian therefore is to expect a complete ignorance of the contemporary scientific perspectives from him. To identify fully with the discarded theories and argue with the fervour with which the original doctrine was propounded, would be impossible. To write a defense of the discarded theories would virtually tantamount to writing a critique of the modern science. To become a complete contemporary of the savant studied, as Butterfield and others even before Pagel and Rattansi have suggested, would require going back in time, travelling across scientific revolutions backwards, and, to use Butterfield's own imagery in an inverted sense, donning a new thinking cap upside down. Clearly as a rigid methodological prescription it is an impossible demand to make from a historian of science. Yet, if the suggestion is not seen in the straight jacket of methodological prescription, then this is exactly what every competent historian attempts to do, to a greater or lesser extent, in order to capture the intellectual cross-currents of any age.

BIBLIOGRAPHY

1. Ball W. W. R.: *An Essay on Newton's "Principia"*, London 1893.
2. Brewster, Sir David: *Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*, Edinburgh, 2 Vol., 1885.
3. Burtt E. A.: *The Metaphysical Foundations of Modern Physical Science*, London 1925, p. 349.
4. Debus, A. G.: "The Medico-Chemical World of the Paracelsian", in: Teich and Young (eds.) (13), p. 85–99.
5. Elkana Y.: "Scientific and Metaphysical Problems: Euler and Kant," in: *Boston Studies in Philosophy of Science* (BSPS), Vol. XIV, p. 277–305.
6. Hesse M.: "Reasons and Evaluations in History of Science," in: Teich and Young (eds.) (13), p. 127–147.
7. Koertge N.: "Inter-Theoretic Criticism and the Growth of Science," in: BSPS, Vol. VIII, p. 160–173.
8. Lakatos I.: "History of Science and its Rational Reconstruction," in: BSPS, Vol. VIII, p. 91–136.
9. McGuire J. E., Rattansi P. M.: "Newton and the 'Pipes of Pan'", in: *Notes and Records of the Roy. Soc. Lond.* 21, 1966, p. 108–143.
10. Pagel W.: *Paracelsus: An Introduction to Philosophical Medicine in the Era of Renaissance*, Basle, New York 1958.
11. Pagel W.: "The Spectre of van Helmont and the Idea of Continuity in the History of Chemistry", in: Teich and Young (eds.) (13), p. 100–109.
12. Singer D.: *Giordano Bruno: His Life and Thought*, New York 1950, p. 378.
13. Teich M., Young R. (eds.): *Changing Perspectives in the History of Science*, London 1973, p. 490.
14. Walker D. P.: *Spiritual and Demonic Magic from Ficino to Campanella*, London 1958.
15. Yates F.: *Giordano Bruno and the Hermetic Tradition*, London 1964, p. 457.
16. Yates F.: "The Hermetic Tradition in Renaissance Science", in: C. S. Singleton (ed): *Art, Science and History in Renaissance*, Baltimore 1968, p. 270.