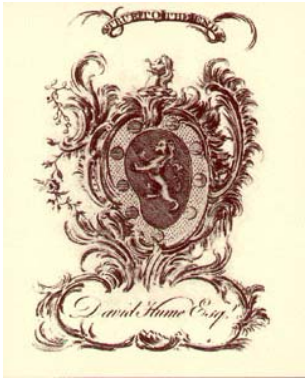

Hume's Interest in Newton and Science
James E. Force
Hume Studies Volume XIII, Number 2 (November, 1987) 166 - 216.

HUME'S INTEREST IN NEWTON AND SCIENCE

Many writers have been forced to examine -- in their treatments of Hume's knowledge of and acquaintance with scientific theories of his day -- the related questions of Hume's knowledge of and acquaintance with Isaac Newton and of the nature and extent of Newtonian influences upon Hume's thinking. Most have concluded that -- in some sense -- Hume was acquainted with and influenced by Newton's thought in particular and scientific thought in general.[1]

The genesis of this paper is the recent point of view put forward by Peter Jones which challenges the many permutations of this almost ritualistic standard line by removing Hume entirely from the Newtonian and the scientific scenes of thought. Jones argues that Hume knew less about Newton and science, and needed to know less about Newton and science,[2] than he believes is required by the above interpretation. Indeed, Jones argues that Hume's fundamental assumptions, which, according to Jones, derive ultimately from a form of Ciceronian humanism, drive a "wedge" between Newton's thought and that of Hume.[3] Even Hume's introductory remarks in the Treatise about his universal "science of man" are, for Jones, a declaration of independence from the materialistic trend (as Jones sees it) of Newtonian science[4] and not, as so many commentators have maintained -- however tenuously or strongly -- evidence for linkage of Hume's project with Newtonian or scientific thought.[5]

Jones baldly argues that Hume totally lacked interest in science in general and in Newton and Newtonian science in particular. Following J.H. Burton's observation that Hume's work is surprisingly free from the "opinions" of contemporary scientists,

Jones states there is no evidence that Hume ever studied science at the University of Edinburgh or that he "pursued" scientific studies of any formal sort.[6] Regarding Newtonian scientific thought, he emphasizes the paucity of specifically Newtonian scientific textbooks in the early eighteenth century which might have been available for Hume to study[7] and argues that nowhere in Hume's writings is there evidence of precise and detailed knowledge of Newton's science beyond what is available in Chamber's Cyclopaedia.[8] Jones acknowledges that, in the Introduction to the Treatise, Hume utilizes a "general version" of Newton's "Regulae Philosophandi" from the beginning of Book III of Newton's Principia. Nevertheless, in Jones' view, Hume's fundamentally humanistic orientation separates him completely from any Newtonian influence.[9] Finally, according to Jones, Hume does not betray the least bit of knowledge of Newton's mathematics and its role in Newton's experimental methodology.[10] On this evidence Jones grounds his central claim of Hume's "total lack of interest in contemporary science."[11]

What references there are to Newton and to science in Hume's works Jones finds "traceable to essentially literary predecessors such as Fontenelle or Montesquieu, or to standard works of theologians or free-thinkers."[12] The absence of clearly direct references to what Jones feels are scientific works results both from Hume's "total lack of interest in science" and from his commitment to a form of Ciceronian humanism which is "inimical" to what Jones finds to be the obvious materialistic tendencies of science in the early modern period.[13]

Jones' account of the Ciceronian and French contexts of Hume's thought is excellent. But his claim that Hume had no interest whatsoever in science

is simply too strong and finally forces us to view science in Hume's day as equivalent to science in our own time, a manifestly anachronistic point of view. Throughout this paper, my argument will be conditioned by my view that Hume's interest in science cannot be separated from his epistemology or his religious scepticism. Hume's interest in science was precisely that of a man of letters of the eighteenth century vitally engaged in determining the proper use of scientific methodology in establishing the limits of the secular science of man once it has been freed from the fetters of theology.[14] Hume's interest in theological and epistemological issues inevitably gave rise to a strong interest on his part in the science of his day and in Newton's contributions to it. Hume came at the end of great sixteenth- and seventeenth-century traditions of secular theologians such as Galileo, Descartes, and Newton, who believed that the new science rendered the traditional modes of theologizing obsolete. In Hume's case, it also renders the entire pursuit empty and vain.[15]

My project is to show that Hume was indeed interested in science and that he did in fact utilize precise, possibly even direct, knowledge of Newton and other contemporary commentators on science in his attacks upon the characteristic synthesis of science and religion which marked his era. Hume's use of these materials in his religious scepticism and also in his "science of man" shows that his interest is an abiding one as important in his intellectual makeup as any other tradition, including the Ciceronian and French background to his thinking. That Hume's sort of scientific interest (and his sort of science) bears no relationship to what an employee at the Cavendish Laboratory would call scientific is no

reason to treat it as not truly scientific, not serious somehow, or as evidence for both a "total lack of interest in science" on the one hand and for the absolute centrality of some other tradition or traditions in the background of Hume's philosophical development on the other.

I attempt to establish Hume's interest in science in the following three sections of this paper. The first section is a straightforward marshalling of Hume's eleven direct references to Newton in his published works. Hume is his own best spokesman regarding his interest in and knowledge of Newton and I have quoted these passages at length.

The second section is more speculative. In it, I attempt to show that one much overlooked aspect of Hume's attack on the design argument in the Dialogues (in Part Two) may possibly be a direct reference to Newton's Principia.

The third and last section is an extremely brief attempt to sketch the wider aspect of the scientific scene of thought in the 1720s, 30s, and 40s and to show, from this survey, that the doing of science at this time is inextricably bound up with religious philosophizing. The establishment of this point does much to correct the anachronistic view that science then is the same as science now and consequently to illustrate the nature of Hume's interest in science.

I. Hume and Newton

To ascertain what Hume knew of Newton and how he used this knowledge, it is first necessary to array the eleven direct references to Newton in Hume's writings in a roughly chronological order.

(1) From the Treatise, published in 1740:[16]

> As long as we confine our speculations to the appearances of objects to our senses, without entering into disquisitions concerning their real nature and operations, we are safe from all difficulties, and can never be embarrass'd by any question.
>
> ...
>
> If we carry our enquiry beyond the appearances of objects to the senses, I am afraid, that most of our conclusions will be full of scepticism and uncertainty. Thus if it be ask'd, whether or not the invisible and intangible distance be always full of body, or of something that by an improvement of our organs might become visible or tangible, I must acknowledge, that I find no very decisive arguments on either side; tho' I am inclin'd to the contrary opinion, as being more suitable to vulgar and popular notions. If the Newtonian philosophy be rightly understood, it will be found to mean no more. A vacuum is asserted: That is, bodies are said to be plac'd after such a manner, as to receive bodies betwixt them, without impulsion or penetration. The real nature of this position of bodies is unknown. We are only acquainted with its effects on the senses, and its power of receiving body. Nothing is more suitable to that philosophy, than a modest scepticism to a certain degree, and a fair confession of ignorance in subjects, that exceed all human capacity.

(2) From "Of the Middle Station of Life,"[17] an essay which appeared in the 1742 edition of the Essays and which was then withdrawn from publication:

> Were we to distinguish the Ranks of Men by the Genius and Capacity more than by their Virtue and Usefulness to the Public, great Philosophers wou'd certainly challenge the first Rank, and must be plac'd at the Top of human Kind. So rare is this Char-

> acter, that, perhaps, there has not, as yet, been above two in the World, who can lay a just Claim to it. At least, Galilaeo and Newton seem to me so far to excel all the rest, that I cannot admit any other into the same Class with them.

(3) From "Of the Rise and Progress of the Arts and Sciences,"[18] an essay first published in 1742:

> What checked the progress of the CARTESIAN philosophy, to which the FRENCH nation shewed such a strong propensity towards the end of the last century, but the opposition made to it by the other nations of Europe, who soon discovered the weak sides of that philosophy? The severest scrutiny, which NEWTON'S theory has undergone, proceeded not from his own countrymen, but from foreigners; and if it can overcome the obstacles, which it meets with at present in all parts of Europe, it will probably go down triumphant to the latest posterity.

(4) From A Letter from a Gentleman to his friend in Edinburgh, published in 1745:[19]

> No one, till Des Cartes and Malebranche, ever entertained an Opinion that Matter had no Force either primary or secondary, and independent or concurrent, and could not so much as properly be called an Instrument in the Hands of the Deity, to serve any of the Purposes of Providence. These Philosophers last-mentioned substituted the Notion of occasional Causes, by which it was asserted that a Billiard Ball did not move another by its Impulse, but was only the Occasion why the Deity, in pursuance of general Laws, bestowed Motion on the second Ball. But tho' this Opinion be very innocent, it never gained as too much contrary to received popular Opinions, and too little supported by Philosophical Arguments, ever to be admitted as any thing but a mere Hypothesis. Cudworth, Lock, and Clark make little or no mention of

> it. Sir Isaac Newton (tho' some of his Followers have taken a different Turn of thinking) plainly rejects it, but substituting the Hypothesis of an Aetheral Fluid, not the immediate Volition of the Deity, as the Cause of Attraction. And, in short, this has been a Dispute left entirely to the Arguments of Philosophers, and in which Religion has never been supposed to be in the least concerned.

(5) From the Enquiry Concerning Human Understanding,[20] published in 1748:

> I need not examine the vis inertiae which is so much talked of in the new philosophy, and which is ascribed to matter. We find by experience, that a body at rest or in motion continues for ever in its present state, till put from it by some new cause; and that a body impelled takes as much motion from the impelling body as it acquires itself. These are facts. When we call this a vis inertiae, we only mark these facts, without pretending to have any idea of the inert power; in the same manner as when we talk of gravity, we mean certain effects, without comprehending that active power. It was never the meaning of Sir ISAAC NEWTON to rob second causes of all force or energy; though some of his followers have endeavoured to establish that theory upon his authority. On the contrary, that great philosopher had recourse to an etherial active fluid to explain his universal attraction; though he was so cautious as to allow, that it was a mere hypothesis, not to be insisted on, withoiut more experiments.

(6) From An Enquiry Concerning the Principles of Morals, published in 1751:

> Thus we seem, upon the whole, to have attained a knowledge of the force of that principle here insisted on, and can determine what degree of esteem or moral approbation may result from reflections on public interest and utility. The necessity of justice to

> the support of society is the sole foundation of that virtue; and since no moral excellence is more highly esteemed, we may conclude that this circumstance of usefulness has, in general, the strongest energy, and most entire command over our sentiments. It must, therefore, be the source of a considerable part of the merit ascribed to humanity, benevolence, friendship, public spirit, and other social virtues of that stamp; as it is the sole source of the moral approbation paid to fidelity, justice, veracity, integrity, and those other estimable and useful qualities and principles. It is entirely agreeable to the rules of philosophy, and even of common reason; where any principle has been found to have a great force and energy in one instance, to ascribe to it a like energy in all similar instances. This indeed is Newton's chief rule of philosophizing.[1]
>
> [1] Principia, Lib. iii. (E 203-204)[21]

(7) In the spring of 1751, Hume's brother, the 42-year-old bachelor, John Hume of Ninewells, married Agnes Carre of Cavers, the daughter of another border laird. This letter from Hume to his cousin, Mrs. Dysart, refers to that event:[22]

> Our Friend [John Hume], at last, pluckt up a resolution, & has ventur'd on that dangerous encounter. He went off on Monday morning; and this is the first action of his life, wherein he has engag'd himself without being able to compute exactly the consequences. But what Arithmetic will serve to fix the proportion betwixt good & bad Wives, & rate the different classes of each? Sir Isaac Newton himself, who cou'd measure the courses of the Planets, and weigh the Earth as in a pair of scales, even he had not Algebra enough to reduce that amiable Part of

> our species to a just equation: and they are the only heavenly bodies, whose orbits are yet uncertain.

(8) From the Dialogues concerning Natural Religion, Part 3. Though not published until 1779, both Norman Kemp-Smith and M.A. Stewart have concluded that this section of the Dialogues was finished by 1751:[23]

> CLEANTHES: In reality, would not a man be ridiculous, who pretended to reject NEWTON'S explication of the wonderful phenomenon of the rainbow, because that explication gives a minute anatomy of the rays of light; a subject, forsooth, too refined for human comprehension?

(9) From The History of England, published in 1754:[24]

> That James was a middling writer may be allowed: that he was a contemptible one, can by no means be admitted. Whoever will read his Basilicon Doron, particularly the last two books, the true law of free monarchies, his answer to cardinal Perron, and almost all his speeches and messages to parliament, wil confess him to have possessed no mean genius. If he wrote concerning witches and apparitions; who in that age, did not admit the reality of these fictitious beings? If he has composed a commentary on the Revelations, and proved the pope to be antichrist; may not a similar reproach be extended to the famous writer Napier; and even to Newton, at a time when learning was much more advanced than during the reign of James? From the grossness of its superstitions, we may infer the ignorance of an age; but never should pronounce concerning the folly of an individual, from his admitting popular errors, consecrated by the appearance of religion.

(10) From The History of England, published in 1756:[25]

In 1677, the old law for burning heretics was repealed; a prudent measure, while the nation was in continual dread of the return of popery.

Amidst the thick cloud of bigotry and ignorance, which overspread the nation, during the commonwealth and protectorship, there were a few sedate philosophers, who, in the retirement of Oxford, cultivated their reason, and established conferences for the mutual communication of their discoveries in physics and geometry. Wilkins, a clergyman, who had married Cromwel's sister, and was afterwards bishop of Chester, promoted these philosophical conversations. Immediately after the restoration, these men procured a patent, and having enlarged their number, were denominated Royal Society. But this patent was all they obtained from the king. Though Charles was a lover of the sciences, particularly chymistry and mechanics; he animated them by his example alone, not by his bounty. His craving courtiers and mistresses, by whom he was perpetually surrounded, engrossed all his expence, and left him neither money nor attention for literary merit. His contemporary, Lewis, who fell short of the king's genius and knowledge in this particular, much exceeded him in liberality. Besides pensions conferred on learned men throughout all Europe, his academies were directed by rules and supported by salaries: A generosity which does great honour to his memory; and, in the eyes of all the ingenious part of mankind, will be esteemed an atonement for many of the errors of his reign. We may be surprized, that this example should not be more followed by princes; since it is certain that that bounty, so extensive, so beneficial, and so much celebrated, cost not this monarch so great a sum as is often conferred on one useless overgrown favourite or courtier.

But though the French academy of sciences was directed, encouraged and supported by the sovereign, there arose in England some men of superior genius who were more than sufficient to cast the balance, and who drew on themselves and on their native country the regard and attention of Europe. Besides Wilkins, Wren, Wallis, eminent mathematicians, Hooke, an accurate observer by microscopes, and Sydenham, the restorer of true physic; there flourished during this period a Boyle and a Newton; men who trod with cautious, and therefore the more secure steps, the only road which leads to true philosophy.

Boyle improved the pneumatic engine invented by Otto Guericke, and was thereby enabled to make several new and curious experiments on the air, as well as on other bodies: His chemistry is much admired by those who are acquainted with that art: His hydrostatics contain a greater measure of reasoning and invention with experiment than any other of his works; but his reasoning is still remote from that boldness and temerity which had led astray so many philosophers. Boyle was a great partizan of the mechanical philosophy; a theory, which, by discovering some of the secrets of nature, and allowing us to imagine the rest, is so agreeable to the natural vanity and curiosity of men. He died in 1691, aged 65.

In Newton this island may boast of having produced the greatest and rarest genius that ever arose for the ornament and instruction of the species. Cautious in admitting no principles but such as were founded on experiment; but resolute to adopt every such principle, however new or unusual: From modesty, ignorant of his superiority above the rest of mankind; and thence, less careful to accomodate his reasonings to common apprehensions: More anxious to merit than to acquire fame: He was, from

> these causes, long unknown to the world; but his reputation at last broke out with a lustre, which scarcely any writer, during his own life-time, had ever before attained. While Newton seemed to draw off the veil from some of the mysteries of nature, he shewed at the same time the imperfections of the mechanical philosophy; and thereby restored her ultimate secrets to that obscurity in which they ever did and ever will remain. He died in 1727, aged 85.

(11) From The Natural History of Religion, published in 1757:[26]

> It is for the same reason, I maintain, that Newton, Locke, Clarke, etc. being Arians or Socinians, were very sincere in the creed they profest: And I always oppose this argument to some libertines, who will needs have it, that it was impossible, but that these philosophers must have been hypocrites.

It is true that in none of these texts does Hume discuss any of the earth-shattering mechanical propositions of the Principia. But whatever these texts may or may not indicate about Hume's knowledge of Newton's mathematics and mechanics, they reveal emphatically that he is interested in Newton's contributions to the science of his day. His interest is clearly to enlist Newton's methodological principles, the famous "Rules of Reasoning," for his own philosophical enterprise of establishing the limits of human understanding in his own new "science of man." Hume also makes clear that many of Newton's followers go beyond the strictures of the "Rules" in their explanations regarding the vacuum, second causes, and God as a causal agent; Newton's "Rules" rightly limit enquiry into the "hidden springs and principles," the "ultimate secrets" of nature, and Hume unbashfully claims to understand Newton on this

point better than Newton's followers. Hume firmly emphasizes that Newton's religious heterodoxy is both sincere and chiefly due to the defects and ignorance of Newton's historical era which influenced his theological enthusiasm for such doctrines as millennialism. Hume also makes clear that this particular aspect of Newton's thought is distasteful to him because it goes beyond the boundaries of decent scepticism. Finally, Hume's understanding of and appreciation for Newton's reputation, which Hume regards as the righteous consequence of Newton's modest scientific methodology, is evident.

These texts speak eloquently to Hume's interest in Newton's thought. On the question of Hume's interest in Newton it does not matter that Hume writes nothing of conic sections or the lunar apogee and that he may possibly have learned what he does know about Newton's ideas from other, even literary or theological, sources. Like Boyle, Hume often speaks with the vulgar while he thinks with the learned. Hume is an eighteenth-century man of letters attempting to understand the limits of knowledge and, in so far as the problem of science is the problem of what one can know about unobservable mechanisms, his interest is riveted upon Newton whom he sees as a great ally in the cause of moderate scepticism.

II. Hume's Use of Newton's "Rules of Reasoning" in his Criticism of the Design Argument

Hume's interest in what one can know about unobservable mechanisms in the physical world of nature, and his intense admiration for Newton's "Rules" in this regard, carries over into his religious scepticism which quite possibly may be, in

part, a brilliant application of Newton's own "Rules of Reasoning" to an aspect of his criticism of the design argument. It even seems possible that Hume may derive his understanding of Newton's "Rules" from his own direct reading of Newton's text.

Hume's manner of referring to authors whom he has read and pillaged is not often a direct footnote (such as in the footnote to Newton's "chief rule of philosophizing" in the Principia cited above from the second Enquiry). It is virtually impossible to catch all the echoes of other writers' words and phrasings as Hume assimilates, recasts, and transforms them in the forge of his genius. Such echoes to other works abound in his works, but loom especially in the Dialogues.

In the Dialogues, Hume, through his spokesman, Philo, repeats for the sake of clarity that the underlying principle of the design argument is the proposition that "Like Effects prove Like Causes. (D 165) The mainspring of the argument as stated by both Cleanthes and Philo is in fact a close paraphrase, almost a direct quote, of Newton's second "Rule" of reasoning concerning the principle of uniformity with respect to causes.[27] The Newtonian philosopher, William Whiston, who follows Bentley, Newton, and Hume himself in grounding the design argument upon this "Rule" states that this "Rule" is so "clear, natural, obvious, and sure," that it is grasped "without occasion for a tutor to instruct us in it at first, or for a Logician to improve us in it afterward."[28]

Hume does not attack this "Rule" of reasoning. His first move is to attack, beginning in Part 2, the instantiation of this rule for the purposes of the design argument. Hume argues that the works of man do not closely resemble the works of

nature. The balance of the Dialogues is largely devoted to offering possible alternative analogies or models which may possibly, sometimes even plausibly, account for the observed order in our every day experience.

His second move is more intriguing. He attacks the improper understanding of the second "Rule" on the part of Newtonian design theists (including Newton) in a distinctive and highly ironic fashion which suggests that Hume may have derived his own understanding of Newtonian methodology from a close and direct reading of this section of the Principia.

Philo initiates this aspect of his attack when he states, in Part 2, that "A very small part of this great system, during a very short time, is very imperfectly discovered to us: And do we thence pronounce decisively concerning the origin of the whole?" (D 149) Hume makes this second objection again and again: "But can a conclusion, with any propriety, be transferred from parts to the whole?" (D 147); or, finally, "And will any man tell me with a serious countenance, that an orderly universe must arise from some thought and art, like the human; because we have experience of it? To ascertain this reasoning, it were requisite, that we had experience of the origin of worlds...." (D 149-50)

The first three of Newton's "Rules of Reasoning" must be read in the light of Newton's crucial fourth "Rule":

> In experimental philosophy we are to look upon propositions inferred by general induction from phaenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phaenomena occur, by which they may either be made more accurate, or liable to exceptions.

> This rule we must follow that the argument of induction may not be evaded by hypotheses.[29]

This rule qualifies the first three. According to Rule 4 every inference from experience, no matter how general or clearly derived from past experience, is fallible and corrigible and must be continually subjected to experimental verification, i.e., to the test of experience. Experience, especially in science, is the ultimate test. Without the limiting Rule 4, Rule 1 (the principle of simplicity) and Rules 2 and 3 (variations of the principle of uniformity) may be read as a priori or "imagined" hypotheses which "evade" the test of experience.[30]

In the Dialogues, the point of Hume's seemingly innocent queries about the apparent inadequacy of reasoning from the part to the whole is that all design theorists -- Newton and Newton's followers alike -- read the second "Rule," "Like Effects prove Like Causes," as a hypothetical, a priori assumption or hypothesis about the nature of the universe. Newton and other design theorists, in their assertions regarding the design analogy and without any direct empirical experience, feign the metaphysical hypothesis that nature will continue to be found to be uniform with respect to causes. Hume argues simply that the part cannot be made the rule for the whole in advance of experience of the whole.

In the first Enquiry discussion of the problem of induction, Hume makes clear the logical basis for the difficulty encountered by this aspect of the design inference. He writes:

> When a man says, I have found, in all past instances, such sensible qualities conjoined with secret powers: And when he says, Similar sensible qualities will always be

> conjoined with similar secret powers, he is not guilty of a tautology, nor are these propositions in any respect the same. You say that the one proposition is an inference from the other. But you must confess that the inference is not intuitive; neither is it demonstrative: Of what nature is it, then? To say it is experimental, is begging the question. For all inferences from experience suppose, as their foundation, that the future will resemble the past, and that similar powers will be conjoined with similar sensible qualities. If there be any suspicion that the course of nature may change, and that the past may be no rule for the future, all experience becomes useless, and can give rise to no inference or conclusion. (E 37-38)

As Hume remarks slightly earlier in his discussion, "Where is the medium ... which join propositions so very wide of each other?" (E 37) In the case of the design inference, the demonstration of a causal deity of the whole of creation of a particular sort relies on a "medium" which we must forever lack. We must have a complete and perfect sample of experience to make such an inference, not, as with the Newtonian design theorists, only the a priori assumption that, as in the past, so, too in the future, "Like Effects will prove Like Causes." As Hume states in Part 2 of the Dialogues, "To ascertain this reasoning, it were requisite, that we had experience of the origin of worlds" as well as experience of the totality of creation. Hume argues that

> ...when we look beyond human affairs and the properties of the surrounding bodies: When we carry our speculations into the two eternities, before and after the present state of things; into the creation and formation of the universe; the existence and properties of spirits; the powers and operations of one universal spirit, existing without beginning

> and without end; omnipotent, omniscient, immutable, infinite, and incomprehensible: We must be far removed from the smallest tendency to scepticism not to be apprehensive, that we have here got quite beyond the reach of our faculties. (D 134-35)

For Hume and for Newton it is perfectly acceptable to reason from the part to the whole so long as the scientist or design theorist recognizes that such reasoning is fallible and corrigible and has the ontological status of a regulative hypothesis adopted as a methodological assumption only and which is always subject to the checks and revisions of future experience. Hume, in text (10) cited above, explains that Newton is a greater natural philosopher than Boyle because he puts the "imaginary" mechanical philosophy back into the bottle by cautiously refusing to countenance any "principles but such as were founded on experiments" thereby restoring Nature's "ultimate secrets to that obscurity in which they ever did and ever will remain." For Hume, all design theorists, including Newton, go wrong when they forget this crucial and cautious procedure and, in their inferences concerning the nature of the deity, read Rule 2 without the governing, regulative Rule 4. This is precisely what Hume says of Newton's followers in his direct references to them quoted at length above (see, especially, text (5)) and, in his design argument, Newton is himself guilty of the same thing.

Hume thus cautiously applauds Galileo's own proper limitation of inductive inferences in the Dialogues. Only after the observations of the telescope "enabled us to extend the same arguments and phenomena from one to the other," (D 151) does Galileo conclude that the substance of the earth is

similar to or analogous with that of the earth. For Hume, it really doesn't matter how much apparent evidence of design and order is turned up by all the new sciences because that catalog can never be complete. But design theorists read that catalog in a false light by assuming that the future course of experience will continue to show that Like Effects prove Like Causes. But Rule 2 is not the rule for the whole of creation in advance of empirical experiments. Instead, it is, as Rule 4 dictates, merely a regulative principle intended to guide future enquiry after the manner of Newton's utilization of the "hypothesis" (in the non-pejorative sense of the term because it is understood in the light of Rule 4) of an "Aetheral Fluid" to account, possibly, should experiments confirm it, for action at a distance.[31] (See texts (3) and (4) above.)

I do not argue that Hume necessarily derives his view concerning the limitations of the argument from induction from his reading of Newton's fourth "Rule" of reasoning. But, I do believe that his criticism of this aspect of the design argument in Part 2 of the Dialogues is a self-conscious and resounding echo to this part of the Principia. I now want to try to show the plausibility for the view that Hume's understanding of the regulative function of Rule 4 possibly derives from his own close reading of this part of the Principia. This part of my argument is limited by my knowledge of the sources from which Hume may possibly have read this interpretation of Rule 4 in the same way that the design argument is limited by our finite human experience of creation: my experience is not complete or perfect. Jones emphasizes the paucity of Newtonian textbooks and commentaries when he argues that nowhere in Hume's writings is there evidence of a precise and

detailed knowledge of Newton beyond what is available in Chamber's Cyclopaedia. The opposite is more nearly the case. I.B. Cohen and A. Koyré once proposed a history of the commentaries on the Principia and abandoned the project when they realized that it would necessitate a book of some "1,500-2,400 pages of small type."[32] I do not pretend to have the knowledge of all of the commentaries on the Principia necessary to claim that Hume's understanding of the proper way of reading Rule 4 stems from his direct reading of the Principia itself, but I think it quite likely that this is the case.

First, in fairness to Jones, I think that Hume was familiar with Chamber's article on "Newtonian Philosophy." This article is probably the source for Hume's remark in text (2) above concerning the slow progress abroad of Newton's thought as well as, perhaps, for Hume's knowledge of gravitation which is what the bulk of the three folio columns of the article addresses under the heading of "the new principles which Sir Isaac Newton has brought into philosophy."[33] But Chamber's article does not once mention Newton's "Rules of Reasoning."

Are there any Newtonian textbooks or commentaries which do refer to Newton's "Rules" and especially to the proper way to interpret the crucial Rule 4? At this point, it is necessary to give an account of the development of the famous "Regulae Philosophandi" with which Newton begins Book III of the Principia.[34] Newton writes the crucial fourth Rule only for the third edition of the Principia published in 1726 under the editorship of Henry Pemberton. Naturally enough, none of the commentaries on the first two editions of the Principia, such as those by David Gregory,[35] or John Keill,[36] can therefore mention this crucial "Rule."

Commentaries on the third edition after 1726 such as those by John Clarke,[37] and the editor of the third edition, Henry Pemberton,[38] do give brief glosses of Rule 4, but do not discuss it in connection with the problem of induction or, more importantly, in connection with the design argument. Even Colin Maclaurin, a famous Newtonian commentator with whom Hume possibly studied while a student, makes no mention of the "Rules of Reasoning" in his posthumously published Account of Sir Isaac Newton's Philosophical Discoveries (1748.)[39]

None of the popularizers of the Newtonian design argument of which I am aware, even those such as William Whiston or Wilhelm Jacob van'd Gravesande[40] who specifically mention the role of the first three "Rules of Reasoning" (which had appeared in different form in the first two editions) in connection with the design argument, seek to limit the design argument by demanding experimental observation of the original creation or of a complete and perfect experience of the whole of the completed creation. Whiston and Gravesande produce versions of the design argument exactly like that of Cleanthes in the Dialogues or that of Newton in the "General Scholium" as a consequence.

Around 1750, it seems at least possible that only Hume saw that Rule 4, interpreted as a method to guide us in shaping our expectations regarding future experience which the actual experience may well prove false, applies to Rules 1, 2, and 3 and consequently limits the design inference sufficiently to destroy it for the purposes of Christian apologetics. Not only is Hume justified in his direct claim above to have understood Newton more accurately than Newton's

disciples, it seems clear that, regarding the design argument, Hume understands Newton better than Newton understood himself.[41]

I would add only that Hume's interpretation of Newton's "Rules" -- and especially of Rule 4 and his acute awareness of its possibilities when deployed in his new "science of man" for illustrating the limits of human understanding regarding knowledge of propositions about things unobserved and unobservable -- given my interpretation above, probably derives from his own close reading of Newton's text. At least, I have been able to find no other properly Newtonian source which utilizes Rule 4 in this fashion.[42] Finally, however, even if Hume's knowledge of the problem of induction and of the application of Rule 4 to the design argument does derive from some contemporary Newtonian source, or even some other source altogether, and not from his own reading and internalizing of Rule 4, his interest in these "Rules" is beyond doubt.

III. Science in Eighteenth-Century Society and Hume

Just as Hume's interest in Newton's thought is a vital and serious one, it seems to me that his interest in science in general is also quite serious given his goal of completely destroying the unique synthesis of science and religion which existed in the first half of the eighteenth century. Echoing J.H. Burton's view about the surprising lack of "opinions" from contemporary scientists in Hume's writings, Jones argues that such opinions could have buttressed and illuminated Hume's arguments, especially in the Dialogues, and so it must be lack of knowledge of these works which prevented him from utilizing them, one consequence of his lack of

interest in science. What scientific theorizing there is in Hume's rhetoric, argues Jones, derives not from serious scientific works but is "traceable to essentially literary predecessors such as Fontenelle or Montesquieu or to the standard works of theologians or free-thinkers."[43]

As in the case of Hume's interest in Newton, Hume's interest in general science is precisely what one ought to expect from an eighteenth-century man of letters curious about all intellectual topics of contemporary importance but whose special project is to define the limits of human enquiry and banish from it any sort of theology, natural or revealed. The fact that so many of Hume's arguments rely on examples traceable to sources which we today should characterize as literary, theological, or deistic, and not as "scientific," tells us more about science in our day than it does about science in Hume's time when religion was an integral part of the scientific enterprise.

For a rough gauge about how critically-minded men of letters viewed science as part and parcel of theology in the first half of the eighteenth century, a cursory survey of the Gentleman's Magazine is a useful starting point.[44] The most random sampling reveals a dazzling range of scientific news and information in juxtaposition with theological and doctrinal controversies.

In 1734, Hume describes the symptoms of his "Disease of the Learned" and travels to La Fleche to write the Treatise. In the Gentleman's Magazine for that year, amongst all the travel reports, political opinions, literary satires, and general news of the happenings in the republic of letters there are, in each monthly issue, a "Register of Books Publish'd" including those on scientific topics such as chemi-

stry,[45] "Philosophy and Physick."[46] There is also an essay in which the writer replies to a previously published essayist and advises him to study Edmund Law's book entitled An Enquiry into the Ideas of Space, Time, Immensity, and Eternity and Joseph Clarke's book entitled A Further Examination of Dr. Clarke's Notions of Space. The writer of this essay then explains why these works on scientific metaphysics are important:

> I would more especially advise him to study the Dissertation on the Argument a priori; which may teach him the Meaning of the Terms, shew how they are misapplied to the divine Existence, and of what Importance it is both to Religion and Science to throw them off, and rest the Proof of a Deity upon a more solid and rational Foundation.... If the Argument a priori had no better Advocates than this Gentleman, as it has been losing Ground daily, and sensibly decaying for some time, I apprehend it will soon be quite out of Doors, and sent to seek its Fortune among the occult Qualities of the old Philosophers. We may venture to foretel, without the Gift of Prophecy, that it will find no Admittance no where, but among the Castle-builders in Infinite Space, or among Squarers of the Circle, and Searchers after the Philosopher's Stone.[47]

In 1739, two years after writing to Henry Home of Kames about the excision of the essay "concerning Miracles" from the Treatise,[48] the Treatise is published and Hume claims, in another letter to Henry Home, that it may provoke a "total alteration in philosophy."[49] In that year there appears in the Gentleman's Magazine a lengthy "Life of Dr. Boerhaave." The author of this article describes Boerhaave's scientific empiricism and concludes with a telling example of its application:

> When he [Boerhaave] laid down his office of Governor of the University in 1715, he made an Oration upon the Subject of attaining of certainty in natural Philosophy; in which he declares, in the strongest Terms, in favour of Experimental Knowledge, and reflects with just Severity upon those arrogant Philosophers, who are too easily disgusted with the slow Methods of obtaining true Notions by frequent Experiments.... He never doubted of the spiritual and immaterial Nature of the Soul, but declared that he had lately had a kind of experimental Certainty of the Distinction between Corporeal and Thinking Substances, which mere Reason and Philosophy cannot afford, and Opportunities of contemplating the wonderful and inexplicable Union of Soul and Body, which nothing but long Sickness can give. This he illustrated by a Description of the Effects which the infirmities of his Body had upon his Faculties....[50]

In 1751, the year in which Hume concludes at least the first three parts of the Dialogues and is the first non-medical man elected Secretary (jointly) of the Philosophical Society of Edinburgh, there are in the Gentleman's Magazine lengthy articles on the properties of air,[51] cosmology,[52] Dr. Pringle's experiments on putrefaction and antisepsis,[58] Newton's definition of light as a means of confuting the author "of the dissertation of the trinity in unity illustrated by the scripture type,"[54] and the text of Maupertius's speech to the Royal Academy of Berlin which concludes:

> I have thus enumerated all the sciences, which are now the objects of our labour and attentions; but I have not mentioned one, which was the principal concern of this society and its first establishment. The first article in the rules of the royal academy imported, that one of its classes should be applied to the

> study of religion, and the conversion of infidels, an article, which is perhaps less remarkable for substance than form. By our modern regulation no particular class is appropriated to this work, which may be considered as common to all: For in the study of Nature are discovered indubitable evidences of the existence of deity: His wisdom, and the laws by which he regulates the universe, are learnt from geometrical truths....[55]

These few examples illustrate the synthesis of science and religion in the first half of the eighteenth century. One of Hume's most basic purposes in erecting his new "science of man" is to attack this synthesis as it exists and wherever it exists. It is no wonder that it doesn't sound "scientific" in any modern sense given the integration of science with religion in Hume's day and Hume's intention to sever the connection.

But even within this context, I believe, in contrast to Jones, that there are distinct echoes of scientific theories of which Hume was aware and which Hume used consciously as 'grist for the mill' of his religious scepticism. Once again these are brief and concealed references, reverberations only, but which have to count as evidence of Hume's interest in the science of his day.

In the Dialogues, Hume shows awareness for recent scientific developments in astronomy, optics, psychology, geology, microscopy, cosmogony, and electricity and, most importantly, insight into how to adapt data from these scientific fields for his religious scepticism.

In astronomy, Hume displays knowledge of the development of proof for Copernican doctrine and argues that the only sort of proof Galileo has for this theory is founded upon the same Newtonian

Principle of Uniformity (Rule 2) as is Cleanthes' design argument. The important difference is that Galileo's view that terrestrial matter is uniformly analogous with lunar and supralunar matter is firmly based upon the telescopic observations of the Jovian moons in contrast to Cleanthes' imagined, a priori hypothesis of metaphysical uniformity throughout the whole of the universe in advance of our experience. (D 136; and especially 151). Furthermore, Hume is explicit about the use of astronomical discoveries by design theorists. Philo puts this point forcefully:

> All the new discoveries in astronomy, which prove the immense grandeur and magnificence of the works of nature, are so many additional arguments for a Deity, according to the true system of theism: But, according to your hypothesis of experimental theism, they become so many objections, by removing the effect still farther from all resemblance to the effects of human art and contrivance. (D 165)[56]

Specific resonances to Newton's Opticks exist in the Treatise and occur in the Dialogues as well.[57] Cleanthes asserts that "Light is in reality anatomized" (D 136), thus accurately repeating Newton's theory from the Opticks, Book One, Part II, Prop. IX, Prob. IV, which is Newton's account of rainbows by the "Refraction of the Sun's Light in drops of falling Rain."[58] Cleanthes directly attributes this theory to Newton when he claims that anybody "who pretended to reject NEWTON'S explication of the wonderful phenomenon of the rainbow, because that explication gives a minute anatomy of the rays of light" would be simply "ridiculous." (D 136)

In addition to references to the discovery of the nature of light and "true system of the heavenly bodies" (D 136), Hume, as befits a scientist of human

nature, mentions the mechanistic human psychology of Thomas Hobbes and David Hartley in his passing reference to human thought as merely the "agitation of the brain." (D 148) If this mechanistic theory is correct, argues Hume, how little reason there is to make human thought the model for the apparent order in the whole of creation.

In geology, Hume seems at one point to build his case against the design theorists on the basis of current speculation about the theory of mountain-building. He argues that the design analogy can be utilized to support the ancient Greek theory that the earth is like the body of an animal because "A continual circulation of matter in it produces no disorder: A continual waste in every part is incessantly repaired: The closest sympathy is perceived throughout the entire system: And each part or member, in performing its proper offices, operates both to its own preservation and to that of the whole." (D 170-71) Hume may or may not be referring to the geological model of mountain-building by the cyclical process of uplift and erosion, but it seems likely that this is what he has in mind with this example, especially when Philo then goes on to refer to the existence of marine fossils high in the Alps and other evidence that dry land was once covered by water. (D 174)[59]

The welter of publicity surrounding the discoveries of microscopists and the immediate co-opting of these discoveries to buttress the synthesis of religion and science in the early decades of the eighteenth century forms the background to Cleanthes' argument about how the revelation of this new universe <u>in parvo</u> provides the design theist with more evidence for the design analogy. Philo counters by pointing out that such discoveries actually weaken

the design analogy by illustrating yet again that the cause of such magnificently designed effects must "be vastly different from mankind, or from any object of human experience and observation." (D 166)[60] This same dissimilarity is shown the further our knowledge of anatomy, chemistry, and botany increases, Hume argues. (D 166)[61]

In cosmogony, Hume displays familiarity with the then widespread theory that the earth had, at one time, been a comet. Hume states that a comet may be "the seed of a world; and after it has been fully ripened, by passing from sun to sun, and star to star, it is at last tossed into the unformed elements, which everywhere surround this universe, and immediately sprouts up into a new system." (D 177) Hume may here be referring either to Descartes or, what is more likely, to the widely known theory of William Whiston espoused in Whiston's New Theory of the Earth.[62]

Finally, from the first decade of the eighteenth century, electrical phenomena had been the focus of increasing scientific speculation. It was some electrical experiments which had provoked Newton's late hypothesis about the existence of a subtle "Aetheral Fluid" throughout the universe which caused gravity. Just as Hume repeats that there is no ultimate explanation for why gravity exists, he argues that there is no such explanation for electrical phenomena. (D 182)[63] Hume's juxtaposing of the incomprehensibility of aether with the incomprehensibility of both electricity and elasticity hints, at least, of his knowledge of this late turn in Newton's thought.[64]

IV. Conclusion

Hume's interest in Newton and science is beyond doubt. He knows what he needs to know about both, which is quite a bit, given his purposes and the context of science in the society of his time. To dismiss Hume's short, veiled allusions to scientific theories in the Dialogues as "essentially literary" or the product of non-scientific sources is to ignore the focus of an Enlightenment man of letters upon the synthesis of science and religion in his day and to eliminate both the direct and veiled references to the scientific works which Hume does make as simply impossible a priori. To argue that Hume exhibits a "total lack of interest in science" anachronistically redefines the parameters of eighteenth-century science while ignoring an important historical fact such as Hume's election to the post of (joint) Secretary to the Philosophical Society of Edinburgh. As joint Secretary, Hume edited two volumes of essays on medicine, astronomy, optics, meteorology, physiology, and biology. Benjamin Franklin actually sent Hume, as Secretary to the Philosophical Society of Edinburgh, an essay on lightning rods and it is interesting to speculate whether Hume may possibly have discussed the opposing theories of Franklin and King George II with Sir John Pringle, President of the Royal Society and one of Hume's physicians in his final illness.[65]

Echoing one of his own very early statements (in his letter from 1734 to, in all probability, John Arbuthnot) and following his election as joint Secretary of the Philosophical Society, Hume prefaces the first volume of scientific essays published under his supervision with an explanation for why the

Philosophical Society of Edinburgh chooses not to treat "the sciences of theology, morals, and politics":

> However difficult the inferences in these sciences [i.e., theology, morals, and politics], the facts on which they are founded, are extremely obvious; and we could not hope, by our collections, to be in this respect of any service to the public. The great delicacy of the subject, the imperfections of human understanding, the various attachments and inclinations of mankind, will for ever propagate disputes with regard to these parts of erudition. And it is the peculiar happiness of geometry and physics that as they interest less the passions of men, they admit of more calm disquisition and inquiry.[66]

Hume "lived widely, read widely (in Greek, Latin, French, and Italian), and wrote widely."[67] The attempt to choose one context as the primary background for Hume's eclectic philosophy focuses Hume too narrowly. He is a man of letters in the eighteenth century and is indebted to Newton as well as to Cicero, to Hobbes as well as to contemporary Scottish debates in science, natural religion, and metaphysics. In the final expression of his thought, his transforming genius must also be acknowledged.

James E. Force
University of Kentucky

1. I do not intend to examine in great detail all the varying interpretations of Hume's thought which treat Hume's interests in science, Newton, and Newton's possible influences upon Hume's philosophical development. By and large, these

interpretations fall into four categories (although parts of one interpretation may be integrated into another):

(1) The "Model" School of Interpretation. Many writers, such as James Collins, Barry Stroud, John Laird, and Antony Flew, have argued that Hume's attempt to develop a secular basis for the "science of man" (and to make all other disciplines subsidiary to it) is "Newtonian" in inspiration. Just as Newton's one, unifying, general principle of gravitation covers the movements of falling sparrows and orbiting moons, Hume's principles of mental association provide a completely general explanation of human behavior.

(2) The "Methodological Influence" School of Interpretation. Some writers, such as Duncan Forbes, Norman Kemp Smith, and James Noxon, have discerned and emphasized Newton's influence on Hume's philosophy chiefly in Hume's experimental methodology which, as with Newton's, is grounded in experiments and empirical observations. Occasionally, as in the work of James Noxon (see Note 47 below), this school of interpretation is accompanied by a developmental corollary according to which Newton's methodological influence on Hume holds only during Hume's youth and that, with age and philosophical maturity, Hume outgrows this early influence.

(3) The "Strong" School of Interpretation. Proponents of this view, such as Nicholas Capaldi and David Miller, hold aspects of both the preceding Schools of Interpretation and so view the influence of Newton on Hume to be very strong.

(4) The "Contextualist" School. Writers in this category are distinguished by their approach to the study of Hume's philosophy. Refusing to reduce Hume to a text, they have insisted on reading Hume as a man in a specific period. Many of the writers who have already been mentioned have a degree of the contextualist approach in their work, but the recent work of David Fate Norton, M.A. Stewart, and John Wright

have followed this fruitful line of inquiry with such a great degree of skill and hard work that they constitute a separate category. Newtonian influence often remains a factor in their interpretations but often is attenuated as they examine how Hume's works respond to specific challenges from his more immediate historical and social contexts and to his more immediate intellectual contemporaries. Norton, for example, has shown the profit to be derived from reading Book 3 of the Treatise (1740) in the light of the Newtonian moralist George Turnbull's Principles of Moral Philosophy (1740). (David Fate Norton, David Hume. Common-Sense Moralist, Sceptical Metaphysician [Princeton: Princeton University Press, 1982], pp. 152-63.) John Wright, for another example, has shown the effect of the Kames-Stewart debate upon Hume's own claim that Newton had ascribed activity to matter itself. (John Wright, The Sceptical Realism of David Hume [Minneapolis: University of Minnesota Press, 1983], pp. 162-4.) Finally, M.A. Stewart has reconstructed Hume's targets in the ninth part of the Dialogues in a way which interposes Lord Kames and George Anderson between Newton and Clarke. (M.A. Stewart, "Hume and the 'Metaphysical Argument A Priori'," in A.J. Holland, ed., Philosophy, Its History and Historiography [Dordrecht: D. Reidel, 1985], pp. 243-70.)

A highly significant new "Contextualist" approach to the entire topic of Hume's interest in and knowledge of science has recently been advanced by Michael Barfoot. On the 4th of June, 1986, Barfoot announced, in a paper read to the 'IPSE 86' project and entitled "Hume's Early Scientific Education at the University of Edinburgh," his momentous discovery of a new source which casts light on the entire "culture of science" in Hume's day. This paper has been extensively recast and will appear in the series Oxford Studies in the History of Philosophy under the title "Hume and the Culture of Science in Early Eighteenth Century Britain." A

"Contextualist" to the core, Barfoot offers startling new evidence regarding Hume's training in natural philosophy during the mid-1720s which includes the discovery of Hume's membership in the Physiological Library founded by Robert Stewart for Stewart's students and those interested in natural philosophy. Barfoot suggests, rightly, that the catalog of this library "offers us a map illustrating the ways in which forms of natural knowledge, styles of mathematical representation, systems of logic and philosophy, and natural theological apologetics were perceived to be closely related and part of the culture of science in early eighteenth century Britain."

2. Peter Jones, Hume's Sentiments. Their Ciceronian and French Context (Edinburgh: The University Press, 1982), p. 11. As his title indicates, Jones is very much in the school of the "Contextualists." But he seeks to reject the standard view, held in varying degrees as delineated in Note 1, that there is in fact any scientific and Newtonian context to Hume's thought.

3. Ibid., pp. 13-4.

4. Ibid., p. 15.

5. In addition to the general approaches to the whole of Hume's work depicted in Note 1 above, there is one work literally in a category by itself when any discussion is undertaken concerning the linkage of Hume's religious scepticism in the Dialogues concerning Natural Religion and Newton's design argument. Since its first publication in 1963, Robert H. Hurlbutt's Hume, Newton, and the Design Argument (Lincoln: University of Nebraska Press, 1963) has remained the single most illuminating source on the subject. Its publication as a revised edition in 1985 is to be applauded.

6. Jones, Hume's Sentiments, p. 12.

7. Ibid.

8. Ibid.

9. Ibid., pp. 13-4.

10. Ibid., pp. 12-3.

11. Ibid., p. 17.

12. Ibid.

13. Ibid.

14. Paul Russell has succeeded in placing Hume's intellectual project in his "science of man" into an important but much overlooked context -- that of Thomas Hobbes's own similar project. See "Hume's Treatise and Hobbes's The Elements of Law," Journal of the History of Ideas (Jan., 1985), pp. 51-63, and his as yet unpublished article, which he kindly permitted me to see, "Hume's Scepticism and the 'Atheism' of the Treatise."

15. See Amos Funkenstein, Theology and the Scientific Imagination from the Middle Ages to the Seventeenth Century (Princeton: Princeton University Press, 1986), p. 201.

16. David Hume, A Treatise of Human Nature, ed. L.A. Selby-Bigge, second edition with text revised and notes by P.H. Nidditch (Oxford: The Clarendon Press, 1979), "Appendix," pp. 638-639. My tactic of simply laying out the texts in which Hume directly quotes or refers to Newton derives from the presentation given by Christine Battersby at the Hume Society Conference held at Trinity College, Dublin, in 1981. See Note 47.

17. David Hume, "Of the Middle Station of Life," in The Philosophical Works, ed. Thomas Hill Green and Thomas Hodge Grose, 4 vols., (London, 1882), Vol. IV, 379. Donald W. Livingston kindly pointed this text out to me.

18. David Hume, "Of the Rise and Progress of the Arts and Sciences," in Works, Vol. III, 183.

19. David Hume, A Letter from a Gentleman to his Friend in Edinburgh, ed. Ernest C. Mossner and John V. Price (Edinburgh: The University Press, 1967), pp. 28-9.

20. David Hume, An Enquiry concerning Human Understanding, in Enquiries concerning the Human Understanding and concerning the Principles of Morals, Reprinted from the Posthumous Edition of 1777 and Edited ... by L.A. Selby-Bigge. Third Edition with Text Revised and Notes by P.H. Nidditch (Oxford: Clarendon Press, 1975), p. 73n. Further references will be cited as 'E' followed by the relevant page number(s).

21. Hume's reference here to Newton's "chief rule of philosophizing" is intriguing. The "chief rule" seems, at first sight, to be Newton's second "Rule": "Therefore to the same natural effects we must, as far as possible, assign the same causes." (Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His system of the World, Translated in English by Andrew Motte in 1729. The translations revised, and supplied with an historical and explanatory appendix, by Florian Cajori, 2 vols. [Berkeley and Los Angeles: University of California Press, 1934], Book Three, Vol. II, 398) Hume is intimately familiar with the second "Rule." As I argue in the second section of my paper, Philo clearly states that this "Rule" underlies the design argument. But here it seems to me that Hume may possibly be referring to the fourth "Rule" as Newton's "chief rule of philosophizing." In the text from the second Enquiry, Hume states that the "chief rule" of ascribing similar causes for similar effects must be applied only in instances where they have empirically been found to be the same. If this reading of Hume's statement here is correct, then the "chief rule" is actually the fourth "Rule" which likewise limits application of the second "Rule" to experienced phenomena: "In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.." (Newton, Mathematical Principles, 2:400.) If Hume believes that the fourth of Newton's "Rules" is in fact the "chief rule of philosophizing," then my case in the second part of my paper concerning Hume's detailed knowledge of Newton's "Rules" in his criticism of the design argument is somewhat strengthened.

22. Hume to his cousin Mrs. Dysart of Eccles, 19 Mar., 1751, in The Letters of David Hume, 2 vols., ed. J.Y.T. Greig (Oxford: The Clarendon Press, 1932), Vol. I, 158-9.

23. David Hume, Dialogues concerning Natural Religion, ed. Norman Kemp Smith (Edinburgh: Thomas Nelson & Sons Ltd., 1947), p. 136. For the dating of this section of the Dialogues, see Kemp Smith's "Introduction" to this edition, pp. 87-96, and M.A. Stewart, "Hume and the 'Metaphysical Argument A Priori'," p. 266. Further references to the Dialogues will be cited as 'D' followed by the relevant page number(s).

24. David Hume, The History of England. From the Invasion of Julius Caesar to the Revolution in 1688, 8 vols. (London, 1782), Vol. VI, 196-7.

25. Hume, The History of England, Vol. VIII, 332-4.

26. David Hume, The Natural History of Religion, in The Natural History of Religion, edited by A. Wayne Colver, and Dialogues concerning Natural Religion, edited by John Valdimir Price (Oxford: The Clarendon Press, 1976), p. 79.

27. Jones allows that Hume "was familiar, at most, with the Prefaces, Definitions and Axioms of Principia, together with the General Scholium, the Rules of Reasoning in Book III and Cotes's famous Preface in the second edition." (Hume's Sentiments, p. 12.) Later he acknowledges Hume's view of the "value" of a general version of these "rules" "in his own endeavour;" nevertheless Jones concludes that, "although there is some overlap, Hume's fundamental assumptions about man and his nature are already driving him apart from Newton...." (Hume's Sentiments, pp. 12-13.) From this he concludes that Hume totally lacks any interest in science, including Newtonian science, by which he means, apparently, some "serious" kind of science that does not include scientific metaphysics. Jones's refusal to acknowledge the permeability between the boundaries of modern-day disciplines for a man of letters in the eighteenth century is extremely misleading. On his view, the following quote in which a Newtonian scientist-theologian makes explicit the connection between the second Newtonian "Rule" and the design argument, has nothing whatsoever to do with real science. William Whiston writes:

> ...every unbyassed Mind would easily allow, that like Effects had like Causes; and that Bodies of the same general Nature, Uses, and Motions, were to be deriv'd from the same Originals; and consequently, that the Sun and the fixed Stars had one, as the Earth, and the other Planets another sort of Formation. If therefore any free Considerer found that one of the latter sort, that Planet which we Inhabit, was deriv'd from a Chaos; by a parity of Reason he would suppose, every one of the other to be so deriv'd also. (A New Theory of the Earth [London, 1696], "Introductory Discourse concerning the Genuine Nature, Stile, and Extent of the Mosaick History of Creation," p. 40.)

28. Whiston, Astronomical Principles of Religion, Natural and Reveal'd (London, 1717), p. 255.

29. Newton, Mathematical Principles, Vol. II, 398.

30. In my interpretation of the regulative use of the fourth "Rule," I am following closely the interpretation of E.A. Burtt who argues that if it is not, then Newton would be guilty of asserting, in his first three "Rules," certain and *a priori* principles in the fashion of Descartes. (It is for this reason that Newton probably adds the fourth "Rule" in the third edition of 1726. See Note 40.) Burtt cites a supporting text for this interpretation from the Opticks and concludes that "...in his strictly scientific paragraphs the emphasis is overwhelmingly in favour of their tentative, positivistic character, hence the fourth rule of reasoning in philosophy ... must be regarded as imposing definite limits on all of the other three." (E.A. Burtt, The Metaphysical Foundations of Modern Science [Garden City, NY: Doubleday, 1954], p. 219.)

31. Philo emphasizes the difficulties in applying the "experimental" principle, "Like effects prove like causes," to "theological argument." He says, "Now it is certain, that the liker the effects are, which are seen, and the liker the causes, which are inferred, the stronger is the argument. Every departure on either side diminishes the probability, and renders the experiment less conclusive. You cannot doubt of this principle: Neither ought you to reject its consequences.

All the new discoveries in astronomy, which prove the immense grandeur and magnificence of the works of nature, are so many additional arguments for a Deity, according to the true system of theism: But according to your hypothesis of experimental theism, they become so many objections, by removing the effect still farther from all resemblance to the effects of human art and contrivance." (D 165)

As far as Hume is concerned experimental theists such as Cleanthes (or Newton) misunderstand their own principle and its limitations. The more observational and experimental data which comes in -- and which according to the fourth "Rule" must be actively sought -- the weaker the design analogy.

32. I. Bernhard Cohen, Introduction to Newton's Principia (Cambridge: Cambridge University Press, 1971), p. xi.

33. Jones states the "'Newtonian Philosophy' could be understood in very different ways, depending on the presumed knowledge of the audience and the required precision of the speaker" and cites Chambers' article on "Newtonian Philosophy" as evidence for a hierarchy of Newtonians some of whom understand the difficult mathematical sections of the Principia and the majority who could not. (Hume's Sentiments, p. 12.) Jones regards the former as not serious enough for consideration or as evidence for any real interest in serious Newtonianism on their part.

It is necessary, then, to examine just what Chambers does say about "Newtonian Philosophy" in his famous Cyclopaedia article from 1728, the year following Newton's death. He first defines "Newtonian Philosophy" generally as "the doctrine of the universe, and particularly of the heavenly bodies; their laws, affections, &c. as delivered by Isaac Newton." Chambers next, as Jones points out, distinguishes five other usages of the term. It is used variously to refer to the "new philosophy" of "corpuscularianism"; to the "method or order which Sir Isaac Newton observes in philosophizing"; to "that wherein physical bodies are considered mathematically"; "that part of physical knowledge, which Sir Isaac Newton has handled, improved, and demonstrated in his Principia"; and, finally, to "new principles which Sir Isaac Newton has brought into philosophy."

Jones certifies only the third usage, "that wherein physical bodies are considered mathematically," as signifying genuine "Newtonian Philosophy." Then he argues that, because "There is no evidence that Hume was competent to follow the mathematical core of the Principia" and "because we may infer that he understood the 'Newtonian method' in one or more of the non-technical senses that became popular in the first half of the eighteenth century," Hume cannot be interested in serious Newtonianism.

If our wish is to understand the context of the people of an era, we must permit them to speak for themselves. If Chambers records that these various senses are all part of "Newtonian Philosophy," we must acknowledge that "Newtonian Philosophy" then had a wider, more latitudinarian, meaning than it does today when it has been reduced to just what Jones says it is, i.e., the mathematical sections of the Principia. Chambers, to continue with his article, goes on to spend three folio columns elucidating the chief points of Book III (save for the "Rules" which he does not once mention), especially gravity "which some condemn as an occult quality, and others as miraculous, and praeternatural causes." He notes, after observing the slow progress of the "Newtonian Philosophy" abroad, the "general acceptance" of it, apparently in all its senses, at home. (Ephraim Chambers, Cyclopaedia: Or, An Universal Dictionary of Arts and Sciences...., 2 vols. [London, 1728, s.v. "Newtonian Philosophy.")

34. Alexandre Koyré, "Newton's 'Regulae Philosophandi'," in his Newtonian Studies (Chicago: University of Chicago Press, 1965), pp. 261-72.

35. David Gregory, Astromiae, physicae et geometriae elementa (Oxoniae, 1702.)

36. John Keill, An Introduction to Natural Philosophy (London, 1720.) This work is an English translation of a Latin work which first appeared in 1720. Also of importance in this regard is Keill's An Introduction to the True Astronomy (London, 1721), the English translation of a work published in 1718.

37. John Clarke, A Demonstration of Some of the Principal Sections of Sir Isaac Newton's Principles of Natural Philosophy (London, 1730), pp. 98-104. Clarke directly quotes all four

"Rules" and emphasizes the necessity of empirical observations in order to evade "hypotheses," but he does not refer at all to the application of these "Rules" to the design argument.

38. Henry Pemberton, A View of Sir Isaac Newton's Philosophy (London, 1728), pp. 23-6. The fourth "Rule" is simply paraphrased in four lines.

39. Colin Maclaurin, An Account of Sir Isaac Newton's Philosophical Discoveries, 2nd ed. (London, 1750), pp. 396-412. On p. 400, Maclaurin states, "The plain argument for the existence of the Deity, obvious to all and carrying irresistable conviction with it, is from the evident contrivance and fitness of things for one another, which we meet with throughout all parts of the universe. There is no need of nice or subtle reasonings in this matter.... It strikes us like a sensation." Compare this with Cleanthes' remark in Part 3 of the Dialogues (D 154): "Consider, anatomize the eye: Survey its structure and contrivance; and tell me, from your own feeling, if the idea of a contriver does not immediately flow in upon you with a force like that of sensation." (I have added emphasis to both quotes to show the points of resonance.)

Now it is the case that the Newtonians do not possess the exclusive concession on the eyeball as the perfect example of design. But the above text by Maclaurin suggests the wide dissemination of this idea in a Newtonian setting which held the design inference arising from its contemplation to be as forceful as sensation and which was recognizable then as Newtonian in inspiration. Buried in his theological manuscripts, and so unknown to Maclaurin (unless he discussed it with Newton or someone who knew Newton's views on this point) is the following highly suggestive text. Newton writes, "Whence is it that the eyes of all sorts of living creatures are transparent members of ye body, having on ye outside an ... transparent skin, & within ... a crystalline lens in the middle & a pupil before the lens all of them so truly shaped & filled for vision, that no Artist can mend them? Did blind chance know that there was light & what was its refraction & fil the eyes of all creatures after the most curious manner to make use of it? These & such like considerations always have & ever will prevail with man

kind to believe that there is a being who made all things & has all things in his power & who is therefore to be feared." (Newton, "A Short Scheme of the True Religion," Keynes MS 7, King's College Library, King's College, Cambridge.)

40. The most interesting interpretation of the application and importance of Newton's "Rules" which I have been able to find is that of the Newtonian experimentalist, Wilhelm Jacob 'sGravesande. In the Preface of his Mathematical Elements of Physicks, Prov'd by Experiments: Being an Introduction to Sir Isaac Newton's Philosophy, Made English ... by Dr. John Keill, F.R.S. (London, 1720.) Naturally, as this book precedes the publication of the third edition of the Principia by some six years, there is no mention in it of the fourth "Rule." None of its subsequent editions or translations, including the translation of the sixth edition by J.T. Desaguliers, contains any discussion of the fourth "Rule." Still, his discussion of the first three "Rules" is interesting for its resonance with Hume's views that when making probable inductions, we assume, from habit, that the future will resemble the past. 'sGravesande writes:

> But to return to Physicks. Here we must judge of the Agreement of Things with our sensible Ideas. For Example, the Extension and Solidity of Matter, which we affirm upon this Foundation, are certain beyond Controversy: We do not here enquire whether the Senses may not on some Occasions deceive us, and how that Error may be remedied, but only consider the thing in general.
>
> In Physicks we cannot make a Judgement immediately, or directly concerning all our Senses. But there is another proper way of Reasoning, tho' not Mathematical, founded on this Axiom: That is to be accounted true, which if it be not allowed, Humane Society could not subsist, or the Method of Mens Living would be destroyed. From which Proposition, which no one can make any doubt of, the second and third Newtonian Rules of Philosophizing are most evidently deduced.

> For unless we account those things as generally true, which every where appear such, where we can make any Experiments; and that like Effects be supposed to arise from a like Cause, who can be able to live one Moment of Time in Ease?
>
> Indeed, without attending to it, every one doth daily admit the following Reasonings to be indubitable; and sees evidently that the Conclusions from them cannot be called into Question, without supposing the Destruction of the present Frame and Constitution of Things.
>
> A Building, to-day perfectly firm in all its Parts, will fall down to-morrow of its own accord; that is, the Cohesion of the Parts of Bodies, and their Gravity, which I never saw, nor heard of, chang'd, without the Intervention of some external Cause, will not be changed this Night; for there will be the same Cause of Cohaesion and Gravity to-morrow as to-day. The Certainty of which Reasoning can only be deduc'd from the above mentioned Principles....
>
> I have used such and such Food for several Years, I will also take it to-day without any Fear.
>
> When I see Hemlock I conclude there is Poison in it, tho' I have made myself no Experiment....
>
> All these Reasonings are founded upon Analogy: And it is not to be doubted but we are put under the Necessity of Reasoning by Analogy, by the Creator of all Things. This therefore is the proper Foundation of Reasoning.

It's interesting to note here how, without benefit of the fourth "Rule" and its insistence upon experimental verification, the first three "Rules" can be the basis for dogmatically making certain claims about the future. It's extremely speculative, of course, but it seems at least possible that the fourth of Newton's "Rules of Reasoning" (which Hume may possibly refer to as the "chief rule of philosophizing" -- see Note 21), may be the basis for his whole criticism of induction.

41. This point is made by James Noxon in his Hume's Philosophical Development. A Study of his Methods, Corrected ed. (Oxford: The Clarendon Press, 1975), p. 76. The early influence of Newtonian scientific methodology, argues Noxon, wanes as Hume matures philosophically and comes to realize the tensions between his early, Newtonian-inspired psychology and his philosophy and also develops a growing hostility to what he recognizes as the enthusiastic excesses of the Newtonian theologians. I was privileged to hear Christine Battersby's excellent critique of this position in a paper entitled "Hume, Noxon and Newton" which she delivered to the Hume Society Conference held at Trinity College, Dublin, in 1981. Battersby examined the course of Hume's long involvement with Newton and the sciences and argued conclusively against such a developmental thesis. There is a strong affinity between Noxon's development thesis and the position of Jones who also talks of how "Hume's fundamental assumptions about man and his nature are already driving him apart from Newton...." (Hume's Sentiments, pp. 13-4.) Or, again, "In fact, Hume's own philosophical reflections led away from Newton...." (Hume's Sentiments, p. 18.) The difference between them is that for Noxon, the acknowledged early methodological interest of Hume in Newton is a serious scientific one whereas for Jones, as a result of his refusal to acknowledge the permeability of the disciplines in Hume's day, this sort of interest, not being mathematical, is simply not serious.

42. If our criterion for a serious interest in "Newtonian Philosophy" is to be a clear understanding of the mathematical sections of the Principia, which take up most of the book, then, as now, few people could be classified as having been directly influenced by Newton's work. As Jones points out (Hume's Sentiments, p. 12), Voltaire observes that "In London, very few people read Descartes, whose works have become quite useless ... neither do many read Newton, because one must be very learned to understand him." (Voltaire to Abbé Bignon, late 1713, in Voltaire, Oeuveres complètes de Voltaire, ed. Beuchot, 72 vols. [Paris, 1834-40], 37: 191) Jones takes this statement as evidence that Hume lacks any serious interest in Newton. I take it as evidence for the need to rethink how we conceive of what counts as serious interest in Newton and in science in the

Age of Newton. In Jones's view, of course, Voltaire must himself lack any serious interest in Newton and science.

43. Jones, Hume's Sentiments, p. 17.

44. Hume reveals the importance of the Gentleman's Magazine in the dissemination of news within the republic of letters in his letter to William Mure of Nov. 14, 1742. In January, 1742, in the second volume of Essays Moral and Political, Hume had published his character sketch of Sir Robert Walpole. In his letter to Mure, Hume claims that only with the reprinting of his piece on Walpole in the Gentleman's Magazine are his Sentiments "publish'd to all Britain." See The Letters of David Hume, 1:44. I would argue, judging from the tremendous number of references to Newton and Newtonian Philosophy in the pages of the Gentleman's Magazine, that it is a most important source for expanding our understanding of the extent and spread of Newton's ideas (and of ideas whose proponents claimed a linkage with Newton) within the society in which Hume lived. In general, I fully agree with Jonathan Ree's criticism of historians of philosophy in which he chides many of the practitioners of that gentle art for their general tendency to ignore any sort of archival work and their sad indifference "to the use of sources other than the publications (or at most the manuscripts), of the canonized Great Dead Philosophers." (Ree's views are voiced in a "Letter" published in the British Society for the History of Philosophy Newsletter, No. 1 [Autumn, 1986], p. 3.) Jones, of course, would dismiss this source as too popular to tell us anything about real science of real Newtonian Philosophy in Hume's day.

45. Gentleman's Magazine, May, 1734, p. 335.

46. Ibid., June 1734, p. 335.

47. Ibid., September, 1734, pp. 483-4.

48. The Letters of David Hume, 1:24.

49. Ibid., 1:26.

50. Gentleman's Magazine, March, 1739, p. 115; and April, 1739, p. 174.

51. Ibid., July, 1751, pp. 314-5.

52. Ibid., pp. 315-7.

53. Ibid., December, 1751, pp. 556-8.

54. Ibid., May, 1751, p. 203. This reply is directed at an essay published in the Gentleman's Magazine in September, 1750, pp. 398-9. According to the author of this reply (in May, 1751), the original essayist had confused light with air. By way of correction, this author (from May, 1751) proceeded to introduce Newton's definition to show that light is distinguished from air "which is a gross, ponderous, elastic fluid, and is only the medium or vehicle, but by no means the substance, of light."

55. Gentleman's Magazine, May, 1751, pp. 218-22.

56. Compare this quote from a committed Newtonian design theorist who, in the following passage, does exactly what Philo complains about in the above text. William Whiston writes:

> But then as to the nature of the fix'd stars, 'tis in all probability the same with the sun's; and so each of them may have their respective systems of planets and comets as well as he has. Which things, considering that the number of them is continually found to be greater, according as the telescopes we use are longer and more perfect, do vastly aggrandize the idea of the visible universe; and ought proportionally to raise our admiration of the Great Author of the Whole to the highest degree imaginable. (A New Theory of the Earth, p. 33.)

57. In her 1981 paper entitled "Hume, Noxon and Newton," Christine Battersby cites the following resonance between Hume's writing and the Opticks of Newton. In the Treatise, where Hume is discussing absolute time and arguing that our idea of time is built up by the mental succession of experienced events, Hume references John Locke and gives an apparently Lockean example to prove his point. Hume writes, "If you wheel about a burning coal with rapidity, it will present to the senses an image of a circle of fire; nor will there seem to be any interval of time betwixt its

revolutions...." (T 35) Battersby cites the actual passage from Locke which presents a very different image with a metaphor to the "Images in the inside of a Lanthorn, turned round by the Heat of a Candle." (John Locke, An Essay concerning Human Understanding, ed. P.H. Nidditch [Oxford: The Clarendon Press, 1975], p. 184.) The specific image to which Hume appeals in the Treatise, our perception when wheeling a burning coal about us with rapidity, is used twice by Newton in the Opticks (Sir Isaac Newton, Opticks or a Treatise of the Reflections, Inflections & Colours of Light. Based on the Fourth London Edition, 1730. [New York: Dover Publications, Inc., 1952], pp. 141 and 347.)

58. Newton, Opticks, p. 169.

59. The idea of a geological catastrophe had been popularized by Thomas Burnet in his Theory of the Earth (1681-90) which, by 1700, had been the subject of thirty-two rebuttals including that of William Whiston, A New Theory of the Earth (1696.) There are many other discussions in which the authors, like Philo in Part 6 of the Dialogues, argue that "...it may rationally be supposed, that there were then great Mutations and Alterations made in the superficial part of the Earth...." (This quotation is from John Ray, Three Physico-Theological Discourses [London, 1721], p. 121.) Jones flatly ignores this mention by Hume of fossils and geological upheavals and instead states that "there is no reference to Buffon's exciting speculations on the origins of universe or of man, no apparent interest in Hutton's revolutionary geological theory which had developed over thirty years from the 1750s...." (Hume's Sentiments, p. 17.) As I mention in the text, Hume may not be referring to the strictly geological notion of cyclical mountain building and erosion. The perpetual circulation of matter may be a reference to the alchemical view of the operation of aether possibly as entertained by Isaac Newton. Here is a quote from Newton's Correspondence which is hauntingly similar to the idea briefly sketched by Hume. Newton writes:

> For Nature is a perpetuall circulatory worker, generating Fluids out of solids, and solids out of Fluids, Fixed things out of volatile & volatile out of fixed, subtile out of gross & gross out of

> subtile. Some things to ascend & make the upper terrestrial juices, Rivers and the Atmosphere; & by consequence others to descend for a Requitall of the former. And as the Earth, so perhaps may the Sun imbibe this Spirit copiously to conserve his Shineing, & keep the Planets from receding further from him (Newton to Oldenburg, 7 December 1675. The Correspondence of Isaac Newton, 7 vols. Edited by H.W. Turnbull, et al. [Cambridge: Cambridge University Press, 1959-77], 1: 366.)

Regarding the alchemical nature of this text, see J.E. McGuire, "Transmutation and Immutability: Newton's Doctrine of Physical Qualities," Ambix 14, No. 2 (June, 1967), p. 85.

60. The Newtonian, J.T. Desaguliers, to take one example, had utilized Newtonian cosmogony as a model for understanding the microscopic world. (See Arthur Quinn, The Confidence of British Philosophers. An Essay in Historical Understanding [Leiden: E.J. Brill, 1977], p. 76.) Whiston, to take another example, writes that the microscope reveals "entire Bodies themselves in parvo." (Whiston, A New Theory of the Earth, pp. 299-300.) Nearer to Hume's day, Henry Baker had published his very popular (though undoubtedly not serious) The Microscope Made Easy in 1743 which is supplemented in 1753 with his two-part Employment for the Microscope. In the former work, Baker writes about how Malpighi, Leeuwenhoek, Hooke, Grew, and others all "bear Witness, that the Microscope has discovered not only in the larger Seed, such as the Walnuts, Chestnut, ... &c., but also in the smaller...." (Baker, The Microscope Made Easy [London, 1743], Part ii, Chapter xlvi.)

61. If a similarity must be insisted upon, the problem is that the inference reveals "a mind like the human," thus making Hume's transition from arguing about the analogy between human products and natural things to, instead, arguing about what possibly may be inferred about the nature of the creator if one takes the analogy as a given.

62. First espoused by Descartes in the Principia Philosophiae (Oeuvres de Descartes, 12 vols., ed. C. Adam and P. Tannery [Paris, 1897-1910], 8:156-7), the theory of the cometary origins of the earth gained wide recognition in the first

half of the eighteenth century as the result of William Whiston's A New Theory of the Earth which went through six editions during the first half of the eighteenth century. In his remark about a comet possibly being the "seed" of the world, Hume may be referring to Descartes or Whiston. Hume may have known Whiston's New Theory directly (as Berkeley did) or through the lengthy summary of Whiston's New Theory in Buffon's Histoire et théorie de la terre, vol. 1, Histoire naturelle (Paris, 1749), Premier discours, Article II. Jones points out (Hume's Sentiments, p. 17) that Hume owned "some volumes" of Buffon's great work in 1766 and is surprised that Hume does not refer to him. It may be (though it need not necessarily be) the case that Hume's reference to a cometary seed is to Whiston via Buffon.

63. It is Hume's view that the only job for a scientist (or a man of letters speculating about the limits of such inquiries) is to describe particular sequences of events and, thus, to build up a picture of the structure and behavior of natural processes and mechanisms. Seeking for the "ultimate cause" of the whole is beyond, as far as the moderate sceptic Hume is concerned, what a scientist or any other human being can hope to attain. For a clear and accurate account of Hume's views on causal explanation in science and the vanity of pursuing "ultimate causes" after the manner of Newton, see Donald W. Livingston, Hume's Philosophy of Common Life (Chicago: University of Chicago Press, 1984), Chapter 6, especially pp. 160-7. The effect of this searching analysis is once again to place Hume within the sphere of Newtonian influence. Livingston shows how Hume is a sceptical critic of Newton's search for ultimate causes but points out that Hume's standpoint is not from outside of the tradition of belief in ultimate causal connections -- "it is rather the result of a searching examination of one who is still within the tradition" (p. 166). For corroborative texts from the Dialogues, see pp. 174 and, especially, p. 191.

64. Hauksbee's electrical experiments before the Royal Society in 1705-6 provoked Newton's theorizing on electricity, a subject which he had not touched upon for thirty years. In his theorizing concerning the binding effect of electrical forces upon the particles of bodies,

Newton emphasizes their extreme elasticity. According to Westfall, "When he reintroduced an aether of similar qualities into his philosophy a few years later, he argued from its properties that it was composed of particles that repelled each other powerfully. (Richard S. Westfall, Never at Rest. A Biography of Isaac Newton [Cambridge: Cambridge University Press, 1980], p. 747.) J.L. Heilbron has argued recently that Newton finds support for his later view concerning the connection between electricity and gravity in the experiments of such disciples as Hauksbee and Desaguliers. In an unpublished draft addition for the Opticks edition of 1717/8, Heilbron states that Newton "discusses a microscopic correlate of the gravitational aether...." (J.L. Heilbron, Physics at the Royal Society during Newton's Presidency [Los Angeles: The William Andrews Clark Memorial Library, U.C.L.A., 1983], p. 64.)

65. During Hume's last years, Pringle became embroiled, as President of the Royal Soceity, in a controversy with King George III concerning the most effective design for lightning rods. The chief advocate of the pointed conductor was Benjamin Franklin, prize-winning Fellow of the Royal Society and, from 1775, an active rebel against crown rule in the American colonies. On political grounds, the King rejected the pointed conductor advocated by the rebel leader and the Royal Society and installed at the royal palaces the rounded, blunt lightning rod. In 1777, King George met with Pringle and urged him to use his influence within the Royal Society to reverse the Society's official stand favoring the pointed conductor. Pringle, in a reply worthy of his departed friend and patient, David Hume, replied, "Sire, I cannot reverse the laws and operations of nature." Because of his own age (71) and because he had openly rebuffed the Soceity's royal patron, Pringle did not stand for re-election to the Presidency of the Royal Society in 1778. (Sir Henry Lyons, The Royal Scoeity, 1660-1940; A History of its Administration and its Charters [Cambridge: Cambridge University Press, 1944], pp. 193-4.) In 1762, at Hume's request (in his capacity as Joint Secretary of the Philosophical Society of Edinburgh), Franklin had sent Hume and the Philosophical Society a paper on the use of the lightning rod. (Ernest C. Mossner, The Life of David Hume, 2nd ed. [Oxford: The Clarendon Press, 1980], p. 394.)

66. David Hume and Alexander Munro, Editors, Essays and Observations, Physical and Literary, Read before a Soceity in Edinburgh and Published by them, Vol. 1 (Edinburgh, 1754), pp. vi-vii. This text is reprinted in Scots Magazine XVI (1754), pp. 185-6.

67. T.E. Jessop, "The Misunderstood Hume," in Hume and the Enlightenment. Essays Presented to Ernest Campbell Mossner, ed. William B. Todd (Edinburgh: The University Press; Austin: University of Texas Humanities Research Center, 1974), p. 12.