CHAPTER V.

SCIENTIFIC LABOURS AND THE PRINCIPLES OF THE UNIVERSE (1556-1558)

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CHAPTER V

I. Acquitted of the charges of conjuring and treason, and cleared of suspicion of heresy by Bonner, Dee was soon restored to the flavour of the authorities, and the following year put forward the first of various "national schemes" he promulgated at intervals throughout his life. Its substance was embodied in his Supplication to Q. Mary....for the recovery and preservation of ancient writers and monuments, followed by five articles supplementing this, with details of his proposal for the establishment of a "Library Royall," which he exhibited to the Queen on January 15th, 1556 (1). Dee was already laying the foundations of his own vast, though relatively specialised collection of books and manuscripts; he employed at least one copyist at home, and perhaps others abroad on occasion; sometimes, works of high importance or secrecy, such as Trithemius' Steganographia he transcribed with eager industry himself, and he seems to have been in fairly frequent receipt of books sent from a number of foreign cities (2). The existence of a notebook recording his borrowing of eleven books and manuscripts, all concerned with astronomy, physics or mathematics (they include works by Oresme, Urso, Jordanus, Bradwardine, Avicenna), from Peterhouse, which were never returned and later reappear in the catalogue of his private library (1582) might indicate that his methods of acquisition were not always altogether scrupulous (3). But it is possible that the same sort of arrangement was made as with Trinity, which presented him with an M.S. of Witelo's perspective, in return for various printed books he had given the College (4).

The times, ever since the dissolution of the monasteries, had been propitious for the formation of such private collections. Further opportunities were offered by the confusion in the universities under Edward VI; in Oxford the most narrowly prejudiced and turbulent branch of the religious reform party gaining control, many libraries were pillaged and sold off or destroyed; illuminated MSS and works of metaphysics proving especially unpopular, while despite the authorities' attempted encouragement of mathematics, books on astronomy or geometry, because of the mysterious diagrams they contained, were generally "accounted Popish or diabolical, or both" and were rigorously purged. Whole libraries it was said could be bought "for an inconsiderable nothing"; Duke Humphrey's collection, some of whose contents found their way into Dee's hands, was broken up and the whole University Library dispersed (5). John Bale in a letter of 1560 to Archbishop Parker, in which breathes the same spirit as Dee's Supplication gives a vivid picture of the background of Dee's scheme and the conditions which this aimed to alleviate. Bayle writes "as concernynge bokes of antiquite not printed: when I was in Irelande I had great plenty of them, whome I obtayned in tyme of the lamentable spyle of the lybraryes of Englande, through myche fryndeshypp labour and expenses. Some I founde in stacyoners and boke bynders store howses, some in grosers, sopesellers, taylers, and other occupyers shoppes, some in shypps ready to be carryed oversea into Flaunders to be sold for in those uncircumspect and carelesse dayes, there was no quycker merchaundyce than lybrary bokes (i.e., for use in binding new works), and all to the destructyon of learninge and knowledge of thynges necessary in this fall of antichriste to be knowne — but the devyll is a knave they saye — well, only conscience, with a fervent love to my countray moved me to save that myghte be saved."(6) Similarly Dee, who in 1570 wrote that one of his major preoccupations for many years had been the discovery and preservation of the monuments of past learning and of the ancient philosophers (7), observes in this supplication, "how that, among the exceeding many most lamentable displeasures, that have of late happened unto this realm, through the subverting of religious houses, and the dissolution of other assemblies of godly and learned men, it hath been, and for ever among all learned students, shall be judged, not for the least calamity, the spoile and destruction of so many and so notable libraries wherein lay the treasure of all antiquity, and the everlasting seeds of continual excellency within this your Grace's realm." The last phrase reveals how far Dee's motives are from a disinterested antiquarianism — which indeed hardly appears as a widespread phenomenon until a much later age; he is principally attracted — all else being a very secondary consideration — by the thought of its benefits that the realisation of his scheme would bring for contemporary scholars in their search for metaphysical truths and scientific discoveries "whose travailes, watchings, and pains" he suggests, in this way "might greatly be relieved and eased; for that such doubts and points of learning, as much cumber and vex their heads, are most pithyly in such old monuments debated and discussed."

Dee proposes the immediate establishment of a commission "for the seeing and perusing of all places within this her Grace's realm, where any notable or excellent monument may be found, or is known to be." Haste and secrecy are essential, for many of these "do still yet (in this time of reconciliation) dayly perish," and he fears that owners, hearing of the scheme might "hide and

convey their good and ancient writers (which nevertheless were very ungodly done, and a certain token, that such are not sincere lovers of good learning)." Typically he is most suspicious of the destructiveness of the ignorant, imagining manuscripts "perchance of purpose by some envious person enclosed in walls, or buried in the ground, to the great injurie of the famous and worthy authors and the pitiful hindrance of the learned in this your Highnes realm." Recipients of filched treasures of the monasteries if not made to disgorge these, were to be compelled to make them publicly available, for the commission was to be empowered to borrow for a certain time all manuscripts they discovered for copying purposes. The process of transcription, which would increase their availability and preserve for posterity what might otherwise perish "by private men's negligence (and sometimes malice)," was to be begun at once. The results were to form the "Library Royall," and, ambitiously, Dee suggests the scheme that should apply far beyond England, declaring he has a "furder devyce," whereby "all the famous and worthy monuments, that are in the notablest Librarys beyond the sea (as in Vaticana at Rome, St. Marci at Venice, and the like at Bononia, Florence, Vienna, etc.) shall be procured unto the said Library of our soveraign Lady and Queen, the charges thereof (beside the journeying) to stand in the copying of them out, and the carryages into this realm only."

Though Dee repeats that the whole may be executed "without any one penny charge unto your Majestie" he gives no hint as to how expenses are to be met beyond suggesting that "My Lord Cardinal's Grace and the next Synod" be requested to grant an order "for the allowance of all necessary charges." Perhaps this is one of the reasons why no more is to be heard of the scheme outside Dee's own draft of it. Mary, in this, seems to have showed herself less concerned for the preservation of the intellectual treasures of the religious houses than her father had been, who earmarked numbers of them for his private collection at the successive dissolutions (as evidenced by the marks for this purpose set against many items in surviving inventories of the books these institutions had contained, and the catalogue of his Westminster library (1542), which contains about three hundred MSS "at a low estimate," conveyed from them), which form the nucleus of the Old Royal Collection in the British Museum (8). Indeed Dee's scheme may to some extent be a reminiscence and an extension of Henry's actions, since he had granted Leland the antiquary a commission under the Great Seal, to make a search for such monuments in England, and to peruse the libraries of all cathedrals, abbies, priories, colleges, and places where the records, writings, and "secrets" of antiquity might survive (9). Dee's farsighted proposals came to nothing; their spirit was perhaps a little, though not by much, in advance of the time; Archbishop Parker interested Elizabeth's Privy Council in a very similar scheme, in 1560, though it was never implemented, and "some sixty or seventy years after the dissolution, we find that the tide has turned, our great collections are in process of considerable magnitude."(10) Dee's own library (11) was remarkable enough to become an object of contemporary curiosity; Elizabeth herself for example "with her most honourable Privy Councell and other her lordes and nobility" rode out to Mortlake to examine it (12), and from notes of loans to various persons etc. it would appear that Dee wished its riches to be widely and usefully employed. There are indications however that he never abandoned his ideal of a great national collection; traces of it are to be found perhaps in the plan put forward in 1570 under the name of Humphrey Gilbert, then his close associate, for the founding of an academy; for the library of this was to be entitled by statute automatically to receive a copy of every new work printed within the Queen's Dominions (13). Now although we have noticed, and shall have cause to later, Dee's conviction that many topics should, if written about at all, be treated with the maximum of obscurity, and his strong inclinations to intellectual secrecy, a habit of which grew upon him in his later years until his open declarations as to the nature of his pursuits appear sometimes (after the courses he entered upon with Kelly had commenced) in flagrant contradiction with the facts, nevertheless the present plans, and many other points in his life and works clearly declare his genuine desire for a wider dissemination of knowledge — at least among "scholars." While it is undeniable also that he looked to these to form a fairly exclusive aristocracy of learning whose activities should not be attended by overmuch publicity — the unfortunate consequence of which he was himself to have only too much reason for dreading — or too freely communicated to the world at large, nevertheless he also seems to have considered it as not least among the responsibilities of such men, that they should attempt to raise the general standard of education, and to combat the prevailing ignorance of the multitude. He himself, as in his augmentation of Recorde and in the English Euclide, was to devote considerable energy to the cause of popular instruction, to advocate an increase in teaching or publications in scientific subjects in the vernacular, and to urge the growth of a much closer cooperation between the theoretician and the artificer; this last class indicating all members of the community who practised, uncritically following tradition, or merely empirically, by skill and craft, anything which had

reference to principles which the learned could investigate "philosophically," with logic and devised experiment.

II. Dee's activities in other spheres at this time provide further evidence of the advanced position he now held in relation to contemporary thought. His acquaintance John Feild, who had been arrested with him on the conjuring charge, issued an ephemeris. It was a revision of the Prutenic tablets (1551) of Rheinhold, who, combining observations of Hipparchus, Ptolemy and Copernicus, had compiled new orbit elements from them. Thus confidently leaving out of consideration the conclusions of Stoeffer, Pictati, Simi, Mizaldus "& reliquae illius turbae, quae Alfonsi vititur Hypothesi," Feild declares he has followed only Copernicus and Rheinhold "quorum scripta stabilita sunt et fundata veris, certis, & sinceris demonstrationibus," and he clearly regards the publication of his work as an important event in the progress of English astronomy (14). The tables of Rheinhold and Copernicus Feild had employed at the instances of Dee, who contributed a prefatory letter, dated July 3rd, 1556. The title of the whole is Ephemeris anno 1557 currentis juxta Copernici et Rheinhaldi Canones fideliter per Joannem Feild Anglum, Supputata ac examinata ad meridianum Londiniensiem...Adiecta est etiam brevis quaedam Epistola Joannis Dee, qua vulgares istos Ephemeridum fictores merito reprehendit. The three references to Copernicus in Dee's page and a quarter of introduction (15) are almost the earliest to appear in print in England; perhaps the first is the passage in Recorde's Castle of Knowledge (1550) in which the scoffing of the ignorant is sharply reproved (16). Dee's letter is propaganda to urge the more general use of the works of the three giants of "modern" astronomy; Copernicus, Rheticus and Rheinhold, "praeclaramoz horum famam, istorum hominu aures iam cirumsohasse diutius" — the achievements of Copernicus, which have done much to rectify past errors, being singled out for special praise — "Illius quide, ob labores plus oz Herculeos, in coelesti disciplina restauranda, eademoz firmissimis rationum momentis corroboranda ab eodem exantlatos" (Dee adds with reserve in parenthesis, "Cuius de hypothesibus nunc non est differendi locus") "horum vero, propter eam quam ostenderant strenuam in illius insistendo vestigys diligentiam." Dee then administers a rebuke to those astronomers or critics "qui divinas Copernici vel non noverint vel comtemperint lucubrationes." Copernicus hypotheses which he does not discuss here, Dee was acquainted with through the de Revolutionibus of 1543 of which his library boasted several copies and through Rheticus' Narratio Prima (1541). He may well have known also the Commentariolus, which was circulating in manuscript — Gemma Frisius, for example, had spoken of it in a letter to Dantiscus in 1541. Copernicus' theories had become fairly widely known however long before any of these works appeared, during the thirty-six year period through which he had delayed publication; thus in the early fifteen thirties, Luther had spoken contemptuously of "the fool who wishes to turn the whole of astronomy upside down," by teaching the mobility of the earth (17); nor again was the theory, except in the fullness and astronomical completeness with which he presented it, peculiarly original even in the day, to Copernicus; one of Calcagnini's writings, early in the century for example, which Dee read in the folio Opera of 1544, is entitled Quod caelum stet terra moveatur, vel de perenni motu terrae...Commentatio. The importance of this work of which the title is frequently quoted, in accounts of the rise of the heliocentric system, is that it is not a scientific treatise, and is not concerned with mathematical or physical questions directly; it is, like so much of Calcagnini's writing, merely another piece of elegant humanistic pedantry, resting almost entirely on quotations from the classics and erudite or ingenious comments on them. (One of the few direct arguments he employs — that on a ship the land seems to the passengers to be in motion, is used as an illustration only of Plato's position in the Gorgias that we must judge with the intellect and not with the eyes.) Thus he proves his case by attempting to show the commonness of the opinion among the ancients; he cites Plato's teachings in the Timaeus, deduces that Archimedes must have thought the earth mobile or he could not have made his famous boast about moving it, and that a metaphor employed by Hesiod ("quom nocte terra natam...nigris exornavit alis") proves when properly examined that he was of the same opinion (18). His work thus tends to show that the question at issue was a matter of debate among scholars before Copernicus, on quite other grounds than its astronomical utility.

Dee's printed writings in astronomy, the present letter, the Aphorisms, and the brief work on stellar parallax occasioned by the appearance of the new star in 1572, give in their paucity, no good index of the considerable reputation he won in this field — which made his name so familiar to Tycho Brahe — and which seems the result of extensive activities, personal contacts and correspondence, of which all too little evidence now survives. Thus Richard Forster, who himself seems to have made no radical distinction between the Ptolemaic and Copernican systems, in a three page note appended to an Ephemeris for 1575, which acknowledged his debts to the mystical Platonist and Copernican, Cornelius Gemma, pays Dee high tribute for his services to English astronomy: "Languet apud now in ipso pene exortu Mathematicum disciplina, que apud Anglos primum renasci coepit, e tenebris in lucem enersa, per solertiss. Mathematicum nostrate Ioannes

Dee, nouarum hypothesium, & Ptolomaice doctrine acerrimum vindicam. Et nisi vir ille ingenue Atlanti humeros supposuerit, brevi tandem fiet, vt tota cum Copernici et Rheinholdi coelo corruat, tanta est apud nos in artem grassatic imperitorum, & impunitas, vti hanc disciplinam Uranise sacram, temerare nihili aestimatur."(19) Nevertheless we have no direct statement by Dee on his views in regard to the heliocentric systems, though his pupil Digges presents it with an almost passionate advocacy in his translation and expansion of sections of Copernicus' treatise in 1576 (20) Dee's attitude despite his frequent laudatory references to Copernicus as an observer and calculator, as in his treatise on the Calendar of 1582 (21) remained non-committed as regards the physical truth of the "hypothesis." He was not restrained from accepting them, it may be noted, by his astrological beliefs; the theory of celestial influences he propounds in the Aphorisms, allows the effects of these to be regarded as a function solely of the relative positions at any time of the earth and planets, and many Copernicans were also ardent astrologers, as for example, Rhetious himself, who describes the circle of the eccentricity of the apogee of the sun as being "in very truth the Wheel of Fortune" and as controlling the rise and fall of the great empires of the world (22). Even less would alchemical doctrines (Terrestrial Astronomy), and the establishment of such large scale analogical schemes between this and celestial astronomy, which was an important, often controlling, feature of scientific thought in Renaissance generally, and of some importance as to Dee himself as the Monas proves — militate against the new hypotheses"; they were if anything in their exaltation of the innate dignity of Gold, the solar metal, more naturally concordant with Copernicanism than the older system (23). At the same time Dee cannot be claimed as a supporter of the Ptolemaic system, as regards which he displays an equal reserve: that this seems presupposed in some incidental passages of the Preface cannot be allowed much weight, since for a variety of practical purposes, when speaking "vulgarly," as in an exposition of astronomical aids in navigation, a Ptolemaic universe would remain the most natural to employ the use of it not necessarily implying more than the recognition of the greater convenience of taking the earth as the fixed point of reference on such occasions. Further, Dee's conclusions on the new star (24) meant the abandonment of various tenets, such as the immutability of the heavens, long associated with orthodox Ptolemaicism though not essentially involved in its central hypothesis (his study of methods of measuring its parallax designedly supplements a work of Digges, professedly written from a Copernican standpoint, and Dee carefully points out whenever for convenience his diagrams take the earth as a fixed centre, that he is drawing them merely according to the hypothesis of a diurnal revolution of the fixed stars). Dee's personal theory moreover, that this star's diminishing brilliance was a result of its recession from the earth in a straight line seems to involve a rejection of the Aristotelian solid orbs — which even Peuerbach had accepted, and the circular motion properly belonging to heavenly bodies (one of the chief dogmas illustrating the radical difference between their nature and that of sublunar phenomena), while Dee's suggestion seems also very difficult to reconcile with a mobile heaven (though equally so with the revolution, though not the rotation of the earth), since such rectilinear movement in relation to the earth and the maintenance of the same relative position to the fixed stars, if the sphere of these revolved daily, would mean the ascription of an actual spiral course to the new star, of a kind which it is extremely doubtful whether orthodox Ptolemaicists would ever have admitted into their system.

The apparent ambiguity in Dee's attitude towards the rival theories is not particularly surprising when viewed in its context of sixteenth century astronomical knowledge, though his caution here in refusing to embrace conclusions that could be judged to be in excess of what might be warranted by available evidence contrasts with the confident dogmatism that characterises other aspects of his thought. As "formal" methods of saving the appearances, considered in separation from teachings derived from any other science the two systems were equally adequate. That of Copernicus, while it involved a reorganisation of available data, made use of no facts or observations that could not be held already to be fully taken into account, and explained, by the Ptolemaic system. It brought no particular increase in accuracy or predictive power; for the older combinations of epicycles and eccentrics could successfully represent the positions of observed heavenly bodies to within one minute of arc. If the Prutenic tables were more accurate than the Alphonsine — which were found to be a whole month in error in their forecast of the conjunction of Jupiter and Saturn in 1563 — this was a result of the much superior abilities of Rheinhold as a calculator, as compared to his predecessors, and not at all due to his use of the Copernican hypothesis in compiling them, for since Copernicus had continued to follow the conventional scheme of compounding the planetary orbits from combination of circles, and since in practice all results had to be stated in relation to the earthly observer, his hypothesis did not represent any gain in simplicity, or any real change in the method, of astronomical calculations (25). Dee's praise of Copernicus' personal achievements in this respect, might also seem to be somewhat exaggerated.

Rheinhold, though claiming Copernicus to be unsurpassed as an observer, does not rate him very high as a calculator; observing that when utilising Copernicus results for the Pritenic tables he was compelled to compute everything afresh for himself. But even Copernicus' original observations are not over abundant, and indeed he "needlessly complicates his theory in order to bring it into conformity with certain ancient and mediaeval observations. Throughout his work he adopts an entirely uncritical attitude to traditional data of this kind, and makes no allowance for the possibility of serious errors of observation, fraud or textual corruption (26). The chief intention of his letter to Werner seems to be to administer a severe reproof to that astronomer for daring to cast doubts on the accuracy of the factual data recorded by the Ancients, particularly Ptolemy, in the interests of a theory which would require various modifications to be made in these, while according to Copernicus "We must follow in their footsteps, and hold fast to their observations, bequeathed to us like an inheritance and if anyone on the contrary thinks that the ancients are untrustworthy in this regard, surely the gates of this art are closed to him....I cannot be persuaded that in noting star-places they erred by 1/4 or 1/5 degree or even 1/6 degree as our author believes."(27) Later in life he found cause to abandon this position, and to stress the acute necessity for entirely new observations to be made, to confirm or correct the traditional data, but those of his own which he was able to amass and employ in De Revolutionibus were sufficient for the description of the motions of Mars and the earth only. Dee's enthusiasm is perhaps partly due to the importance of Copernicus' work for the rectification of the Calendar. Copernicus had declined the invitation of Leo X in 1514 to cooperate in a scheme to this end, and on the grounds that the courses of the sun and moon, and hence the length of the year and month, were still not known with sufficient exactitude to make the undertaking practical. But thereafter he devoted many years to observations for the better determination of the length of the tropical year, and these and the Prutenic tables served as a basis for the later Gregorian reform, and Dee's similar proposed alteration in the English Calendar.

No direct confirmatory evidence could be found in support of the Copernican hypothesis, although Dee, and many others, recognised the high significance that would have to be attached to the discovery of stellar parallax and towards which in consequence they directed considerable efforts. None however was detected until 1832 (by Henderson, accurately measured 1838, Bessel), after which time, if the revolution of the earth were dispensed with, it would have been necessary to have attributed to each star a motion round the circumference of a small circle, completed by everyone of them in the same period of one solar year. But in the sixteenth century inevitable consequences of the Copernican hypothesis seemed even to be in entire conflict with observation, for it would follow from it that the diameter of Venus at the apogee — as Osiander had already pointed out in his notorious anonymous preface (28) — should appear as increased four times, and that Mercury and Venus should present phases similar in kind to those of the moon. These difficulties were only resolved by the work of Galileo, to whom the solutions were suggested by telescopic observation. Copernicus' claim to have reduced the number of circles needed to represent the celestial machinery to 34 (actually 38 were still required), did not lack a certain aesthetic appeal for mathematicians, but the chief advantage by contemporary standards of the new hypothesis — and even so it was a somewhat abstract and negative one to set against the weight of evidence opposing its fundamental assumption — was that it managed to preserve the important principle of uniform motion by dispensing with the equants, which, though necessary to the Ptolemaic scheme, had plainly violated this principle and long been looked upon as a troublesome imperfection in an otherwise totally acceptable system; for its recourse to the fictional equants seemed the one point at which the Ptolemaic representation could not be accepted as in accord with a physical reality. Copernicus writes: "Yet the planetary theories of Ptolemy and most other astronomers although consistent with the numerical data, seemed likewise to present no small difficulty. For these theories were not adequate unless certain equants were also conceived, it then appeared that a planet moved with uniform velocity neither on its deferent nor about the centre of its epicycle. Hence a system of this sort seemed neither sufficiently absolute nor sufficiently pleasing to the Mind," and he set himself to seek for "a more reasonable arrangement of circles."(29)

Despite the greater "harmoniousness" that the Copernican hypothesis, as its supporters were fond of pointing out, displayed it did nothing directly to assist astronomical progress, and had against it the whole weight of a generally accepted physics; its appearance indeed could only have "pour resultat immediat d'augmenter le desarroi de la pensee humaine."(30) So much that seemed highly probable in other sciences had logically to be discarded, or radically altered, if this were accepted, that even such a suspension of judgment as Dee's is indicative of bold and independent views. For the Ptolemaic scheme was not merely descriptive but cold bring many

reasons from natural philosophy as to why the universe had this particular arrangement, offering to a large extent plausible causal explanation; what the Copernicans could advance by way of explanation in this style was in the main perforcedly of a distinctly "Pythagorean" cast. Thus Wilkins' advocacy in the seventeenth century still draws heavily on Kepler's theories of the harmony of the solar system, to explain the reasons why things must be as they are on the Copernican hypothesis: "Now if any ask" he writes in illustration of the advantages of the theory, "why there are but six Planetary orbs? Kepler answers: Quia non oportet plures quam quinque proportiones esse, totidem nempe quot regularia sunt in Mathesi corpora. Sex autem termini consummant hunc proportionum numerum."(31) The survival and advance of Copernicanism is due very largely to those to whom such reasons as this appealed, its eventual general acceptance is again less the result of any new empirical evidence, than its integration into the new physics of Newton, the theory of gravitation offering a dynamic interpretation to the Copernican, but to no other, representation of the solar system (32). However, as De Morgan observed as early as 1836 "Before the time of Galileo, in our opinion, every Copernican was an ingenious theorizer supporting a system which though simple and possible was met by unanswerable and crucial arguments, mixed with others derived from pure assumptions common to both parties."(33) The situation, as Dee seems to have felt it, is well summarised by Tycho Brahe "Nostra vero aetate Nicolaus Copernicus quem alterum Ptolomaeum non immerito dixeris, cum desiderari quaedam in Ptolomaeo ex observationibus a se factis deprehendisset, et hypotheses ab ipso constitutas quiddam absoni et contra axiomata Mathematica peccans admittere judicasset...coelestium motuum scientiam ita restaurauit, ut nemo ante ipsum exactius de siderum cursu sit philosophatus. Quamvis enim phisicis principiis quaedam contraria struat...tamen quo ad Mathematica axiomata nihil absurdi admittit: quod in Ptolemaicis et usitatis hypothesibus, si rem penitus introspiciamus, animadvertere licet. Hae enim motus in suis Epiciolis et Excentricis, respectu eorundem circularum centri, irregulares, quod absurdum est, constituunt, regularemque siderum motum per irregularitatem inconvenienter saluant. Ex his duobus artificibus, Ptolemaeo et Copernico, omnia illa, quae nostra aetate in astrorum revolutionibus perspecta et cognita habemus, constituta ac tradita sunt."(34) Such a statement seems to indicate that the chief difference between the opposing parties is at this period to be looked for in the relative emphasis they each placed on the two sciences of Physics and Mathematics, which was indeed largely true. Aristotle's statement that those who do not place the earth in the centre of the universe — the Pythagoreans — are men who perversely, do not seek for proof in the appearances, the foundation of natural philosophy, but in abstract theories (35) is echoed by Francis Bacon who concludes a list of the great inconveniences of Copernicus' hypothesis "et quod tantum immobilis introduxit in naturam, ponendo solem et stellas immobiles praesertim corpora maxime omnium lucida et radianta....et alia nonnulla, quae fille sumit, ejus sunt viti, qui quid vis in natura fingere, modo calculi bene cedent, nihili putet."(36)

Nothing could show more clearly the complete discrepancy between the Copernican thesis and the total picture offered by Aristotelian physics than the arguments Alexander Ross still thought fit to bring forward in the middle of the next century. That these have an air of fatuity and irrelevance is due only tot he fact that they are drawn from premisses which no Copernican — and Ross pretends naively to be unaware of this — could ever admit. Thus even such statements as that the earth can be no planet "for then forsooth we should be living in a star" has a complete conclusiveness about it, if the older thesis of the absolute qualitative difference between the worlds above and below the moon, the perfection, unchangingness, and simple, non-elemental, composition of the heavenly bodies is accepted. Or again Ross continues to presuppose the spheres of the four elements at the centre of the universe and examines Copernicus' displacement of the earth from the centre in the light of this: "How inconvenient and unhealthy were man's habitation if it were nearer the heaven than it is, for the air would be too pure and improportionable to our gross bodies. For they that travel over high hills find their bodies much distempered. Acosto witnesseth that they who travel over the high hills of Peru fall to vomiting and become desperately sick, and many lose their lives by reason of the subtilty and pureness of the air." Or again, accepting Aristotle's reification of the directions up and down from the centre, to explain causally the architecture of the universe by reference to degrees of heaviness and lightness, taken as degrees of tendency towards or away from this centre, he writes "Sense tells us that the grosser simple bodies are, the lower place they have in the Universe. The heaven being a quintessence and of the purest matter is uppermost....And reason tells us that God is the God of order: And what a disordered world should we have, if gross and heavy bodies were uppermost, the light and purest bodies beneath."(37) Copernicanism then involved a multiplication of new physical hypotheses, wholly gratuitous if the Ptolemaic description of the heavens were retained. The Aristotelian assumption, just employed by Ross, that bodies tended to a single centre was simple, satisfactory,

and backed by the authority of common experience. Even the solar system lacked all but a geometrical centre on the Copernican scheme, for the sun was displaced from this as a result of the attempt to represent the elliptical planetary paths as combinations of circles. The only solution to this difficulty — and Dee may have inclined to this belief also, since he held that all material things, including the heavenly bodies, were possessed of weight, was Digge's position in the treatise already quoted: "For Gravity is nothinge els but a certain proclivity or naturall covetinge of partes to be coupled with the whole, whiche by divine providence of the Creator of al is given and impressed into the parts, yt they should restore themselves into their unity and integritie concurringe in spherical fourme, which kinde of propriety or affection it is likelye also that the Moone and other glorious bodyes wante not to knit and combine their partes together, and to mainteyne them in their round shape, which bodies notwithstandinge are by sundrye motions, sundrye ways conveighed."(38) Such a suggestion — containing a first approach to the theory of universal gravitation perhaps, but at this time beset with many difficulties and backed by no evidence, becomes invariably associated with Copernicans. Sixty years after Digges, Wilkins in A Discovery of a New World almost echoes his words: "if you reply that then according to this there must be more Centres of Gravity than one; I answer, 'Tis very probable there are; nor can we well conceive what any piece of the Moon would do, being severed from the rest in the free and open Air, but only to return to it againe."(39) Galileo shows his spokesman Salviatus using a similar example, and being countered by a citation of the conventional doctrine of the impartibility of the heavenly bodies, and hence the impossibility of the supposition of a piece temporarily separated and therefore the total artificiality of the problem this new gravitational theory claimed to resolve; and Salviatus later enquiring "Why may we not believe that the Sun, Moon and other mundane Bodies, be also of a round figures, not by other than a concordant instinct, and natural concourse of all the parts composing them? Of which, if any, at any time, by any violence were separated from the whole, is it not reasonable to think, that they would spontaneously and by natural instinct return," he is rebuked by Simplicio: "if you in this manner deny not onely the Principles of Science, but manifest Experience and the Senses themselves, you can never be convinced or removed from any opinion which you once conceit."(40) The charge of repudiating, neglecting or unnecessarily reinterpreting perceptual data in the interests of a wire-drawn Pythagorean theorising is perhaps the most frequent of all charges made against the Copernicans. They had apparently even considerable difficulty in explaining their application of the principle of the relativity of motion, Simplicio when it is pointed out that a body falling apparently rectilineally down the side of a tower must, if the earth move, follow a very different, and curved path in "absolute" space, bursts out "But for God's sake, if it move transversely, how is it that I behold it to move directly and perpendicularly? This is no better than the denial of manifest sense and if we may not believe sense at what other door shall we enter into disquisitions of Philosophy" (41): and Salviatus, after long debate, finally exclaims that he does not wonder at the small number of "Pythagoreans" and Copernicans in the world, but rather that any should exist at all: "I cannot find any bounds for my admiration how that reason was able in Aristarchus and Copernicus, to commit such a Rape upon their Sences, as in despite thereof, to make herself mistress of their credulity."(42)

There are few early examples of verifiable evidence being urged to support the mobility of the earth, and these frequently based on errors of observations — as for instance Leonardo's argument (43) that a stone dropped freely from a tower did not fall parallel to the side, but landed some distance away from the base, or that of Copernicus' master, Maria de Novara, who, believing the structure of the universe to be governed by simple mathematical relations, rejected the Ptolemaic framework as too cumbrous to be true, and claimed to prove the earth had motion not only from the decrease in the obliquity of the ecliptic, but from a systematic increase in the latitude of places in Southern Europe that he thought he could establish as having occurred. In general the dispute was governed by initial axioms common to both sides, Galileo cites some of these, "That Nature does not multiply things without necessity": "That she uses the most direct and simple means and does nothing in vain" — axioms which militated either for or against Copernicus, according to the temper of the spokesman (44), the endeavours of the rival parties being directed to showing how their own system best accorded with these. The uniformity and pattern each revealed in Nature was the chief source of various merits claimed on either side — Galileo for instance urges that, since the time of revolution of every planet from Saturn downwards is admitted by all to be proportionate to the size of its respective sphere it is illogical to disturb the order of this series by assigning to the greatest sphere of all — the empyrean — the shortest time of revolution, i.e., twenty four hours, while the motions that must be assigned to the earth in the heliocentric system would fit exactly with the place it holds in the universe on such a representation (45). Arguments based on "value" similarly played a frequent and considerable part — that the earth was

not worthy to occupy the centre of the universe, that the earth was worthy of having a place in the heavens. Thus Galileo: "As for the earth we strive to ennoble and perfect it, whilst we make it like to the Caelestiall Bodies, and as it were place it in Heaven, whence your Philosophers have exiled it" (46); and Tymme, translator of Dee's Monas, in a summary of the theories of Copernicus and Cusanus, clearly feels their strongest arguments to be of such a type as: "it is a condition farre more noble and divine to be immoveable than to be moving and unstable, which quality of motion and instability better agreeth with the Earth."(47)

An important example of the type of philosophical tenet held in common by both Copernicans and their opponents and conditioning much of their thought, is that of the "naturalness" and perpetuity of all circular motion. Digges declares "right or straight motions only happens to those things that stray and wander or by any meanes are thrust out of their natural places...The circulare motion always contynueth unyforme and equall by reason of his cause, which is indeficient and alway continuinge. But the other hasteneth to ende and to attayne that place where they leave lenger to be havye or lighte, and havinge attayned that place, theyr motion ceaseth." Thus his answer to the objection that the earth in motion would fly apart, or at least throw off all things not attached to its surface, is "These thinges whyche are naturally mooved have effects contrary to sutch as are violently carried," the earth and its contents are such entities as are endowed with "natural" movement and hence "remayne stil in their perfit estate and are conserved and kepte in their most excellent constitution."(48) This too is Galileo's first line of defence against the argument that bodies on land fall perpendicularly, but do not do so in relation to a moving ship when dropped down the mast; "It is a thing very manifest, that the motion of the Ship, as it is not natural to it, so the motion of all those things that are in it is accidental, whence it is no wonder that the stone which was retained at the round top being left at liberty descendeth downwards without any obligation to follow the motion of the ship," but the return of a cannonball shot straight in the air to the spot it was fired from, remains compatible with the earth's motion "for the faculty of following the motion of the earth, is the primary and perpetual motion, indelibly and inseparably imparted to the said ball, as to all things terrestrial, and that of its own nature doth and ever shall possess the same."(49) Galileo indeed in his reverence for circular motion, accepting the view that rectilinear must always represent the restoration of order after something has been forced out of its rightful place, but denying that there can ever be such "disorder" as this would imply in Creation, and endeavouring further to confute Aristotle's distinction between the mundane and celestial realms based on the prevailing type of motion in each, attempts to exclude rectilinear motion altogether from nature, and to discover the true "circular" paths, which, for example bodies which appear to fall perpendicularly must "in fact" follow, instancing in support of this thesis even the movements of man's body as being compounded of circles, each single joint permitting the bone pivotted there to turn only as the radius of a circle (50).

In the sixteenth century the Copernican theory was not presented by its defenders to the world as a novelty. The importance that might attach to emphasizing its previous lengthy and respectable history in philosophical thought is attested by the case of Dee's friend Pedro Nunez, who shows clearly "que son excessive veneration envers les geometres d'antiquite fut la seul motif qui le detourna d'adopter plutot l'elegant systeme de Copernic, son contemporain, au lieu de la theorie de Ptolemee."(51) Its supporters — and this way may well have led Dee to regard it with increased cordiality — partly because of the type of arguments they had chiefly to rely on in its defence, partly to offset the opposing authority of Aristotle and their rejection of a large number of dogmas of orthodox physical science, claimed to be only reviving doctrines held by Pythagoras or Plato. References to Philolaos, Hicetas, Aristarchus were diligently collected. Copernicus himself pretends that the inspiration of such previous examples was what principally encouraged him to continue to explore what might otherwise have seemed a palpable absurdity. Digges confidently equates the heliocentric system with the Pythagorean revolution of the earth about the central fire, entitling his tractate a perfit description of the coelestial Orbes according to the most ancient doctrines of the Pythagoreans of late revived by Copernicus.... The testimony of Theophrastus, or of Plutarch in the Life of Numa was invoked to show that Plato in old age regretted having sometimes given the earth the central position in the universe, which position belonged by right to some nobler body, and frequently cited also was a passage in the Timaeus, which could be interpreted as implying his belief in the rotation, or even revolution of the earth (52). It was even possible to read "Copernicanism" into Cabalistic writings (53). Its association with Renaissance neo-Platonic thought perhaps stems from Cusa, who, although his precise views on the earth's motion are somewhat obscure (they seem closer to the doctrine of the Timaeus than of Copernicus), is often referred to — as by Calcagnini, Tymme, Wilkins, Leybourn (54) — as the reintroducer of the theory in the modern age. A further link with neo-Platonism is forged by the

almost religious reverence sometimes manifested by Renaissance thinkers towards the Sun, and which must be later noticed in Dee. Copernicus himself had spoken of it as "the soul, the light of the world — placed on a royal throne in the centre of the Universe, where it guides the family of the Stars circling around it."(55) The comparison of the One to the Sun, and of its emanating rays of light to intellectual illumination, is a recurrent metaphor in the Enneads and although there it may be no more than an analogy, the same image was thoroughly materialised, by Posidonius and the later stoics, for whom genuinely physical effluxions from the sun, which is endowed with a power of "undiminished giving," play an important part in maintaining the ordered processes of the Universe. Many similar theories, combining these two points of view, portions of Dee's Aphorisms and his Monas taken in conjunction would make one illustration, are to be found in scientific writings of the Renaissance; and the Copernicanism of Cornelius Gemma for example is closely connected with them. Though Gemma claims after discussing the Ptolemaic system "Sed observatis multo conformior est illa divini Copernici ration..." he is chiefly concerned in his mentions of it in the De Arte Cyclognomica to elaborate the metaphysical significance of the theory. His work establishes long lists of parallels between the various sciences, the material, intellectual and spiritual worlds; image and referential statement mingle inextricably — for the discovery of the scheme of universal analogies facilitates the type of transition by which an argument drawn from one phenomenon can be immediately extended to almost any other; and that the universe is the outward revelation of an independently existing intelligible pattern which can either be discovered in it, or, which itself known in part initially, can provide an a priori basis for the general interpretation of the world — he takes as proved by biblical references to the book of God: "Quemnan hic, queso, librum intelligat quisquam, nisi forte munda intelligibilem sive Archetypum atque intellectum comunem?" From such a standpoint he finds the sun to be the image of God in the World, it is the source of intelligibles, intellect being an orb illumined by its rays, it is "princeps aut anima mundi," and he discusses Copernicus' theories under such headings as "Sol mediu mundi aliorum syderum dux. Planetae omnes ad solis arbitria moventur. Solis vis actuali. Syderum vires a sole in actu provocantur." etc.(56)

But the attitude of critical reserve towards the various rival hypotheses which Dee showed also claimed to have its roots in the old Platonic approach, which Aristotle had vulgarised in thinking it necessary that hypotheses should be mechanically realisable, and who had hence, absurdly, postulated solid spheres. As for Plato, Simplicius' commentary on the De Caelo, had recorded that he used to set the problem to his pupils in the Academy of finding the simplest possible mathematical formula for the motions of the heavens consistent with observations. This was apparently to be done without any reference to physical assumptions, militating for or against the probability or even possibility of the result. Such independent mathematicism, the Renaissance astronomers could point out, was in fact professed by Ptolemy himself as the proper approach for the theoretical astronomer (57). Again, Proclus, in the commentaries on the Timaeus and Republic, praising the value of the Chaldean and Egyptian observations, had stressed that as true conclusions could be reached from false assumptions the consonance of an hypothesis with observation must remain an insufficient test of its truth. Epicycles and eccentrics he attacks as obviously artificial, however necessary as aids to calculation, and while astronomers might find it convenient to analyse complex planetary motions into simple ones, no mechanism should be supposed as existing in nature reflecting such a scheme. (He suggests that the intermediate cosmological status of the planets causes them actually to follow types of motion intermediate between the circular and rectilinear. (58)) The foremost example of such views in the Renaissance is of course Osiander's anonymous preface to the De Revolutionibus: all that astronomy can do is to observe the motions of the stars, he points out, and "Deinde causis earumdem, seu hypotheses cum veras assequi nulla ratione possit." Of astronomical theories he declares flatly "Neque anim necesse est, cas hypotheses esse veras, imo ne verisimiles quidem, sed sufficit hoc unum, si calculum observationibus congruemtem exhibeant." For this reason in de Revolutionibus those are followed that are "mathematically most easily understood." The philosopher, he observes, may perhaps demand greater probability, but neither he nor the astronomer will be able to discover anything certain or to teach it on this topic unless it has been made known to him by divine revelation, while "he who takes everything that is worked out for other purposes as true, would leave this science probably more ignorant than when he came to it."(59) Similarly Ramus, while praising Copernicus highly, repeatedly pleads for an astronomy to be devised and taught based solely upon "logic and mathematics," and completely removed from the influence of any preconceived physical notions (60). This attitude of critical reserve and suspended judgment, which Dee would seem to have shared, was further assisted in the sixteenth century by the variety of equally plausible kinematic descriptions of the heavens available, the possibility of which

Osiander had also mentioned. Not only were "new astronomies" produced by Tycho Brahe, Raymarus, Ursus, Maginus and others, but that the earth might not be the centre of all the planetary orbits was a time honoured view that had long received a certain amount of favour. It had for instance been known to the middle ages through Martianus Capella, who following Heraclides of Ponticus (who taught the doctrine combining it with that of the rotation of the earth about 350 B.C.) allowed Venus and Mercury to revolve about the sun, thus simplifying to some degree the otherwise puzzling irregularity of their courses and distances from the earth (61). Vitruvius had also reproduced this theory (62), Scotus Erigena added Mars and Jupiter to the number of planets that revolved about the sun — thus adumbrating, except in so far as Saturn was concerned, the Tychonic system — his source being apparently Chaldicius' commentary on the Timaeus, though he himself ascribes the doctrine to Plato (63). Jean de Pene, an acquaintance of Dee and of similar views, discussing applications of optics to astronomy in 1555 (64) declares it certain that Venus and Mercury revolve about the sun, while the weight of the authority of the Pythagoreans, Plato, Philolaus, Ecphantus, Seleucis, Aristarchus, Archimedes and Copernicus, leads him to admit the possibility — he does not go further — that the earth may be only a star traversing the Zodiac in the space of one year, around the Sun.

The preface of Osiander though it has been generally and sharply censured, since Kepler first detected and denounced its author, and however inexcusable any element of deception that may have been designed to have been suggested by its careful anonymity, seems today to have a very temperate and distinctly modern flavour. But its sophistication is indicative rather of a critical state of mind, contemplating what has already been achieved, than of one that may be prompted to make original discoveries, or produce novel formulations, by the zeal that accompanies a somewhat narrower, more intense view, that provides incentive to such efforts by encouraging a necessary overestimate of the probable value or certainty of the achievement. Copernicus had not, any more than had Kepler and other innovating pioneers of the day embarked upon his self-appointed laborious task with no end beyond the construction of fictional devices, whose chief merit was to be more aesthetically pleasing to mathematicians. Though Osiander's view seems to be in accord with that of numbers of contemporary astronomers, such as Dee, and however impregnable their position was on the available evidence, it was not that of Copernicus who in his letter to Paul III (65), speaks of his works "composed in proof of this motion" of the earth, though he says he long hesitated whether the better way were not to follow the example of the Pythagoreans, who, as the epistle of Lysis to Hipparchus proves, were wont to pass on the mysteries of philosophy not in books and writings but from mouth to mouth in personal communication with their friends and disciples. There were many others who also could not remain content in what seemed a negative state of indecision. Digges declares confidently (66) "If Copernicus (a man never sufficiently to be praised) had been now alive, as indeed he might have been, since he would now have been not more than 100 years old, we might have hoped that, so far as mortal weakness would permit, men would have had absolute knowledge of the celestial system," while the erroneousness of the Ptolemaic system he observed was sufficiently evident from its monstrous disaccordance with itself, for it fitted together as badly as heads, hands and feet taken from obviously different individuals; Kepler was equally convinced that it was "a most absurd fiction" to hold "that phenomena of nature can be demonstrated by false causes."(67) Such thinkers had to be prepared to accept very grave philosophical and theological consequences that seemed to follow. Some have been referred to already. One of the most controversial, if the earth be considered as being of a similar nature to other heavenly bodies — and Digges refers to it always in some such fashion as "this little dark starre wherein we live" and Cusa had called it "stella quaedam nobilis, quae lumen et calorem et influentiam habet aliam et diversam ab omnibus aliis Stellas," (68) — was the possibility of a multiplicity of worlds. That there might be "a particular World in every Star," Wilkins finds a probable speculation, which he says was held by Cusa and Nicholas Hill as well as Bruno (69). Kepler's suggestion that the moon and planets might be inhabited had previously been put forward by Benedetti (whose theories of falling bodies Dee explicitly adopted (70)), who had argued that the centre of the lunar epicycle could hardly be taken as the chief or single object of creation (71). To admit such a possibility involved refighting the battle which supporters of the existence of the Antipodes in an earlier age — such as Bishop Vergil of Salzburg — had found themselves drawn into, for it appeared to reflect on the justice of God thus to suppose that there might be a race of beings, dwelling, as seemed to follow, beyond reach of all salvation (72). Another related difficulty was the acceptance of the vast "enlargement" of the cosmos, which inevitably accompanied the heliocentric assumption, and the huge "gap" that was created by the theory between Saturn and the fixed stars. Aristarchus had for this very reason been led to produce the greatest of such estimates of the total extent of the universe, made in

antiquity, declaring that the sphere of the orbit of the earth to the outermost one of the stars bore the same proportion as the earth's size to that of the entire universe on the older system (73). Whether the Universe possessed bounds at all was a question Copernicus had declared "best left to the Philosophers," but Digges is emphatic that the only ground for judging it finite had been the mistaken belief that the outer sphere must revolve (74). The consequence was not only to emphasize the comparative smallness of the earth and solar system, but also the probably very restricted part of the universe that could be seen at all from them, which again raised problems as to man's status in relation to the intention and purpose of God's creation. (Raleigh, for instance, takes as the criterion for investigating the nature of the stars the probable functions they are designed to serve for man's benefits, and restricting what may be assumed about them to this sphere (75).) Thus Digges calls the "Orbe of Stars," "The Palace of foelicitye garnished with perpetualle shining and glorious lightes innumerable, far excellinge our sonne both in quantitye and qualytye," describing it later, as "reachinge up in Sphoericall altitude without ende. Of which lightes it is to bee thoughte that we onely behoulde sutch as are in the inferioure parte of the same Orbe."(76) But though the new system might at no point directly conflict with religious dogma, it aroused hostility by the negative or destructive effects that followed from its denial of a representation of the Universe that had been thoroughly comfortable and accommodating in this respect, and had proved a fertile source of arguments, illustrations and analogies in support of orthodox belief. Copernicanism, however much it might better accord with a later Deism, offered to any more precise dogmatism than this, as against the older scheme, only a comparatively barren and unhelpful picture (77). As to the controversy over the implications of various biblical texts, there is much in Galileo's Letter to the Archduchess Christina concerning the rash citation of the testimony of Sacred Scripture in Conclusions meerely Natural.... — to take an example of a typical Copernican view — that might have been written, though on the whole it suggests more immediately kinship with the scientific Platonism of the day, by a member of any school: as for example, his insistence on the parallelism and conformity, owing to their common source, of revelation and the physical universe: "For, from the Divine Word, the Sacred Scriptures, and Nature did both alike proceed, the first as the Holy Ghost's inspiration, the second, as the most observant Executrix of Gods commandments." The dangers of this position arose not from Galileo's insistence on the universally admitted thesis that many texts needed considerable interpretation, or even that they sometimes were to be taken as meaning exactly the opposite of their literal sense, but lay in his setting up as an infallible authority to guide such understanding, beyond both the Church and individual conscience, an autonomous science. All discussions in Natural Philosophy he claimed, should begin "at Sensible Experiments and Necessary Demonstrations....in regard that every expression of Scripture is not tied to so strict conditions as every Effect of Nature: Nor doth God less admirably discover himself unto us in Natures actions, than in the Scriptures Sacred Doctrines," and proceeds to limit the sphere of revelation and the teachings of the Church to such knowledge only as could not be otherwise attained; their purpose is only "to persuade man to the belief of those articles and Propositions, which by reason they surpass all humane discourse, could not by any other science, or by any other means be made credible, then by the Mouth of the Holy Spirit itself."(78) This extreme view was perhaps not shared by all early Copernicans, but towards it they were frequently propelled by the biblical objections of their critics. It is of some significance then that, while he was well aware of the various dangers and difficulties that beset the "new hypotheses," Dee, though he never openly embraced them, never ceased throughout his life to lend them friendly encouragement and speak enthusiastically of their immediate originator.

III. Dee's other works of this period — on astronomical instruments, mechanics, perspective and optics, bear witness to the expanding range of his scientific interests. Most of them we now know only from their titles: De Annuli Astronomici multiplici usu lib 2 (1557); Inventum Mechanicum, Paradoxum, De nova ratione delineandi Circumferentiam Circularem: unde, valde rare alia excogitari perficique poterunt problemata (1556) (79); Trochilici inventa mea (1558). This last, which was probably some combination of pulleys or interlocking cogged wheels, recalls his Aristophanes' "scarab" Galileo at the end of the century, in his Mechanics, discusses at some length a machine called by the Greeks consisting of an upper and lower pulley; the upper attached to the roof or supporting frame, Galileo feels called upon to emphasize, does not diminish the force required to raise an object, but only removes the inconvenience, otherwise arising, of drawing the rope upwards; the lower one, attached to the upper and to the object, he proves, implying the relative novelty of the observation, ideally halves the force required to support the weight (86). The name Dee gives his invention however only reflects the predominant view in the sixteenth century of the functions by which the machine in general might be essentially defined; i.e., it was considered as something for moving weights; Vitruvius — who with Pappus and Hero, represents a main source of the mechanical knowledge of Dee and his contemporaries — defined the machine as "a continuous material system (or, a combination of timbers fastened together) having special fitness for moving great weights."(81) (He somewhat obscurely distinguishes it from an "engine," by the criterion of the number of men, or amount of power required to operate each; an engine could be started by a single hand). But though the pulley, screw, lever, wheel and capstan were widely employed in the sixteenth century, they figure chiefly, and this seems true of all Dee's mechanical thought, in single almost random inventions, or in large scale theoretical designs, such as Besson's, of a hopelessly fantastic and impractical character (82). Their principles remained largely a mystery; Aristotle's unhelpful discussions in the Mechanical Problems (83) formed the basis of many reverent studies. It is perhaps not until Galileo (if we leave out of account the unknown or neglected manuscripts of da Vinci) that there appears, in the Dialogues conserning Two New Sciences clear notions, and methodical and mathematical treatment of such matters as turning moments about a point, the principle of virtual velocities, and it is in the Mechanics in which he has to start by rebutting the common superstition of artificers that machines represent "a cozening of Nature," since they were thought to produce a real multiplication of "force," and insisting that only a redistribution is involved, that Galileo is one of the earliest of modern attempts to do this clearly investigates the nature of the Machine — each device he declares is to be considered under the four heads of "Force" applied, Weight moved, Distances moved by Weight and "Force," and Time, and its "efficiency" is gauged against the best theoretical combination of these factors relative to some proposed end (84). Dee's more primitive view of general principles is set out in the Preface, when he discusses "Menadrie," which, he says, is "an Arte Mathematicall, which demonstrateth, how, above Natures virtue and power simple: Vertue and force may be multiplied: and so, to direct, to lift, to pull to, and to put or cast fro, any multiplied or simple, determined Vertue, Weight or Force: naturally not, so, directible or moveable." Menadrie is very much furthered by other arts (one of which is "Trochilike") and by it"all Cranes, Gybbettes, and Ingines to lift up, or to force anything, any maner way, are ordred: and the certaine cause of their force is knowne." Earlier in the Preface he describes the Art on which his present, lost, "invention" is based; it "demonstrateth the properties of all circular motions, Simple and Compounde. And by cause the frute hereof, vulgarly received, is in Wheeles, it hath the name of Trochilike: as a man would say, Whele Art: by this art, a whele may be given, which shall move ones about, in any tyme assigned. Two Wheeles may be given, whose turnynges about in one and the same tyme (or equall tymes), shall have, one to the other any proportion appointed. By Wheeles may a straight line be described: Likewise a Spirall line in plaine. Conicall Section lines and other Irregular lines, at pleasure may be drawen." Corngrinding, coining, and Saw-mills re its products "and all maner of Milles and Whele works: By Winde, Smoke, Water, Waight, Spring, Man or Beast moved." Later, treating of "Archemaistrie" he sets down Regiomontanus' feats as examples of the applications to this art: "Mervaylous was the workmanshyp of late dayes, performed by good skill of Trochilike, etc. For in Noremberge, a flye of Iern, bayng let out of the Artificers hand, did (as it were) fly about by the gestes, at the table, and at length as though it were weary, retourne to his masters hand agayne."(85)

A work on burning mirrors of 1557 is partially extant (86); Dee's optical knowledge and activities, as Bourne's letter to Burleigh on lenses testifies, were highly thought of at the time, and though any extensive account more properly belongs to a subsequent study accompanying an examination of Dee's own discussion of Optical Science in the Preface it may here be noted that he

and both the Digges, all refer to Roger Bacon as the source and inspiration of their researches in this science (87). Dee's present tract was prompted perhaps by a manuscript he had acquired in 1555, "De speculo Comburenti concavitatis parabolae" (88) (the last sheets of this MS are occupied significantly by early sections — mainly the definitions — from Appollonius' Conics). Burning Mirrors and the military wonders they will affect are repeatedly mentioned by Bacon (89): Antichrist he claims will appear armed with these engines, consuming with them camps, armies and whole cities, and Christendom is warned to construct similar instruments to oppose him. The popularity of his Miracles of Art and Nature in the second half of the sixteenth century, rendered the idea generally familiar. Thus, in 1578, "Burning Glasses" figure as one of Bourne's Devises: but he does not enter into detail, confining himself to pointing out that their construction and use requires great expertness in geometry (90), or again among Napier's "Secret Inventions" (1596) "proffitabile and necessary in theis dayes for the defence of the Iland and withstanding of strangere enemies of Gods truth and relegion," it is suggested that a mirror be prepared capable of burning the enemy's ships at at a distance (91). Of interest in connection with the extent of Dee's personal knowledge is the fact that in the Preface he gives as his authority of Archimedes' use of such mirrors not Tzetzes, as might be expected, but Anthemius (92). Though the scientific exploits of the architect of St. Sophia had been made famous by a number of reports (93), yet if Dee's reference be taken at its face value, it implies that he was acquainted with a work of Anthemius, long believed lost or non-existent, rediscovered only at the end of the eighteenth-century (94), and containing the true formula for the construction of such an engine (which Buffon had independently arrived at in 1747)(95). It solves the problem of construction by an arrangement of plane hexagonal mirrors Dee's treatise which is incomplete does not proceed so far as to deal with this practical aspect; and, though Anthemius' treatise deals with various problems of parabolic mirrors which Dee here treats of, a definite relation between them is perhaps impossible to establish, and taking into account the reference in the Preface Dee may have only known the Paradoxes, later in life, if at all.

Dee entitles his treatise De Speculis Comburentibus. Inventio Joannis Dee Londiniensis circa illa coni recti atque rectanguli sectione quae ab antiquis Mathematicis Paraboli appellabatur. A revival in interest in conic sections took place gradually in the sixteenth century, their history in the West being otherwise a blank since the days of Pappus (96), though significant progress perhaps did not recommence until the work of Kepler and later Desargues (97). Dee's sources perhaps were — for there does not seem to have been any others he might have used — the Latin Apollonius of 1537, Maurolyeo's analysis of the earlier books and attempted reconstruction of books IV and V of 1547 and Joannes Werner's work published at Nuremburg in 1522 which incidentally contained a new method of plotting parabolas: Libellus...super vigintuobus Elementis Conicis. Dee's application of the subject to burning mirrors came probably from various hints in Vitellio, who, it has been thought, may himself have read Anthemius, and who in the thirteenth century had set out to reduce the whole science of optics to geometry and whose Perspectiva remained a standard, advanced textbook, up to the seventeenth century. John Peckham's Perspectiva Communis, for instance, another thirteenth century work still recognised as standard and authoritative at this time, typically confines itself to a treatment of spherical mirrors, and, though near its end it claims to discuss how "Ex concursu radiorum fractoru, possibile est ignem generari," it merely suggests the well known device of using spherical glass bowls filled with water (99). Vitellio however offers the clue to the starting point of Dee's treatise (at the end of which occur among some rough notes some diagrams exactly copied from the appropriate section of the Perspectiva (100)) he rejects as impossible a solution employing any "usual" plane or spherical mirror, though suggesting a combination of these might achieve one, and then after a reference to the work of Apollonius he arrives at the important principle: "Sepculo concauo cocavitatis sectionis parabolae soli opposito, ita ut axis ipsius sit in directo corporis solaris, omnes radij incidentes speculo sequedistanter axi reflectuntur ad punctum unum axis distantem a superficie speculi secundum quartum lateris recti ipsius sectionis parabolae speculi superficiem causantis, ex quo pater quod a superficie talium speculorum igne est possibile accendi," and proceeds to brief directions for the possible manufacture of such a mirror (101). Dee's treatise is unfortunately far from complete: the pagination is disordered; and of what survives only a part is written out in a fair hand, the rest being notes, tentative observations, or partly corrected draft. In contrast with Roger Bacon however, who usually after stating as his principle that a convergence of rays is the true cause of heat, and classifying different types of mirror, then merely confines himself to verbal description or philosophical speculation on the subject, Dee's treatment is severely mathematical, and though he does not reach a stage of elaborating many formal proofs, relying often on what appears obvious from his diagrams, he promises at the beginning that all that

his book contains shall be "by numbers apodictally demonstrated." The surviving fragment consists only of a long series of "definitions," drawn from Apollonius, describing the nature and properties of conic sections, particularly the parabola, and of a reflecting surface modelled on this curve (from which only, he stresses, all rays normal to the axis will come to a common focus) followed by a series of some sixty-seven problems, arising out of these, as for example, "Data combustionis distantia, latus e rectonii elicere, quod eidem parabolae quadrat," (102) some of which give evidence of his considerable geometrical skill and ingenuity. The manufacture for "practical" purposes of such mirrors he does not reach the point of dealing with, perhaps the difficulties (arising from the large size and the standard of accuracy required) that would have to be overcome, which must have become increasingly obvious as he proceeded, was a contributory cause for his apparent abandonment of this work at an early stage.

IV. A section of another work of 1557, upon a subject also more properly discussed in its relations to Dee's thought in a full treatment of the Preface similarly survives in a partially burned condition (103). It has been written out in a fair hand by Dee, and was perhaps designed for publication, for marginal notes give instructions for the placing of the figures in the text. It is headed Elegans et Utilis libellus de ar (te...) cum circino et regula: in usum omniu (.....) tis stuiosorum, imprimis vero pictorum, sculptorum, aurifabrorum, phrygionu, lapicidarum, arcullariorum, et aliorum omnium, qui arte mensurandi (Perspectiva vulgo dicta) delectantur. In quo hanc artem facilius, ex quibusdam iam ante divulgatis libris compraehendere ac discere licet, cum multis elegantibus figuris. Dee here used the term perspective for what he calls "Zographie" in the Preface which he there defines as teaching "how, the Intersection of all visuall Pyramides, made by any playne assigned, (The Centre distance and lightes, beyng determined) may be, by lynes and due propre colours, represented." Zographie is the child of the more general science of Perspective (which deals with all types of radiation, and "concerneth all Creatures, all Actions, and passions, by Emanations of beames perfourmed"), and is also in its turn "the Scholemaster of Picture, and chief governor," (104) Dee's interest in the fine arts in the Preface and elsewhere is confined to the extent to which they can be rendered "intelligible" by mathematical interpretations. He regards the arts in general in the manner attributed to the ancient Pythagoreans: "and assuredly there is no art or craft that has been built up without proportion and proportion is based on number, so that every art is built up by means of number...and to speak generally every art is a system composed of apprehensions and system in number."(105) He and similar thinkers found perhaps in such a theory the reconciliation between Plato's acceptance of the divine inspiration of the artist — as in the Phaedrus — emphasized by the early neo-Platonists' claim that works of art reflected a higher reality, and had reference to the Idea rather than the sensible things, and Plato's condemnation in the Republic of "imitation" of particulars, a process involving, and in painting especially, illusion and deceit; Arts such as music, painting, architecture, sculpture, which Dee discusses in the Preface — and this endeavour permeates many Renaissance treatments of these, could be vindicated by showing them as subject to laws existing independently of sense, and hence their practise as not founded upon random empirical experimentation; for thus their representation of their objects involved no distortion or deception, but deriving from analysable mathematical relations, could be properly described as being "philosophically true."

It had been one of Plato's most reiterated dicta, and one that loomed large in the philosophical tradition stemming from his thought, that the philosopher must "refuse to give the name of art to anything that is irrational."(106) The theme of the Ion is directed to showing that all arts, if they are to be considered of value, must be based upon — or at least finally brought into relation with — some systematic knowledge, and hence though Ion's "rhapsodising" may be the result of divine possession it may still be a danger to truth; for since while composing he is partially out of his senses, and in other respects is without critical insight into his own works, their origin in him is divorced from reason, and he has no means of judging their accuracy. It is made the reproach of the arts — music and painting particularly — in the Statesman (107), that they are — or are treated as — mere "playthings," not practised for any serious purpose. The clue to their rehabilitation however is there said to lie in the extension of the Pythagorean analysis of the musical scale. Thus the "science of measuring" is made to include not only those "arts which measure number length, depth and breadth and thickness in relation to their opposites," but also "those which measure these in relation to the moderate, the fitting, the opportune, the needful and all other standards that are situated in the means between the extremes"; which criteria should receive as far as possible mathematical determination (as the analysis of the Just via "analogies" based on proportions in the Laws); thus "in a certain way all things which are in the province of art do partake of measurement."(108) Painters and sculptors had been censured in the Sophist not for being mere imitators, but for endowing their figures, not with the most "beautiful" proportions but only with such as their individual models appeared to have in life, and those pictures are attacked which, far from representing things as they are, gain their effect only by a view from some one angle or position. These two reproaches the Renaissance set out to remove by means of Perspective, which related the view point to the actuality, and the conjunct subsidiary science of what Dee called "Anthropographie," citing Meletius Durer and others as practitioners of it (109), which found in the varying individual proportions or composition of feature, fixed and determinable indices of "truths" of temperament, constitution and passions.

The high praise Plotinus gave to the "artifacts" of the mind, accorded closely with the Artist's growing theoretical prestige among the neo-Platonists of the Renaissance (for whom even the "craftsman" and "artisan" — their practise based on the one hand on a rational account, and impelled by divine inspiration or insight on the other — could come to be regarded almost as

Creators in their own right, worthy imitators of God, and partakers in some measure of his power in this respect). Thus Plotinus: "For what musician is there, who on perceiving the harmony in the intelligible world, is not moved when he hears the harmony arising from sensible sounds? Or who that is skilled in geometry and numbers, when he beholds through his eyes that which is commensurate, analogous and orderly is not delighted with its view?...The geometrician and arithmetician knowing in the sensible object the imitation of that which subsists in the intellection, they are as it were agitated, and brought to the recollection of reality." Again discussing the status of the arts and sciences in relation to the eternal, their subsistence in "heaven," he decides that insofar as they aim at intelligible symmetry and harmony they are rooted in a spiritual reality and can never perish (110). Such sentiments are reflected exactly in Alberti, whom Dee cites at length in the Preface (111) (Dee concludes, after quoting from the Architecture "we thank you Master Baptist, that you have so aptly brought your Arte, and phrase thereof, to have some Mathematicall perfection: by certaine order, number, forme, figure, and Symmetrie mentall: all naturall & sensible stuffe set apart") and who is partly the source for his present work: "But the judgment that you make that a thing is beautiful, does not proceed from mere opinion, but from a secret Argument and Discourse implanted in the mind itself,....For without Question there is a certain Excellence and Natural Beauty in the Figures and Forms of Buildings which immediately strike the Mind with Pleasure and Admiration." The secret of this is to be found in their Proportion: but "I am every Day more and more convinced of the Truth of Pythagoras saying that Nature is sure to act consistently, and with a constant Analogy in all her Operations: From whence I conclude that the same Numbers, by means of which the Agreement of Sounds affects our Ears, with Delight, are the very same which please our Eyes and our Mind," and therefore proceeds to borrow his rules of general Proportion from "the Musicians, who are the greatest Masters of this Sort of Numbers."(112)

Dee exhibits a similar rationising tendency. Painting is treated in the Preface with a lyrical enthusiasm: the Painter "is mervailous in his skill: and seemeth to have a certaine divine power....What a thing is this? thinges not yet being, he can represent so, as, at their being, the Picture shall seame (in maner) to have Created them." Nevertheless, Dee insists, he is only "but the propre Mechanicien, and Imitator sensible, of the Zographer," who in turn derives his knowledge from the higher principles of "Perspective" (in the wide sense that Dee there ascribes to it), which he claims might almost be called the first and most general and fundamental of all sciences "bycause of the prerogative of Light beyng the first of God's Creatures: and the eye, the light of our body, and his Sense most might, and his organ most Artificiall and Geometricall," a science by which "perfect knowledge can be atteyned," and through which alone can the senses be employed properly and interpreted safely with "perfecter judgement," for we ought to be "ashamed to be ignorant of the cause, why so sundry wayes our eye is deceived, and abused."(113) Unfortunately the surviving fragment of the present treatise has little positive content worthy of comment, though it is interesting insofar as it is indicative of the early fixation of the attitude of mind in Dee. After an opening tribute to Durer, whose work he intends to follow (114), he goes on to insist on the erroneousness of regarding this science as originating merely from acute observation; rather it is the product of investigations arising from speculative ingenuity and exact thought. The assertion he offers by way of proof reveals an important example of a prevailing polarity in Dee's thought, typical perhaps also of the age, for along with his exceeding reverence for the extent of the knowledge of classical and oriental philosophers of antiquity and his laments over the loss of "ancient wisdom," and efforts towards its "rediscovery," yet he also is inclined to stress proudly the progress that is or may be made by, and is available to, the moderns in the fields quite unknown or largely neglected by the ancients. Thus "Perspective," he claims, is a wholly modern discovery, of which the ancients, for all that they were no whit inferior in mere natural acuity of vision, remained in ignorance (115). Dee's statement is a fairly usual one; Vasari, whom Dee had read, attributes the invention of a correct theory of "perspective" to Brunelleschi, and Alberti claimed to be the first ever to write on the topic for painters (116). Dee stresses the intellectual foundation of this science, since he takes the problem of painting to be that of effecting "projective transformations," which is one susceptible of purely mathematical solution. Painting, it could be claimed on such a view, is thus rooted in truth and not illusion, since the geometrical structure of the scene it depicts is still traceable in it; the recognition of "objects" implies that they possess geometrical properties invariant under projection which have been preserved, and, though the value of lengths and angles may be apparently greatly altered, the change or rather translation, is made according to a constant and uniform numerical formula. Dee, however, in this work follows Alberti's method of exposition, who had begun his treatise On Painting by declaring that difficulty and obscurity would follow from an attempt to handle everything in a mathematical way,

and that he will therefore "pursue his discourse according to the custom of painters."(117) Dee similarly seems to set out not to demonstrate rigorously but illustrate. The figures, however, which should accompany the text, which at almost every point is intended as direct comment upon them, have not survived. The text itself is discontinued in mid sentence, when Dee has covered less than a third of the sections of the science he promises initially to discuss. What remains is very elementary; beginning with definitions of the various geometrical entitles — "points," "lines," etc.; it proceeds hardly further than giving the construction of the well-known chequer board pavement (at which point Alberti's exposition had also stopped), and breaks off after some discussion of the usefulness and various applications of this design, just as Dee is about to broach the more difficult question of the representation of points lying above the ground plane.

V. Another work of Dee's of 1557 was upon a somewhat different subject, but one which was of major theoretical and also personal importance for him. This was the Speculum unitatis: sive Apologia pro Fratre Rogerio Bachone Anglo: in qua docetur nihil illim per Daemoniorum fecisse auxilia, sed philosophum fuisse maximum; naturaliterque et modis homini Christiano licitus maximas fecisse res, quas indoctum solet vulgus in Damoniorum referre facinora. Though Dee announced its title in 1558, in the prefatory letter to Mercator attached to his Aphorisms along with those of some others of his works, he never published it, perhaps from caution, perhaps, as some of the surviving MSS of Dee suggest, it might have been the case that he never finished it, or brought it into a state satisfactory to himself, and it is now lost. It gained some fame by repute, however, and its appearance was long looked for expectantly by many (118). A revival of interest in Bacon in England, his sudden rise to popular fame, and the vindication of his character and activities, are a traceable and striking phenomenon of the latter half of the sixteenth century. Significant, since they mark almost the beginning of this rehabilitation, are the changes Bale makes in this respect in the second edition of his work on British writers. In 1548 he had inserted a violent polemic against Bacon as a "prestigiator ac Magus necromaticis, non in virtute Dei, sed operatione malorum spirituum." He had recounted the legends of Bacon's magical feats at Oxford, telling how "Cu malis demonibus consuetudinem habens," exactly as the magicians under Pharoah, he practised incantations and exorcisms and compelled the spirits to perform whatever he wished; Bale added "His artibus in secretis suis negotiis utebatur tunc plurimu prelati, ut patet de Clemente quarto Romano potifice, ad quem accersitus suarum incantantionu leges prescripsit." The list of works here attributed to Bacon includes many such titles as "De necromanticis imaginibus," "Practicas Magiae," "De excantationibus."(119) It may be that protests followed from those who shared Dee's opinions, for the reissue in 1557 omits all such titles as have any implications of sorcery from the list of works, and gives a laudatory account of Bacon's life, the only mention of magic now being "Accessit ei in Mathesi peritia incredibilis, sed absque Necromantia: quamvis ea a multis infametur."(120) The numerous persons set down in Bale's notebooks (121) as the sources of his information on Bacon and his works testify to an already considerable contemporary interest. Some, mainly of a Puritan cast, continued to malign Bacon: Francis Coxe about 1560 retails stories of his performance of blood sacrifice, diabolical compact and miserable end, mixed up with similar legends concerning Cornelius Agrippa (122); but increasingly, scientific writers, perhaps seeing in Bacon a convenient proxy for themselves, and thus by implication defending their own activities, attempted to rebut the defamatory charge of conjuring raised against him by popular imagination or theological prejudice. One of the earliest examples of such an apology in English is offered by Dee's associate Recorde in 1551: reproving the superstition of the multitude which sees in mathematics a branch of the Black Art, he continues "and hereof same it that fryer Bakon was accompted so great a negromancer whiche never used that arte (by any conjecture that I can fynde) but was in geometrie and other mathematicall sciences so experte, that he coulde dooe by them suche thynges as were wonderfull in syght of most people.

"Great talke there is of a glasse that he made in Oxforde, in whiche men myght see thynges that were doon in other places, and that was judged to be done by power of evyll spirites. But I knowe the reason of it to bee good and naturall and to be wrought by geometrie (sythe perspective is a parte of it) and to stand as well with reason as to see your face in common glasse."(123) Towards the end of the century, even in popular writings, Bacon appears as something of a national hero. Even his "necromancy" is amiably, almost approvingly represented in Greene's Friar Bacon and Friar Bungay, produced in 1592, and a naive and delighted pride emerges from the series of contests that are exhibited in the play, between him and the foreign Sorcerer (the German Vandermast), in which Bacon always outdoes his rival by the superiority of his magical spells. (A similar treatment in England of this theme is Rowes' Birth of Merlin in which the eponymous hero, although born of a devil, works always by command not compact and employs his magic arts consistently in support of the Christian British King and is celebrated with a patriotic fervour throughout the play.) That marvels might be done by legitimate means is an idea that now gradually acclimatised itself — thus the prose Historie, tells of Bacon's capture of a seemingly impregnable beseiged town for the King of France, who initially makes it clear he will accept no aid from sorcery, whereupon Bacon reassures him "I will speake onely of thinges perfourmed by art and nature wherein shall be nothing magical."(124) His name appears in contemporary lists of the great Englishmen of the past (125), and the redemption of his character was formally ensured by transforming him into a "Protestant martyr."(126)

Dee frequently recurs to the greatness of Bacon, assiduously collected what manuscripts of his works he could lay hands on, and there are few aspects of his thought where Bacon's influence

is not obviously present. This is particularly so in his views on the methods, purposes and elation to Divinity, of "Archemaistrie," or experimental science, which he exalts as necessary to the completion and perfection of all types of knowledge, in the Preface. It is perhaps also largely a result of Bacon's teachings, (and many of his pronouncements on this subject are strikingly similar to those of his later namesake: "Quanto juniores tanto perspicaciones" declared Roger, "Antiquitas seculi, juvents mundi" echoes Francis (127)) that Dee adds to his reverence for the achievements and supposed marvellous knowledge of antiquity his confident assurance of the powers of the moderns to make original discoveries, and progressively change the face of the world by penetrating, and applying to their own purposes, all the secrets of nature. Again Bacon's Augustinianism is in close accord with Dee's philosophy; his direct knowledge of Plato was not perhaps extensive (he certainly used the twelfth century translations of the Meno and Phaedo (128)), but, though he states that there is universal agreement of competent judges that Aristotle was a far superior philosopher to Plato (129), it is significant that a very high proportion of all his quotations from Aristotle are made from the Secreta Secretorum (130) on which he composed a commentary — which document, revealing an Aristotle turned neo-Platonist and embracing astrology and alchemy, Bacon hails as the most valuable of his works, accepting it as the fruit of Aristotle's old age, his final testament of mature wisdom. However, it is to the type of "magic" that Bacon taught and Dee in the Speculum Unitatis presumably justified, and on other occasions practised and defended in his own person, that some attention must here be given. The term itself as applied in Dee's time might cover any part, or all, of an extensive scale of meanings, ranging from the simplest direct experiment or observation upon the properties of chemicals, herbs or animals (131) to those feats effected by diabolical agencies, either controlled by the magician's power or whose services were loaned as a condition of some compact with hell; while, according to the temper and predisposition of particular writers, a greater or less proportion of this scale was then annexed, as implicitly related, to one or other of these terminal poles (132). To hold that a large part of profane studies was dangerous, at best indifferent, to the soul's welfare — a not infrequent defensive religious attitude, illustrated already in connection with astrology meant that "magic" in its purely pejorative, and most sinister sense, could be given a wide and indiscriminate sphere of application. The learned, authors taking up such a position warned, were particularly susceptible of being led by pride, and an excessive desire for increase of knowledge, into forbidden realms of magical speculation and ultimately to witchcraft; such men fall an easy prey to Satan, he "Puffing them up with conceit of extraordinary skill in Nature's secrets, and so with a vain imagination to be as gods, through such rare knowledge and great power."(133) On the other hand the term magic is frequently used in an equally broad and undefined, but totally innocent sense, and Gabriel Harvey can write, in similar tones to those Dee is accustomed to adopt: "How cometh it to passe that much more is professed but much lesse perfourmed than in former ages? especially in the Mathematickes and in Naturall Magic, which being cunningly and extensively imployed....might wonderfully bestead the commonwealth: with many puissant engines, and other commodious devices for warre and peace...."(134) The root of the genuine, and inevitable, ambiguity of the term, and confusion of mind it covered, can be illustrated from Thomas Browne's attempt to clarify the issue by distinguishing between the origin and contents of knowledge, limiting forbidden magic to such as necessarily included supernatural elements in itself, and removing the opprobrium of the epithet from such as had merely accidental supernatural associations, as for instance in the manner of its discovery. "I conceive there is a traditional Magick, not learned immediately from the Devil, but at second hand from his Scholars, who having once the secret betrayed, are able, and do emperically practise without his advice, they proceeding upon the principles of Nature; where actives aptly conjoyned to disposed passives, will under any Master produce their effects. Thus I think at first a great part of Philosophy was Witchcraft, which being afterwards derived to one another, proved byt Philosophy, and was indeed no more but the honest effects of Nature: What invented by us is Philosophy, learned from him is Magick."(135)

The attractive simplicity of the distinction is deceptive. Browne's analysis — which is not original to himself but can be traced, in almost identical terms, in earlier writers on the subject (136) — does not contradict the usual belief that varieties of spirits might serve as the proximate source of knowledge in any field, that they might be the most simple and direct if not the only way of acquiring certain information, thus, whatever might be judged subsequently to be mere philosophy, suspicion could still attach itself to the original investigators. Particularly was this so in the preceding century, in Dee's day, when the question of how far angelic or diabolical assistance entered into scientific pursuits, was further complicated by the widespread admission of the intermediate race of daimons, who filled a stage in the great chain of being and entered readily

into communication with men or exercised somewhat indefinite influence over them (137). The concept of Natural Philosophy was very flexible, capacious and undetermined in its limits, and in course of fairly rapid evolution. Fuller apologises for Dee's "magic" saying "He was a most excellent Mathematitian and Astrologer, well skilled in Magick, as the Antients did, the Lord Bacon doth, and all may accept the sense thereof, viz. in the lawfull knowledge of Naturall Philosophy."(138) But though the words of such a defence by Fuller and Browne are the same as those used in preceding centuries by such as Dee who found themselves innocently impelled into studies branded by many as falling within the province of necromancy, the idea of nature and what could be known and achieved legitimately by its study had by the mid-seventeenth century undergone considerable changes consequent on the absorption into it of the associations of many years of enthusiastic scientific practice, experiment and success. Natural magic as Dee defends it does not differ greatly in its substance from the activities many critics then and later considered damnable, or at least forbidden; he pleads only for an alteration in evaluation and judgment. The question of the legitimate limits of "philosophical" investigation was not susceptible of simple, clear cut decision, when no well-defined boundaries were generally admitted between the natural and spiritual worlds (attempts to make distinctions along these lines invariably fail to establish any criterion that could have been usefully applied (139)) and the cosmos was viewed rather as a continuum of existences, every level possessed of its peculiar powers, operations, and properties, stretching down from God to the bare potentiality of abstract matter.

A clear illustration of the hierarchical picture of the universe, which might effectively prevent any precise delimitation of the concept "natural" in the sixteenth century, the difficulties of attributing to it much more than emotional or evaluative connotation in its frequent refixing by Dee and others to branches of study, whose harmlessness and legitimacy is thereby intended to be asserted, is provided by Cardan's classification of the types of "divination," a discussion of which occupies a considerable section of the De Rerum Varietate (140). While the word was generally accepted as covering any inference as to future happenings drawn from the observation of any antecedent occurrence, without reference to the manner of making such deductions, it was also regarded as an activity which in all its varieties could be classed as "magical." The unity which Cardan establishes here is thus as important as the distinctions which he erects for the sake of order, between the separate types. Thus his first category is "mathematical divination" — such as the prediction of the eclipses, conjunctions, etc., of heavenly bodies; then comes "artificial divination," which is that which is learned by experience from the uniform succession of phenomena, sailors and farmers acquire considerable skill in it, medical and astrological prognostications are examples of it; another class of divination is "prodigious," which uses as data exceptional occurrences such as earthquakes, comets, meteors, extraordinary behaviours of birds and animals; lastly he treats of a large group which includes more conventionally "occult" practises, in which the spiritual state of the human operator is of prime importance, since they involve the informing of his understanding in various manners by divine agency, ranging from immediate prophetical inspiration, through the interpretation of dreams, as Synesius expounded it, to the use of crystals, mirrors, and other artificial, usually semi-hypnotic devices. In all types of divination Carden warns — and the same assertion is made by even the most experimental of contemporary alchemists also — "natural reason" and "carefulness" are in themselves insufficient foundations; a "pure heart" and a "pure mind" are indispensable concomitants to the discovery and perception of truth. Dee (141) similarly stresses the spiritual significance of even the most physical or mechanical, divinations or experiments. His thought cannot admit the possibility of any "closed" mechanical system, or process, existing independently of and without intelligible relevance to the spiritual framework and intentions according to which God created the world, and this because his won search for law and mechanism in nature and insistence on the application of quantitative method itself springs from the view that these possess intelligibility only because they derive from, and therefore in turn illustrate, the creative mind and purpose of God. This is even to be detected in his discussion of experimental science — in which he once more acknowledged his debt to Roger Bacon "the floure of whose worthy fame, can never dye nor wither" — in the Preface, it contributes to his setting so high a value on it, and accounts for his citation or Artefius Ars Scintrilla as a prime example of this "Archemaistrie" and perhaps explains the cryptic reference to an "(as it were) OPTICAL science," and "the chief Science of the Archemaster," if by this is meant the use of the crystal for "skrying," by which Dee attempted to establish communication with the Angels of God (142).

A classification of types of knowledge, sharing the generic name of magic, in close accord with Dee's apparent views, is made by Naudaeus (143). Man he describes as "a perfect and accomplished creature....ordering and regulating his extraordinary actions either by the particular

grace of almighty God, or by the assistance of an Angel, or by that of a Daemon, or lastly by his own industry and ability. From these four different wayes, we infer four kinds of Magic: Divine, relating to the first, Theurgick to the second; Geotick to the third, and Naturall to the last." Though he carefully illustrates the first only with characters of secure status in biblical or ecclesiastical history, Moses, Joshua, the Apostles, Simeon Stylites, his second class embraces such a various collection as Faustus, Merlin, Nostradamus, Homer, Socrates, Aristotle, Iamblichus, and Porphyry. Thus Dee, passionately rebutting charges of conjuring, which had been raised against him, cites as parallel cases to his own, Socrates, Pico, Trithemius and Apuleius, calling on their respective apologies, made in the face of similar slanders, for his own justification, and he ends his defence significantly, with the example of Moses, who "was instructed in all maner of wisedome of the Aegyptians: and he was of power both in his wordes, and workes," whose "Philosophicall Power and Wisedome" was "nothing misliked of the Holy Ghost," whose miracles were performed at the instigation of God himself. Pliny had nevertheless mistakenly attributed to Moses the practise "of vayne fraudulent Magike" and Dee thereupon warns his own detractors "Let all such, therefore, who, in Judgment and Skill of Philosophie, are farre Inferior to Plinie, take good heede, least they overshoote themselves rashly, in Judging of Philosophers straunge Actes: and the Meanes, how they are done."(144) The part attributed in Magic to angelic intervention or to daimons who might, with no criminal intention or flagitious acts be controlled and commanded by amulets, spells or other means not judged as morally or even casually very different from methods employed to produce any other effects in "practical philosophy" (145) — a view developed theoretically even by Plotinus (146) and which explains for instance the appearance of necromancy in some Arab lists of the branches of the "natural sciences" (147) will be more fitly dealt with when Dee's activities with Kelly are discussed. Here it is only necessary to observe, in regard to such practices, that the distinction between legitimate and forbidden "magic" was not so much made by setting these apart from other modes of investigation, or even by a discriminatory attention to the type of knowledge or effect sought, or manners of operation in themselves, as made in accordance with the supposed moral attitude and intention of the operator (148), which would indicate the good or evil character of the spiritual assistance — which might be held to enter necessarily into all man's speculations, and acts, in some measure — that he was receiving. The implications of the term "nature" as prefixed on justificatory qualification to "Magic," or as used in discussions on the extent of legitimate science, seem to be merely synonymous with what could be known as "good," and the "natural" therefore comes to be considered, in its most fundamental sense, as that which was most intimately connected with and which led most surely to a knowledge of "De Magia naturali, sive licita, et praeternaturali sive illicita," says of the first "ad quam Physicorum et Medicorum Prognostios, ab ipso naturae ordine et signis divinitus in natura conditis sumpta, item Astronomicae praedictiones Ecclypsium, magnarumez coniunctionem, imo etiam Politicae divinationes, iniustis et scoleratis, poenas certo secuturas, denunciantes (quae omnes divinitus approbatae et coccessae sunt....) referri queunt. Et sic Magorum professio olim fuit laude dignissima, quia cognitio illa Dux est ad cognitionem Dei talem quale mons humane post lapsum, extra verbum Dei revelatum ex natura contemplatione concipere potest. Tales Magi ex Theologorum sententia fuerunt, Moises, Josephus, Solomon, et tres Magi Orientales...." The same dichotomy under the headings good and evil "Magic" can be made in every sphere of human science; thus he warns that "Diabolus Medicus est peritissimus" and treats Paracelsus' theories and practices with cautious suspicion, since "Paracelsus non referre dicit, utrum a Deo vel Diaboli petatur auxilium."(150) This same general division is made by Pico, whom Dee cites in his own self justification who writes, referring to the "magical propositions" among his theses "in quibus duplicem esse magiam significavimus, quarum altera daemonum tota opere et auctoritate constat rea, medius fidius, execranda et portentosa. Alter nihil est aliud, cum bene exploratur, quam naturalis philosophiae absoluta consummatio. Hanc omnes sapientes, omnes coelestium et divinarum rerum studiosae nationes, approbant et amplectuntur...ex hac summa litterarum claritas gloriaque antiquitus et poene semper petita...ad hanc Pythagoras, Empedocles, Democritus, Plato discendam navigavere, hanc proedicarunt reversi, et in arcanis praecipuam habuerunt....Illa denique nec artis nec scientiae sibi potest nomen vindicare; haec altissimis plena mysteriis, profundissimam verum secretissimarum contemplationem, et demum totius naturae cognitionem complectitur."(151)

Such high assessments of the value of magic in the Renaissance (which almost inevitably cite the example of Roger Bacon at some point) are not infrequent and are of importance, since magic had never been considered so much as an independent art or science having its peculiar principles and discipline, but was rather taken as the application to the external world, in order to produce effects, useful or wonderful, of principles gathered from any branch of knowledge

whatever; it signified generally, the reduction of theoretical conclusions to practical demonstration; "Magia" defines Pico "est pars practica scientiae naturalis."(152) The single inseparable hallmark of "magic" in all its forms was that it implied the exercise or possession of power to control and alter phenomena, for its end was not a contemplative understanding but an activity. Such had always been its most constant and immediate meaning, and it had as such been always denigrated by such creeds as inculcated a wise passivity as man's best road to realising the perfection of his nature (153). The rapid growth of a multitude of occult "pseudosciences" in the early centuries of the Christian era had been dominated by the impulse to exercise direct control over nature, the environment man found himself in, and, in religion, to achieve internal spiritual "experiences" rather than abstract knowledge, a desire which classical philosophy or natural science offered small assistance in satisfying, and had hardly shown itself aware of (154) (according to Aristotle it was probable "that at first the inventor of any part which went further than the ordinary sensations was admired by his fellow men, not merely because some of his inventions were useful, but as being a wise and superior person. And as more and more arts were discovered, some relating to the necessities and some to the pastimes of life, the inventors of the latter were always considered wiser than those of the former because their branches of knowledge did not aim at utility." (155)) But a similar movement is widely evident in the Renaissance (156), and man's capacity for imitating God as an active creator is increasingly stressed; it results for a considerable period in similar manifestations since it also is denied any obvious guidance by a well-established and fully developed natural philosophy of the day.

VI. Magic might mean no more than applied science; but the Aristotelian picture, while presenting, considered only in itself, an admirably comprehensive and coherent scheme, was possessed only of descriptive virtues, and was almost totally lacking in predictive power or in any hint in its account of "change," of how such processes could be artificially controlled or produced. It offered a full and adequate account of nature as qualitatively experienced, insofar as it might be already known, but as a theory pointed out no avenues for the discovery of further utilisable knowledge. While it could explain all experimental results, its theories did not assist to the obtaining of these, and practice which attempted to draw upon them became soon involved in obscurantism, having recourse to "occult causes" at every stage of procedure; and, as is very clear in the cause of medicine — which was almost overburdened on the one side with elaborate and quite intelligible theory — the attainment of concrete positive results, although the subsequent interpretation of these seldom presented difficulties, was achieved most frequently by chance observations, by random undirected empiricism. In developing an explanatory analysis of the world which conformed as closely as possible to the elements and categories of normal experience, the Aristotelian natural philosophy evaded that "bifurcation of nature" which has been found essential to later science, but only with the consequence that, relations, correspondences, connections, and transmutations, between the "forms" into which nature was thus resolved remained largely inexplicable, these basic elements were too often highly individualised multifarious complexes. Thus if change were conceived, as in the stages of alchemical transmutation, as the successive supervention of new forms, there was little in the character of these forms themselves which suggested means for their direct control, or which allowed clear determination of the condition of their appearance. The obscurity which thus might infect the concept of causation is apparent in Avicenna's account of the activity of the doctor; he aims to provoke the emergence of the "form" of health in the patient, but the limit of his powers is to assist the body into a supposedly appropriate state for the reception of this "form." Very largely, the attempt to construct practical sciences within the Aristotelian framework illustrates what has been aptly called "the non-fertility of hometypal explanation," which less immediately credible "heterotypal" accounts successfully avoid; e.g., despite the patent falsity of declaring that heat is motion, at least a pregnant correspondence is thus established, while nothing is gained by merely though more plausibly, referring it to a calorific principle (157). Yet this type of "explanation" was the inevitable result of the common dogma that all effects are the results of causes whose natures are qualitatively similar to what is manifest in the effect, and which, since not directly perceptible are adjudged "occult" or hidden, and known only by inference from this. Thus medicaments were classified according to the degree of heat, cold, moistness or dryness they possessed (Dee discusses the mathematical question of their compounding in the Preface (158)) — but their natures could not be determined by any general method of examination of the medicines themselves; their qualities were only apparent when they produced heat or cold, etc. in the body of the patient. Later science has perhaps never been able totally to dispense with terms which are necessary for a full account to be given of phenomena, and which nevertheless are little more than covers for ignorance, but these have been usually recognised for what they are — purely descriptive, not susceptible of further analysis into fruitful relations, unabsorbed intractable points in an otherwise coherent closely woven pattern of correspondences; "chemical affinity" (until the recent interpretation of valency by reference to electron groupings) long remained a concept of this order after it had lost — with the abandonment of theories relying on sympathy and antipathy (159) such as most magical doctrines employed — all significance as regards any accepted principles of explanation, but remained indispensable as a description of observed facts, but the Aristotelian terminology in general was of this type and any deductive system based on descriptive labels and abstractions, such as these, established only a vicious circle in which there was no profitable way of return from theory to the actual world which would result in any enlargement in the domain of knowledge, as defined by the particular range of observed facts which had originally gone into the forging of the theory. Since then, at every stage of operations or change, recourse had to be made to essentially unobservable and occult properties in the agent, and there was no demonstrable a priori method of determining whether any phenomenon might not be taken as cause for any effect whatsoever, it is perhaps true that, while "magical" practices have been largely historically associated with neo-Platonic or hermetic thought, their growth was assisted, and many of the arbitrary superstitions or ritualistic forms which one conventionally thinks of them as assuming, were reinforced by the defects exhibited by a current Aristotelian philosophy when called upon to provide a discipline and guidance to meet the new demands for applied sciences.

The confused mingling of extensive credulity, sceptical empiricism, and random experimentation that resulted is evidenced by Torta's Natural Magicke with all its isolated mirabilia,

and tentative, naive attempts to establish criteria of sympathy and antipathy between entities which will allow the prediction of effects, or by Pompanazzi's de Incantationibus, which sets out firmly to give a purely "natural" explanation (that is by rigourously excluding the agency of angels, daimons, or disembodied intelligences in the world) — of religious miracles, the effects of ritual magic, and prodigious and wonderful occurrences, none of which Pompanazzi finds any reason to question in themselves. Overall intelligible system he achieves by ascribing all events to the causal agency of the heavens, and their changing conformation. But this attractive "mechanism," which attributing even the rise and fall of religions to the material, determined, cosmos, allows the temporally limited potency of forms of prayers, charms, symbols connected with the dominant religion of an epoch in the production of miraculous effects — by its very capacity to explain anything at all whether in fact it was real or imaginary, possible or impossible — in "natural" terms is sadly deficient as a guide to the practising magician, who might wish to unite understanding with power. Though Dee's mathematical platonism might hold the key to successful later developments of this kind, and though he might profess as an article of faith, that ultimately all things would be found to be explicable in terms only of number, measure and weight, yet the range of phenomena which he was able to subject to such an exact analysis was extremely limited. A vast domain remained, which if a general picture of nature was to be attained, and one in which comprehension would be supplemented by the possibilities of application, seemingly could be satisfactorily covered only by conventional magical theories (160). Its extent was bounded on the one hand by what a simple analysis could reveal as purely "mechanical," on the other by the volitional acts of the soul, that did not require "explanations." Between these, nature appeared essentially magical, with God functioning as the supreme magician — in the sense that "animistic" explanations were sought, in so far as the characteristic of such a view is to regard things as merely "signs" or "powers" of secret internal virtues. The danger lay in the possible exaggeration of this element in thought (161) as in naturalist empiricist philosophers such as Pompanazzi or Porta, since this, presenting nature as wholly miraculous, destroyed its rationality and ultimately the idea of intelligible order prevailing there, instead of reducing the area over which recourse had to be made to such theories, as the type of neo-Platonic science Dee advocated in general tended to do. Dee was later to inform a disappointed Kelly that he possessed little skill in "vulgar magic" — that is, probably, in illusions, in the production of effects intended only to amaze or astonish, in the miscellaneous hotch potch of charms, philtres, amulets for occasional purposes — the popular idea of the contents of magical lore; by trafficking in which all too many won easy reputation and profit.

VII. The general theories which accounted for the possibility and justified the practice of "magical" operations were features of some importance in his thought, and especially in two aspects of these, one relating to the constitution of the universe that seemed necessarily involved in "explanations" of the success of magical operations, the other regarding the status and powers of the rational soul within it. The first, which posited a generally maintaining intimate interconnection of all entities in the world (Dee's Aphorisms illustrate one working out of a universal scheme on this basis), stems ultimately in large measure from the Stoic cosmology, by which this school assisted more than any other ancient philosophy in establishing the theory of divination, according to which anything rightly regarded, since the cosmos is an organic unity, can be taken as symptomatically indicative of anything else. The view was absorbed into neo-Platonism (162), and is the dominating theme of Synesius' de Insomnis, popular in the middle ages and throughout the Renaissance, which declares divination to be the most divine of the sciences, necessary to the perfection of all the others, possession of which distinguishes man from the brutes, that birds with human intelligence would be able to use man's notions for divinational data, as men make use of birds for this purpose, and that the true philosopher is only he who has knowledge of the secret bonds which underly all apparent diversities and reveal the universe as a complex unity governed by "harmony." As the theory had to explain action occurring at a distance — which magic invariably claimed to produce — it was usually illustrated by reference to sympathetic harmonic vibration — the "lyre image" was frequently used in this connection (163). Prayers, rites, spells it was asserted act by means of "a certain sympathy and similitude of natures to each other; just as in an extended chord, where when the lowest part is moved, the highest presently after gives a responsive motion, or as in the strings of a musical instrument attempered to the same harmony one chord trembling from the pulsation of another, as if it were endued with sensation from sympathy. So in the Universe there is one harmony, though composed from contraries, since they are at the same time similar and allied to each other. For from the soul of the World, like an immortal self motive lyre, life everywhere resounds, but in some things more inferior and remote than in others."(164) The object of the magician was therefore, by utilising his knowledge of these hidden relationships, to bring to actuality what exists potentially already in nature. He operated, Plotinus had declared, by means of this universal law of "sympathy"; his gestures and incantations control things at a distance, since he himself is an intrinsic part of the universe, and "the true magic is this friendship and strife which exists in the great All."(165) Or as Pico described it, "Magicam operari non est aliud quam maritare mundum." "MIrabilia artis magicae no fiunt nisi per unionem et actuationem eorum, quae seminaliter et separatae sunt in nature." "Nulla est virtus in caelo aut in terra seminaliter et separata quam et actuare et unire magus non possit."(166)

The magical teachings as to the power of the soul had also received encouragement from Stoic doctrines, since their general materialism, which attributed the soul's qualities to fire, represented it as an extended and truly physical force, which was therefore to act directly upon matter. They were however more closely related to the neo-Platonic identification of the hierarchies of existence and value, in which the soul standing closer to God, who controls all things, then objects in the elemental world, should therefore logically be possessed of innate mastery and government overall that is lower in the scale of creation. This as a magical theory ("cum namque hominis animae voluntas est maxime imaginative, fuerint vehementes, elementa, venti, et relique materialia sunt nata obdedire eis") Pompanazzi attempts to contravert, attributing it to Avicenna (167) in whose theories it held a necessary place. It was, however, developed at length by Alkindi, from whom Roger Bacon and Dee borrow important principles in their cosmologies. All things, Alkindi had argued, emit species, all magical figures rays of power, all words transmit efficacious likenesses of the concepts of the soul, in accordance with which they were framed and "frequent experiments," he declares, "have proven clearly the potency of words when uttered in exact accordance with imagination and intention, and when accompanied by due solemnity, firm faith and strong desire"; their power is heightened by choosing correct astrological conditions, and concentrating the mind on the name of God or an Angel (168). such views have already been touched upon in relation to the Cabalah, which Pico declares in the 900 Theses, is a higher, more extensive science than practical magic, but is in some measure inseparably involved in all magical operations, for it studies the character of words, and these, the concepts they represent, and the voice which utters them, are the chief instrument of magic, as it was by their means that God originally created all things in their own natures. The view is almost an immediate consequence of Renaissance neo-Platonist epistemology "Die Moglichkeit der Magie flgt nach Campanella aus demselben Prinzip wie die Moglichkeit der Erkenntnis. Denn auch erkennen konnten wir nicht, wenn nicht Subjekt und Objekt, Mensch und Natur ursprunglich und wesentlich eins waren. Wir erkennen einen Gegenstand nur dort wahrhaft, wo wir mit ihm verschmelzen, wo

wir geradezu ihm werden. Cognoscere est fieri rem cognitam — so definiert Companella, cognoscere est coire cum suo cognobili — so definiert Patrizzi den Akt der Erkenntnis. Die Magie druckt diesen Sachverhalt, der sich in Wissen theoretisch darstellt, nur nach der praktischen Seite aus; sie zeigt wie auf Grund der Identitat von Subjekt und Objekt das Subjekt das Objekt nicht nur be reifen sondern auch beherrschen kann, wie es die Natur nicht nur seinem Verstande, sondern auch seinem Willen unterwirft. Demit ist die Magie als `naturliche' nicht als `damonische' gedacht — sum edelsten Teil der Naturerkenntnis und sur Vollendung der Philosophie geworden."(169) To almost any intellectual analysis or description magical powers might be thus ascribed, a belief even more general and unquestioned if these took mathematical forms employing numerical expressions or geometrical diagrams (170).

The theories and practices we have illustrated here as typically magical would have been closely similar to those which Dee must have undertaken to propound and defend in his effort to purge Bacon's reputation of the stain of Necromancy. Thus in his little work on The discovery of the Miracles of Art and Nature and the Nullity of magic; popular in the sixteenth century and after, Bacon reprobates: "The unnecessary aspiring to magick, since both Nature and Art afford such sufficiencies," (171) but he conceives as "natural" any activity whatsoever which does not involve intercourse with wicked spirits, remarking approvingly "without all question the way is incomparably more easie to obtain anything, that is truly good for men, of God, or good Angels, then of Wicked Spirits" (172) — a reference perhaps to the belief previously noted that devils were only empowered to produce illusions. His initial declaration that, as regards charms and talismans, "there is nothing in these days of this kind but what is either deceitful, dubious or irrational," is qualified by the admiration that prayers to God and Good angels have a necessary virtue, and figures are potent if drawn with regard to the ruling, and otherwise appropriate constellations (173); and an analysis of action at a distance concludes "It is clear then that the bare generation and prolation of words joyned with desire and intention" are of considerable effect "in natural operations."(174) This last is a frequent theme in his writings, for "the word is the principle product of the rational soul and its greatest delight," and he summarises magical efficacy as depending entirely "on four influences: the voice formulating the air, the good or evil condition of the ration soul, the body, and the stars."(175) The rational soul, he argues, controls all creatures below the angels "just as we see that heavenly bodies because they are nobler have power over what is inferior," and since it "is without comparison more worthy than the whole animal soul there is no doubt that it has great power in its works when it is free from spot of sin or when commanded by the Grace of God it acts with strong desire and firm intention. But its especial action is the word," by which the saints have always performed their miracles (176), and since it "has especial need of words framed efficaceously and by design, the astronomer is able to form words for chosen times which will have inexpressible power. For when the purpose, desire, and force of the rational soul which is nobler than the stars, are in harmony with the force of the heavens, of necessity either a word or something else is produced of wonderful force in altering the things of this world, so that not only the things of nature but human minds are drawn towards those things which the skilful adept wills, the freedom of the will remaining unimpaired."(177)

The contemporary danger of professing and openly admitting to the study of "magic" even of this type is apparent from the evil notoriety that gathered round Trithemius, or even more acutely round Agrippa, whose writings loomed large in practical importance in a latter period of Dee's life. Agrippa in accounts of the various arts and operations he describes, made free use of the term "natural" as a defensive adjective, with conscious hypocrisy according to his indignant detractors (178). Even the English translator of De Vanitate, in 1569, which was regarded then as his formal recantation, declares while praising this work that its author was "without doubt, a Divel of Hell," who "gave his minde to unleeful artes, contrarie to the Lawes of God and man...he exercised the Arte Magicke, and therein farre excelled all other of his time, but in the ende his wicked knowledge was the cause of his miserable deathe."(179) He has suffered equally harshly at the hands of posterity who have in general accorded him rather contemptuous treatment as a writer (180), though many facts indicative of far different estimates by his contemporaries, perhaps not the least of which is the long continued friendship and discipleship of the enlightened Wierus, warm against the too ready acceptance of either of these types of judgment. His historical importance as an illuminating representative figure indeed directly arises from the fact that his work is almost entirely a compilation, unoriginal in content, based upon respectable authority at every step, and attempts to weld into a synthesis the whole corpus of works bearing on the theory of magic, as well as fragmentary incidental declarations on the subject by previous thinkers, mainly within or with close affinities to a neo-Platonic philosophical tradition. From this point of view his work provides perhaps a more useful typical insight into the learned world of the day than, for instance, the idio-

syncratic writings of his contemporary Paracelsus, and other more original system builders of this time. Thus in defence of this work (which he significantly published in 1531, the year after he had given the world his supposed recantation) — he claimed that it contained nothing at all that he had not drawn from printed works, generally known and approved by orthodox Philosophers, Theologians and Cabalists, such as Plato, Porphyry, Proclus, Calchidius, Sunesius, Ammonius, Psellus, Albertus Magnus, Roger Bacon, William of Paris, Pico, Reuchlin, Riccius "and others like these," so that his work could only be considered one of innocent natural philosophy and true religion, and should give offence to none except those who become alarmed at anything not wholly familiar to them, or who are incapable of understanding anything but obvious puerilities (181). Its three books correspond to the familiar division of reality into three worlds or orders, each lower one being considered an emergence by privation from the adjacent superior, which since more extensive still implicitly includes each separated lower world — the elemental, intellectual and spiritual, the schema Dee adopts in the Preface, and Agrippa attempts to give an "intelligible" account of magical causation as regards each; the instruments appropriate to the respective levels being language, mathematics, and ritual. His general theories are very much of the type already discussed. All things have "occult virtues," connected with their "species" and form, imprinted upon them by Ideas of the World Soul, acting through the medium of the stars; they emit forces which bind them in relations of sympathy and antipathy to everything else in the universe. The natural virtues given off by things travel through the senses and the imagination into the thought where, as a concept, they become the fertile seed which eventually bears fruit, in the shape of work or symbol which the Rational Soul employs for its own purposes, since these contain the essence and emit the forces and virtues, of their original sources; that this is so Agrippa demonstrates by the fact, only explicable by the admission of such a mechanical scheme as the assumption of "rays" given off by "proper names" provides — of the psychological recognition of the object in the word, the production of a correct and vivid image in the mind as a consequence of the hearing of the name (182). It is further of interest that in his piously satirical indictment of profane studies (whose seriousness has been perhaps sometimes over-emphasized by not recognising in it an example of a type of composition which in form and contents existed well within an established "literary" convention, examples of which might be little more than formal and rhetorical exercises) he still, almost alone among human sciences, speaks approvingly of three types of magic: natural magic — "the force above human reason which is the active principle in nature," which is the art of controlling the powers of nature, and actualises artificially her potentialities as by developing a mature plant from a seed in a few days (183); mathematical magic, which by means of numbers and astrology constructs machines (he instances Boethius' feats, in a passage quoted without acknowledgement by Dee in the Preface (184)) — which contrivances, he observes, partake neither of natural nor divine reality, but are intellectual artifacts, which attempt to imitate both these; and Theurgy or divine magic, which is the search for communion with good angels by purifying the soul — though this he warns may become a pernicious superstition in the hands of the foolish (185).

Now Dee in the Prefatory letter to Maximilian in his Monas of 1564 declares that the art he is there dealing with he has previously defended in Speculum Unitatis and while other aspects of the Monas are dealt with fully in the subsequent chapter a few words should perhaps be said of the magical theories on which it rests. In his prefatory letter Dee speaks of the fashion in which all arts and sciences can be learned from a study of his hieroglyphic, in much the same style as the Ars Notoria proclaims the benefits its readers may obtain (186) — a work that consists largely of unintelligible words and sentences, in a similar jargon to that in which Kelly's angels often delivered themselves, supposedly possessed of mystic powers if committed properly to the mind. Dee's Monas, however, shows an attitude that is not content merely to accept unquestioningly magical words or diagrams, as many works of magic were (187) but one which wishes to subject them to a rigorous explanatory analysis, and render as far as possible their nature and power intelligible. Its basis however is the same as that on which words or talismans were usually attributed efficacious virtues (188). Dee's figure combined the characters of the planets and the chief of the Zodiacal signs; now it was through the celestial bodies that the supernatural world controlled and directed the elementary world, but they were considered the chief instruments of creation and government in virtue of their specific configurations in the case of the asterisms, and the possession of natures that could also be diagrammatically or sigillistically reproduced in the case of the planets. Hence by duplicating these signs men might, thus aided by geometry, in some fashion reproduce their effects. As concerns the knowledge they would bring the claim that symbols, or meaningless words earnestly contemplated and impressed upon the mind, would awaken new knowledge there, and this is an intrinsic claim of many of the "mnemonic" systems of

the time, seems perhaps less surprising when the conventional doctrine that the impressions entering through the senses brought with them information or produced effects on the mind (189) for which strictly no correlative could be traced in the mere sensible form of the object is remembered — a usual school instance was the sheep's perception in the form of the wolf not merely of shape, colour, magnitude, etc., but also irrespective of whether it had ever seen such an animal before, of hostility and danger. Similarly therefore, to establish a symmetry in the cognitional situation, it seemed probable that the intellect orientated towards different objects, in perceiving these — intelligible geometric patterns, abstract words — came into possession through them, whether it had been acquainted with them before or no, of a similar surplus of meaning, to what seemed proportioned to their mere forms, on a corresponding higher level (i.e., insights of direct spiritual truths).

VIII. Some of the general theories of this learned magic, treated from a specialized astronomical standpoint, also make their appearance in Dee's Propaideumata Aphoristica, his first major printed work, which was published in 1558, in the same volume as Leowitz' Brevis et Perspicua Ratio Judicandi Genituras ex Physicis Causis et vera Experientia extructa...(190) and Wolf's defence of astrology, cited previously; where it is described on the general title page as "libellus de Praestantioribus quibusdam Naturae virtutibus." It was also reprinted separately with a special title page the same year and reprinted in 1568 with a few verbal changes, which are noted below. Dee in 1570, in the Preface was still prepared to refer his readers to it as the best work of fundamental astrological theory with which he was acquainted (191), but before treating of its sources and implications, a brief resume of its contents is necessary to indicate the scope and objects of the work.

The title page — and Dee would seem to have placed some importance on these visual illustrations to his books, and to have carefully designed some of them himself — is almost identical, except in the poorness of its execution with that of the Monas, and thus underlines its connections with that work from which it might otherwise be thought very different in form and subject matter (192). It represents through the symbol of an ornamental portico interconnections prevailing in the cosmos. The arch is studded with the fixed stars, the base stones of the supporting columns are "terra" and "aqua," the upper corner stones are "Calidum" and "Humidum," (cold and dry are perhaps omitted as mere contrasts, by pravation, of these) midway the pillars show respectively figures of Sun and Moon. From all these points proceed rays to the centre where upon a plaque, in the form of the alchemical egg is drawn Dee's Monas — a compound of the Planetary signs, with the devices "Est in hac monade quicquad quaerunt Sapientes" and " acumine praeditus est instor omnium Planterum"; just below appears the triangle Dee adopted as his personal monogram with the motto "Quaternarius in ternario conquiescens" (i.e., the four elements of the natural world which emerge from the triune deity — the triangle represents a quaternion as well as a trinity according to Dee in the Monas, because God has revealed it as the fourth letter of the Greek alphabet). The whole is surmounted by the same self confident injunction as the title page of the Monas: "Qui non intelligit aut taceat aut discat."

The work opens with a prefatory letter (193) addressed to Mercator, who, Dee remarks, had long besought him to complete and publish "magnum illud opus meum Apodicticum, de Arte nova (ut tu vocas)." This he had hitherto been prevented from doing by a year of illness, "viresque etiam meas, nondum possee tantu sustinere studii laborisqz, onus quantum illud, Herculeum pene (ut perficiatur) requiret opus," and now in anticipation that his labours may bring about his early decease, he appoints Pedro Nunez — with whom, and despite his feud with Finaeus, and the disparaging manner Nunez had spoken of astrology in de Crepusculis, Dee appears to have remained on terms of close friendship — to be his literary executor. As evidence of his industry he gives the titles of eleven works he has composed, "aliorum adhuc tacebo nomina." Two of these, De Nova Navigationum Ratione lib 2 and De Religione Christano lib. 6, do not figure in lists of his writings elsewhere (194). He offers the present work, in order that "Tu ergo qui Naturae observantissimus esse Cultor soles: Naturae in istis Aphorismis, scrutare virtutes verus, virtutes magnas, virtutes paucis vix credibiles Sapientibus, at paucissimus notas." There follows the main body of the text, consisting of 120 "aphorisms," aimed at explaining the basic principles of the operations manifest in the workings of the physical universe.

Dee commences with the affirmation that the initial creation of all things from nothing necessarily occurred in a manner contrary to Reason and Natural Law (I), under whose dominion such creation, or its converse, destruction, of things is not possible (195). But although this is beyond man's power, his science is yet capable of performing great effects: "Mirabiles ergo rerum naturalium Metamorphoses fieri a nobis in rei veritate possent si artificiose naturam urgeremus" (II) (196). In Nature (III) there exists another aspect of its "Esse" besides that which is "conspicua, notaque" which is "quasi seminaliter in naturae latebris, extare Sapientes docere possunt." The manifestations of this, by which it is effective are the rays that are emitted by every entity whatsoever, and fill the universe with their influence "unde omnis locus mundi, radica continet omnium reru in co actu existentium (IV). Both substance and accident give off species, but the former of a more effective kind than the latter "et substantiaru quidem illa quae incorporea & spiritalis est, in hoc munere longe superat illam quae est corporea, ac est fluxis coagmentata elementis," for the more noble an entity the more complete and perfect will be its species (V). Emitted rays differ from one another as the things from which they emanate (VI) but similar rays will produce a diversity of effects according to what it is they are acting upon (VII). Their influence varies with context, their nature, known only through such effects, is not in this sense i.e., regarded as described by the manifest qualities they produce in other entities, absolute in itself

but relational. To act upon something else (VIII) a thing must have some resemblance to it, but also differ from it "aut nulla est actio." Everything therefore in relation to other entities of the universe "ordinem habet & convenientium" (IX) (197). A consideration of this universal interaction which ensures the unity of things separated and permits action at a distance (X) leads to the conclusion that (XI) Mundus iste est quasi lyra, ab excellentissimo quodam artifice concinnata: cuius chordae, sunt huius universitatis res singule, quas qui dextre tangere pulsareque noverit, mirabiles ille eliciet harmonias."(198) It is the general structure of this universal life that conditions the harmonies and the dissonances of the individual strings (XII). The impressions of the senses are not the final cause of even sensible emissions of species, their purpose is more fundamental, the senses are no more than witnesses of these (XIII). Man's mind and spirit are not isolated entities but form an organic part of this total system, they are directly influenced by this immanent radiation, which affects all the senses "& praecipae in spiritu nostro imaginali...& in nos mirabilia agunt" (XIV).

Since the circle (XV) is the patter of perfect eternal motion, and since there is nothing nobler nor earlier created in the natural world than light, "Corporum igitur praestantissimorum et perfectissimorum haec duo maxime propria erunt." Moreover since the mark of existence (XVI) in the universe, a thing's primary and inseparable property, is to be in motion — "quicquid in mundo est, continue movetur aliqua motus specie," and since all motions are interdependent, the controlling and superior source of activity is that of the heavenly bodies (XVII); all other natural motions "et excitantur et ordinatur" by them.

The four elements (199) form the basic constituents of the inferior world. Their effects are said, cryptically, to be principal, secondary and tertiary, and by proceeding by artifice from one to the other men can produce diverse, even contrary results (XVIII) (200). The combinations of the four qualities hot, cold, moist and dry form the true natures by Temperaments or Complexions of all things, which may be discovered by the art of graduation (XIX) (201). "Ex qua elementorum proportione singulie humani Corporis partes, humores, et spiritus constent (qua prope fieri potest) Astrologo est pervidendum." Their potentialities lie in the seed, but their development is prompted and conditioned by the heavenly influences (XXI) "Semen in se potentia nabet generationis cuiusq integru et constantem ordinem: eo quide modo explicandum quo et concipientis loci natura et Circumfusi nobis coeli superuenientes vires cooperando conspirant." All motions in the universe are ultimately awakened by the Primum Mobile as light awakens all the faculties in the mind (XXII).

While preserving a distinction between soul and body, Dee implies that they exist in a symbiotic relation, and even the soul is not exempt from a general system in which the operations of an intelligible causation may be traced; for hence (XXIII) "Medicus per corpus sanat animam atque temperat, Musicus autem per animam corpori medetur et imperat."(202) The powers he attributes to Nature he vividly parallels with the extraordinary properties of lodestone (203) which God has given to man as visible image of the general mechanism in the universe otherwise too subtle to be perceived, which attracts or repels at a distance, projects its "beams" through solid bodies, seeks always a fixed point in the heavens (204) "alias alia euisdem Philosophici lapidis quasi miracula (divino favente Numine) explicaturus." (XXIV)

The stars are like seals imprinting form on primitive matter (but differences in the ease or difficulty of the impressing the relative elegance or lastingness of the result are produced by variations in the matter (XXVI)), by means of rays "alii sensibiles sive luminosi, alii, Secretiores sut Influentiae" which are all penetrating (205) (XXV). Sensible rays can be reflected and refracted, without losing their virtues (XXIX), and the whole system is conceived as finite for the Primum Mobile (XXVIII) Dee compares to a huge concave mirror, reflecting inwards the stellar effluences which are unable to pierce it anywhere — selecting as a proof an argument from a final cause, for although there are other reasons, he writes, the rays do not pierce this since they would be of no use beyond it.

The following sections (XXV-L) consist of an appeal for more and increasingly accurate astronomical observations to be made, in the interests of the philosopher and astrologer to whom it is of the utmost importance to know the true sizes of the stars and planets and their correct distance from the earth at all times; the information it is imperative to secure about the heavenly bodies if their natures and influences are to be properly determined is discussed and Dee touches briefly on the methods for calculating the distances and diameters of the heavenly bodies. One suggestion here foreshadows the tragically futile investigation he later embarked on with Kelly for he asserts "Stella quelibet proprium habet nomen ex ipsius Dei impositione. Sic et naturam in se habet propriam, qualis in nulla alias, eadem omnino invenire potest."(L)(206)

Returning to his general theme Dee asserts (LI) that at any point of space at any instant of

time, the total confluence of rays, which travel in straight lines, is such that it can never be duplicated elsewhere (an absolute individuality is thus attributable to all entities but one nevertheless made up of common factors, mathematically assessable, insofar as the character of a thing results from the affecting rays of which it forms the focal nexus). Natural Magic (LII) can perform more than Nature does unaided, by mechanically disturbing these radiations, for instance Catoptrics (LIII) teaches how to increase, diminish or otherwise modify artificially the stellar effluences (207). Then after discussing the effect of variations in angle on stellar influences and in asserting that "Periodus quascuoz videmus naturae praepotentis inviolabili loge" (LXI) as diligent observers will testify, Dee proceeds to set out a number of definitions of astronomical terms, and to tabulate various factual data (length of the Natural day, the Solar year, etc.) according to the latest values available. (Thus after giving Thebit ben Currat's figures for the length of the year — 365 d. 6h. 9. 20s. — he adds "Copernicus aute aliquanto maioram hoc nostro seculo esse, demonstrauit: per, 20 circiter secunda, scilicet." (203)) His exposition appears to assume the Ptolemaic system since he affirms that the swiftest celestial motion is that which goes round the celestial horizon every 24 hours (LVIII) — Aristotle's cosmic "mechanics," his scheme of the interdependence of all motions in the universe has clear affinities with Dee's general picture in this work — except that the text does not allow one to conclude that Dee regarded the fixed stars as all at a uniform distance from the earth, the reverse is almost hinted at, and hence set in a single sphere — a belief he must anyway have abandoned when he formed his theories of the new star in Cassiopeia in 1572, which theories indeed seem hardly compatible either with the daily revolution of the fixed stars. Dee then warns that what may be directly observable of the stars (LXXIII) are only signs of their true potencies, which are not restricted to their "Motions, Forms and Figures," which we may measure, but other properties and qualities are to be sought out in them of which these are indicative as the invariable accompaniments. In illustration he lists (209) various triadic correspondencies such as Heaven, Earth and the Microcosm (Man); Sun, Gold, and the Heart, which he claims reflect the true structural principles of the universe — a celestial object in each case providing a pattern for the other two.

There follow sections on the various heavenly bodies. The mutual intervals of the fixed stars remain eternally unchanged (LXXV) for on these the stability and perseverance of the whole world depends and Dee argues (LXXCIII) "ab omnibus ergo omnium ordinum fixis, divinissima per coelum distributis harmonia, quantum quasi divinitate simul in terras derivari censendam?" He is very concerned by the question of the retrogressions which seemingly destroy the regularity of the planetary motions by an abrupt change in direction (LXXXVII). He seeks to reconcile this with the universal harmony by a variety of reasonings, to represent it as a merit not a blemish in the celestial economy, and to defend the courses of the planets from the charge of being defective. He does not however invoke Copernicanism to resolve the difficulty, this would not in any case affect the relative positions they assume in regard to the earth in which Dee is from an astrological standpoint perhaps mainly interested here (he concludes that during such periods the tendency of their "influences" must be considered as reversed (210)). The sun is accorded a position of especial dignity "Ut Sol singula coelestia corpora, sua superat magnitudine, sic coelestis luminis quasi fons perennis ac immensus est: calorisqz nobis sensibilis, ac vitalis, praecipuas effector," and since heat and light and motion are the signs of the powers of heavenly bodies, and the sun, exceeds all others by his light (a very different conclusion from Digges's conjectures on the possible magnitude of the stars, but Dee's interests are here "astrologically" orientated) "et Luna proprii motus pernicitate reliquos omnes vincit" (CII), these two are therefore the dominant heavenly influences; "Solem et Lunam omnium in elementali mundo nascentium & vivantium, tum procreationis tum conservationis, praecipuas (post Deum) & vere physicas esse causas...ex his fit, manifestissimum."(CVI)(211)

In conclusion Dee is at pains to point out, in defence of the goodness of creation — and showing the philosophical considerations guiding his physics — that the inaccurately termed "maleficent stars" only draw out, or throw into relief evils (deficiencies) which may be already present in the constitution of what they act upon, "ipsa enim Sidera, perse, nihil operantur mali" (CXII) (212). The central position of the book is reaffirmed "Omnis res quantimoz exiguq in mundo elementorum existens, totius coelestis Harmonie est Effectus; sive exemplu, quodda et imago," (CXIV) directly echoing Alkindi's "Omnis vero res quamvis modice in mundo elementorium agens totius coelestis harmoniae est effectus" (213) — and various calculations are given to exhibit the vast number of the significantly differing planetary conjunction and other aspects, possible, and the whole work is rounded off with two Greek aphorisms, which may be rendered "Did these elemental sympathies not exist, no knowledge would be possible to men: "ut nos Mercurius ille Termaximus docuit" and "It is in these aspects of the Deity, and the emanations

from them that uphold the orderly continuity in naturally occurring things throughout the universe."

Additional light on the theories Dee advocates in this work is provided by one of Jofrancus Offusius', which Dee declares in the Preface to his General and Rare Memorials of 1577 was a direct plagiarism of his position employing without acknowledgement data he had supplied to substantiate this. Dee there prints three letters from Offusius containing requests for information, adding "he being moreover here conversant with, and depending upon this our Bryton Mathematician [i.e., himself] above a whole year." Offusius like Dee was an original and independent practical astronomer and mathematician, like him he had issued his own Ephemeris (in 1557), in which, abandoning the Alphonsine reckoning he had relied largely upon his own system and new observations (214). The de Divina Astrorum facultate, in laruatam Astrologiam of which Dee complains was not published until 1570, at Paris, but its dedication (like that of Dee's Monas it is addressed to the Emperor Maximilian) is dated 1556. Beginning "Pendere haec inferiora e superioribus, illa vero a causa causarum nemine recte Philosophantium dubium esse reor (invictissime rex)," he declares that astrology should have nothing in common with superstitions, blind and occult divinations: "Nostra ars aliud non est, quam ab inspectione operis divini, longa experientia collecta norma et regula, nos incitans ad Opificem ipsum, nu uam satis magnificandum. In qua partim Physice, partum Mathematice procedemus, in dubijs verisimilia amplexantes, speramusque ut etiam scientiae nomine digna in posterum fiat, olim non immerito contempta: nam ante, et si male inspecta, tamen convenians, firma et a ratione non declinans notitia est."(215) He rejects Ptolemaic astrology calling for a new system admitting only "reason" and experience as its foundations — and which would be, in fact, equally compatible with new astronomical theories. He has no faith in predictions made at present, the immediate task as he sees it is the accumulation over a lengthy period of a mass of highly accurate observations of celestial movements and terrestrial changes, which only could serve as a firm basis for the genuine science he hopes astrology may become. Nature he regards as fundamentally geometrical through all its structure and operations, and he devotes his work largely to suggesting methods for the quantitative assessment of the powers exercised by celestial bodies, which he assumes emit the four qualities — themselves, essentially inter-related on the pattern of the regular solids — but in amounts which may be calculated from mathematical consideration of their aspects, elevation, and direction, at any time. The book is full of tabulated, astronomical and physical analyses and data, bearing on this hypothesis direct measurement in the main pre-ponderating over Pythagorean speculation — offering what from this point of view, might well be taken as a supplement, containing the exact scientific and mathematical knowledge underlying Dee's general statement in his Aphorisms.

Dee's work is founded on a doctrine of emanations; a concept frequently given a position of high importance both in metaphysics (as in most "neo-Platonic" systems — as popularised for instance, by "Denys the Areopagite," all creatures achieved their "being" and "nature" from their reception, to varying extent, of God's "super-essential" emanations) and physics and physiology. From a very early period it had proved useful in "explaining" numerous common, but otherwise mysterious phenomena. Empedocles had sought in the action of rays, and the mechanical causation they seemed to allow, an interpretation of sensation. Traces of the theory could be found in the Platonic dialogues — as when "the effluences of existent things" are spoken of, and colour defined as "an affluence of figures commensurate with sight and sensible."(216) It was a necessary assumption if astrology were to be admitted to the ranks of the natural sciences; thus Ptolemy declares, as his starting point that "a certain power emanating from the eternal ethereal substance is dispersed through and permeates the whole region about the earth" (217) (Dee however does not seem ever dogmatically to have accepted the "fifth element" to which Ptolemy refers here as a source of such power, or regarded the celestial emanations as being utterly distinct from those which any other entities of a sub-lunar kind might emit. A recurrent theme for instance of the works of his friend Mizaldus the physician who, quite conventionally regards animal spirits as "ethereal" i.e., of a refined material substance, and similarly it would seem the radiated forces acting upon the world, is that of the harmony, and likeness, between the heavens and the human body, and the measures to be taken for "conciliating" the spirits of the stars and the vital spirits ruling the individual's constitution). It was also common dogma of the alchemists — employed to account for the generation of different metals in the earth (218). The qualities of the magnet which fascinated the attention of Dee — and many others — seemed a confirmatory example of the presence of such unseen radiations for which Light was taken as the visible pattern. In the seventeenth century Thomas Browne still finds it indispensable to complete the theories of natural philosophy but has regretful doubts as to the possibilities of experimental investigation in this sphere: "And truly the doctrine of effluxions, their penetrating natures, their invisible paths and

unsuspected effects are very considerable, for besides this magnetical one of the earth, several effusions there may be from divers other bodies, which invisibly act these parts at any time, and, perhaps through any medium; a part of philosophy but yet in discovery, and will I fear, prove the last leaf to be turned over in the book of nature."(219)

At almost every point parallels and similarities with early or late neo-Platonic writings can be found in Dee's work — in his emphasis on light as the pattern of the radiations that form and maintain the world (220), his exaltation of the sun as the principle single agent, in this half spiritual, half physical scheme (221), his continuous references to "Magic" as an analogy of the world's coherence (222) and so on. The primary source, however, for the world scheme Dee develops in the Aphorisms as also for other aspects of his thought would seem to have been the writings of the 9th century Arab Alkindi (particularly that On Stellar Rays), an important figure in the history of development of neo-Platonic "philosophical science."(223) Alkindi's name was of course frequently conjured with by ignorant astrologers (224) who could have had but little knowledge of his works which remained with a few exceptions unprinted. Many of them had been translated by Gerardus of Cremona, and thereafter circulated fairly widely, the errors of Alkindi on the magic art had been successively condemned at Paris and Oxford in 1348, 1363 and 1376. Pico had cited approvingly the de radiis stellicis and Ramus drew upon the de Aspectibus for his own Optics, while Dee possessed — and had access to others — a number of treatises of Alkindi in MS (225).

Alkindi, beyond all others of his time, would seem to have possessed a profound knowledge of Greek science and philosophy (though it is possible he was only able to read the texts in Syriac versions), he was associated with an important school of translators and was responsible for many Arabic versions, commentaries on, and studies of Hippocrates, Euclid, Ptolemy and a large number of Aristotle's works, including the spurious Theology which introduced the thought of Plotinus in Aristotelian dress, to the Arab world. In his writings he sought, in familiar neo-Platonic fashion to effect an amalgamation of Aristotle's thought with that of Plato; thus in the treatise on the Intelligence and Intelligibles, translated by Gerardus of Cremona, he writes as though they held a single common doctrine on this matter (226) — though the scale of four degrees of knowledge he distinguishes there seems orientated towards a thoroughly Platonic-realist ontology (227). Astrology occupied a large place in his system, for he viewed it as an intrinsic part of philosophy, having intimate relations with physics, mathematics, and metaphysics, all of which contributed to its foundations, and by his treatment, in his day, it has been justly observed, he "fu forse il solo che carcasse di riduire a forma completamente razionale e sistematica i principi e i metodi dell astrologia," (228) Flugel thus summarises his view on predictions "allein wir durfen annehmen dass jene Weissagungen auf wissenschaftlichem Grunde ruhten, in dem aus naturlichen Ursachen naturliche Wirkungen abgeleitat wurden."(229) Or as Naudaeus wrote long before Alkindi though not a Christian was not a "magician" "on the contrary he seems to have no other design in his Books than to referre to Nature whatever was attributed to Angels and Devils."(230)

His primary assumption was that all things in heaven and earth, and this was an inseparable and essential effect of their existence, emitted "forces," susceptible of quantitative analysis but in their effects similar or qualitatively related to their originals — fire, colour, sound were examples of such visible radiation, the action of the magnet (which Dee cites), and the appearance of images in a mirror (which Roger Bacon uses in a similar argument), were examples of the operation of emanations unobservable directly. He adopts as does Bacon and perhaps Dee, the Platonic account of vision (an instance of what seems simply a physiological theory but may almost invariably be taken as symptomatic of more general metaphysical and epistemological views), defending the thesis of the visual ray issuing from the eye, as a necessary factor in "seeing" for the reason that like only responds to like, that the eye is created in imitation of the sun etc. and on the psychological grounds that men need not "notice" things, and never "notice" all of those things, which are materially present in the "possible" visual field, and outer light from which enters the eye (231). These theories of course, as has been noticed, played an important part in magical teachings and indeed the treatise On Stellar Rays in which he most fully developed them and which was widely popular among Renaissance neo-Platonists (232), sometimes passed under the title of The Theory of the Magic Art.

Of these "forces" and of physics generally, he attempted mathematical analysis — a science, which he insisted was necessary to be mastered before any approach was made to logic or philosophy. Nature he held was susceptible of such a treatment for he saw in Euclidean geometry the pattern of physical rationality and simplicity, and "deus...omnia condidit, quae facta sunt, secundum quod perfectius et convenientius fuit."(233) Thus he sets his face against ascribing

hypothetical "qualities" to the various celestial bodies, and building speculations on this basis, for these are only secondary effects apparent in earthly things produced by the position, motion and figures of the asterisms, which are the truly constitutive factors in their nature as agents and can be exactly and mathematically described: so opening a work on meteorological effects consequent upon heavenly change, he lays it down, that it is not proper, as genuine philosophers recognise, ever to say "talis planets in suc ease calidus, aut frigidus, aut humidus, aut sicous, nec talis pars signorum in substantia sua est calida aut frigida, aut humide aut sicca, hec subiecte, generationi vel corruptioni, nec divisioni, nec secudum se faciunt generationem nec corruptionem sed motu suo super epicyclum: directione, et retrogradatione, statione vel elevatione, vel depressione vel elongatione a climatibus quolibet tempore: ot ita viderunt sua corpora fieri maiora et minora causa appropinquationis et elongationis suae a nobis."(234) In his treatise on optics, though experiment and observation play their part he presents the science as one that can be developed and geometrically and deductively. He rejects the Aristotelian position that light is a mere affection of a medium, arguing that since things seem dimmer at a distance and any source of light will illuminate more intensely a smaller space than a large, light must be a "limited substance" (235) and declares that the degree of illumination obtained from any source and the size of the body or space lighted is subject to a fixed law of simple mathematical proportion (236). But he also rejects the pseudo-Euclid's view that the rays are like mathematical lines, and that in consequence small objects might fall between them and remain uneven, he adopts instead the double view that light can at once be treated strictly geometrically as though this were the case, while in fact being a physical and not merely intelligible entity its single rays possess a certain breadth, and thus merge into each other to form a continuum. The form of demonstration to which light could be shown experimentally to be subject, he extended, taking light as a universal pattern of these processes, to cover all varieties of supposed emanations, in a system very close to that reproduced in Dee's aphorisms. It is worth noting that the inspiration of geometry as applied to optics, produced many similar theories among Platonists in the Renaissance, as in the case of Jean de Pene who treats it as a universal protoscience. The view of light as the type of all various emanations which controlled the cosmic processes also had important metaphysical aspects to which Dee was fully attentive, as for example appears in Patrizzi's system with its four elements — "spatium," "lumen," "color" and "fluor" — in which space and light — incorporeal essences — maintain the cohesion and unity of the universe, light being the primal object of knowledge, and which penetrates all things uniting them with God, its original source (Nova de Universis Philosophia in qua Aristotelica Methodo non per motum sed per Lucem et Lumina ad primam causam acenditur). Both Patrizzi's and Dee's thought, have in this respect of course also clear affinities with the cosmology of the cabalists — which represented all things as emanating from Ensoph (the first light) in a descending hierarchy of ten sephiroths, or luminous circles, and four worlds, and in which matter itself is regarded as a crystallisation or condensation of the rays of light and all things in consequence as being essentially spiritual and divine.

The other important single source for the Aphorisms as Burton noticed (237) is Roger Bacon's doctrine of the multiplication of species, which had been taken in part from Alkindi, whom Bacon often praises (though differing from him upon some few points, thus he prefers to follow Alhazen in ascribing to light a finite speed and more immediately perhaps from the teachings of his master Grosseteste who had summed up his whole natural philosophy in his theory of light, which Bacon would seem to have adopted as providing a pattern for the mathematical workings of nature. Grosseteste had exercised considerable influence on the Franciscans in Oxford, where he lectured from 1229-35, and where his doctrine of light as the form of corporeity had become current. Light, which extended to the firmament and expanded owing to its powers of self multiplication he had taken as the active principle in the universe, which endowed passive matter with form, and dimensions, as a consequence all entities whatsoever, he declared in de lineis, anguleis et figuris, threw out particular virtues which acted upon sense or other material objects along geometric lines (238). According to Bacon "Every efficient cause acts by its own forces which it produces in the matter subject to it, as the light of the sun produces its own force in the air....This force is called likeness, image, species, and by many other names....Substance is more productive of it than accident, and spiritual substance than corporeal. This species causes every action in the world, for it acts on sense, on intellect and all the matter in the world for the production of things, because one and the same thing is done by a natural agent in whatsoever it acts because it has no freedom of choice....In those beings that have reason and intellect although they do many things with deliberation and freedom of will yet this action, namely a production of species is natural in them, just as it is in other things. Hence the substance of the soul multiplies its own force in the body and outside the body and any body outside of itself produces its own force,

and the angels move the world by means of forces of this kind...." He records that he "saw a physician made blind while he was endeavouring to cure a patient with disease of the eyes because of the multiplication of the species coming from the eyes of the patient," and instances images in a mirror, as an example of how a species is rendered visible which must nevertheless be presumed to have filled space unobserved between the source and the mirror and the mirror and the eye.

The propagation of species is subject to geometrical treatment it occurs along straight lines (except in animate bodies where "the force of the vital principle regulating the path of the species" compels it to follow the tortuous tracks of the nerves), with an intensity varying according to the angle; it is greatest when arriving perpendicularly "because the perpendicular is shorter and stronger and therefore nature works in a better way in it"; that force is more concentrated along such a path he holds is clear from the observation that a man will die from a perpendicular fall while he can escape all injury if during the fall he can only be diverted from this straight path however near the ground. Some invisible species may penetrate all things as the vision of the lynx, Aristotle and Boethius testify, passes through walls, but they are nonetheless refracted according to the density of the medium, and some may be reflected. This is the opportunity for human science to bend them to its own purposes, as Dee also points out, for "by means of art aiding nature things can be done which the world cannot receive as I shall explain in perspective science," "so Alexander instructed by Aristotle, as the histories state, by means of large polished bodies bent back upon a city the poisonous species of a basilisk placed on the wall to slay the army"; burning mirrors are a further example of such devices.

As extended to astrology the theory has very close affinities with Dee's aphorisms. Every point, Bacon shows in a diagram, can be represented as the apex of a series of pyramids of forces having as their bases the extent of the agents from which these emanate. Bacon affirms that from a general analysis of natural causes into "reciprocal influences of forces, as of light and other agents....it can be shown that nothing within the range of things can be known without the power of geometry," and lays it down that "a mathematical quantity and a physical one are the same as regards being and regards reality but they differ only in the point of view"; and, summarising his whole theory, "By these principles and the like given by means of geometry a man can verify every action of nature because every truth in regard to the action of an agent in a medium or in matter in general, or on celestial bodies and on the whole machine of the world is derived mediately or immediately from the principles just stated."(239)

One further influence should perhaps be mentioned here, though it is perhaps of less importance as regards the Aphorisms, than as providing another element in the background of Dee's thought contributed by the writings of those of his forerunners he chiefly studied. This is the writings of Urso which besides their importance for Dee, are in themselves striking illustration of how attempts could be made by platonists to impose their particular rational scheme even on such apparently unpromising fields as medical science. Dee in the preface to General and Rare Memorials speaking of the Aphorisms — the "Chief Crop and Roote, of Ten yeres his first Outlandish and Homish Studies and exercises Philosophicall," lists a number of persons, Mercator, Alkabitius, Urso from whom "more envious and spitefull false devisers" have since then accused him of having stolen them. Later he addressed a long Latin letter to Camden again chiefly to rebut the charge which he seems to have felt acutely, raised by Robert Turner of Oxford that his work was a plagiarism of the de Elementarum ca mixtionibus and the Aphorisms of Urso (240). The accusation as regards Dee's present work is rather insubstantial, but Dee was nevertheless well acquainted with, and not unaffected by the treatises of Urso generally (241).

Urso (242) who flourished at Salerno — which had perhaps enjoyed an uninterrupted tradition of Greek medicine from classic times, and had from the ninth century been a centre for medical science and the dissemination of translations of Arabic and Greek texts, has been described as "the most important contributor of twelfth century Salerno, and perhaps of the Salerno school in general to philosophical literature."(243) Though his writings evidence knowledge of various works of Aristotle it is Plato who is his professed master and whom he describes as "summus philosophorum" (244). He propounds theories of the possibility of the mind's ascent to God, of an intellectual realm paralleling the natural world in which spiritual faculties act, though these also can produce direct effect upon bodily things, stresses in his physiology and theory of knowledge the active part played by the soul (245) and develops a "rational" theory of magical incantations, which he believes to be of great utility in medicine, from theories, of a type previously discussed, of the necessary link between the word and the thing, in connection with which he treats of the relations between different languages, and argues from the example of the effects produced by rhetoric, that words act directly on the soul which in turn will produce changes in the bodily condition (246). His well developed natural philosophy was designed principally to be of service

to medical theory and practise where his specialist interest lay. He stresses the necessary connection between theory and experience, these being but different aspects of a single reality, and at frequent points draws upon observation and experiment to support his deductions. His writings, particularly his Aphorisms, offer a thoroughgoing attempt to give in some respects exact meanings based on operations or verifiable observation to many commonly loosely employed concepts in the sciences.

Of his book of 169 Aphorisms, with extensive glossulae he writes "weil ich von gewissen verborgenen Dingen nur sehr wenig in lateinischen Schriften fand, sodass man sich daven keine ausreichande Erklarung beschaffen kann, schreibe, ich weiter das Buchlein von den "Aphorismen" womit fur geheime and verborgene Dinge ein neuer Ratgeber (conciliator) erscheinen soll."(247) All things, he holds, are at once active and passive, "aktiv wie die Natur passiv wie die Substanz," the degree possessed by anything, its energy, by which it controls the relatively more inert, is a result of the degree of "motion" it has in itself or is capable of attaining, of which he distinguishes six types (248). Rejecting the Aristotelian position that the four elements cannot be analysed into anything further different in kind (249) he resolves these into combinations of the four qualities (from an examination of which he hopes to come to an understanding of all diseases and their therapies), resolving all these in turn into different varieties of motions, in a primary undifferentiated matter, with regard to some centre, on which depend, and from the knowledge of which motions he thinks may be deduced, all the observable qualitative effects of heat, cold, moisture and dryness (250). As all things are built up from these he offers a general picture of the world in which "alles ist Bewegung" and this "in mechanistische Sinn."(251) He applies his views to astrology, though not in great detail, deriving the effects of the stars from the motions they communicate by radiating forces, to the sublunar world, but his treatment though not in opposition or radically different to Dee's can hardly in itself have served the latter as a text to build his work upon (252), though in many other respects his importance for such a neo-Platonic philosophy of nature as Dee attempted to evolve is obvious. Unfortunately however practically nothing, beyond the fact of his deep interest in it, that he occasionally practised it, and seems to have been preoccupied specially with Paracelsus' theories, is known of Dee's views on medicine, where the direct influence of Urso might be expected to be most clearly apparent.

In conclusion then, Dee's little work is of a kind that might be held to say a great deal or practically nothing at all according to the area of significant connotation and reference allowed to the concepts out of which he chose to build his cosmology. In its day it was fairly widely known — an indication of this is the many charges of plagiarism Dee mentions as brought against it — though it was overshadowed, publicly and perhaps in Dee's own estimation by his later Monas Hieroglyphicas — (253) a work at once more needlessly obscure and less useful in its possible applications. The work is perhaps best regarded as an honest attempt by a practising scientist, who was also something of a philosopher, to give an ordered account of the total operations of the universe, as known by or deducible from accepted observations, in terms of the most general, simple and uniform concepts available. Similar essays, offering contemporarily satisfactory syntheses have appeared in all ages and it does not compare unfavourably with many of these; its terminology and assumptions have little enough meaning today for the philosophy from which they derive and which in their day lent them validity as "explanation," is extinct, but it is no more a work of pure imagination than are perhaps even its modern equivalents. The structure of the cosmos as Dee revealed it is of an admirably severe, and stark, simplicity, in the general outlines, and one which in many of its details he believed was susceptible of verification by rationally directed quantitative experiment, his claim that all things, particularly the "emanations," are to some extent "spiritual," does not lead him to regard their manner of acting as any the less describable on purely "mechanical" principles (rather he sees in the "mechanism" a manifestation of the "order" that derives from God), while it allows him to posit a closer two-way interaction between body and soul, than a more rigid dualism could tolerate. A guiding principle of his work (and significantly it is one that pervasively informs the Platonic dialectic) is that the essences of things are not primary elements but have structures that can be explicated. He sets out to seek for more uniform more intelligible factors in nature than could be obtained by accepting the world as it presents itself, as a farrago of coexisting, conflicting, sense-experienced qualities, or by merely examining these same elements as they were rearranged but not fundamentally altered nor their confusing diversity much diminished in a conventional Aristotelian picture. Dee might well feel that the handful of ultimate unanalysed "essences" and "virtues" he was left with at the end — as emitted by the various planets — still represented a gain in simplicity, for they were limited in number, propagated in identical manner, and their combinations and varying intensities, producing all diverse phenomenal effects, could, he seems to have believed, be mathematically represented. (He seems aware that

only loosely could qualities be directly ascribed to the planets — that Saturn might be said to be cold, dry, and melancholy only because the incursion of its species might be observed as usually associated with an increase of frigidity and siccity in natural objects and of black bile in men, but that these were only the secondary apparent effects of a more fundamental interaction between the planetary species and the recipient, and all that could be certainly predicated of the planets and their emanations were those factors which could be directly measured — aspects, distance, direction — which would vary exactly as their effects, and could be taken as indications of the type and degree of their more occult virtues and the apparent results of these). For its time, certainly for Dee and others of a similar bent of mind, the scheme exposed in the Aphorisms could claim to function as a satisfactory mental framework for the consideration of nature, theologically and scientifically unobjectionable, offering encouragement and no obstruction to experimental investigations, features which might justly render any work worthy of considerable praise.