

## Régis and Rohault

In the history of philosophy, Jacques Rohault and Pierre-Sylvain Régis bear a twofold burden. They are professed followers, epigones. Worse yet, the natural philosophy they teach has been consigned to the Tartarus of fable: not a theory that failed, but something that failed even to be a theory. In the years in which they were turning Cartesianism into a system, Newton and Huygens were preparing its demise. Its empirical claims were refuted, its mathematics was rendered obsolete by the calculus, its vortices and channelled magnetic particles met with the same rough justice Descartes meted out to Scholastic forms and qualities.

Canonical history has little use for such figures. It prefers originals. Yet if ideas and arguments are not to seem to pass magically from one great mind to the next, we must have some account of the channels through which what was once novel and unique sediments into cliché and common ground. Those channels are not without bias and noise. Inevitably, currents from different streams meet and mix more or less coherently in the works of secondary figures, especially in the competitive intellectual world of the later seventeenth century, with its sometimes ferocious polemics fuelled by religious and political opposition. Cartesianism became a movement and—to use Leibniz’s word—a sect, divided within by disputes over the legacy of its founder, and facing opposition without from steadfast Aristotelians, pious theologians, and the avant garde of the new science.

In Régis and Rohault Descartes’ legacy took the outward form of “system”. They present themselves as reworking Cartesian concepts and arguments into something coherent and comprehensive. Rohault, the more modest of the two, aims to reform the teaching of physics, still weighted by the dead hand of Aristotle. He will retain for the old philosophy only what is true and conjoin it with the new physics of Descartes, in whom France is no less fortunate than Greece once was in Aristotle (Rohault 1718, “Præfatio”). Régis, following the plan of the School textbooks, adds to his lengthy treatment of natural philosophy a logic, a metaphysics, and a morale. Other works, he says, pile up experiments, propose hypotheses pell-mell, mix together metaphysics and logic with moral philosophy; and when those parts are combined,

they yield only a “deformed and monstrous” body . He offers instead a “clear and easy System”, so arranged that his readers will even be able to “learn Philosophy themselves without recourse to any Master” (Régis 1690, “Preface”, p. \*\*r-v).

In the effort to systematize and to popularize Descartes’ philosophy, Régis and Rohault found themselves confronting experiments and objections not faced by the master himself. Anatomists had shown Descartes’ anatomy to be mistaken if not fantastic. Régis must adjust the description of the animal-machine to fit: the pineal gland is dethroned and the centre ovale takes its place. Both authors revise the rules of collision, both explain phenomena unmentioned by Descartes himself—the moon illusion, the periodicity of certain fevers. As for objections, in his Entretiens, Rohault attempted to defend Cartesian accounts of transubstantiation and the animal-machine. The metaphysical part of Régis’s Système skirmishes repeatedly with Malebranche. Later, as the inheritor of Rohault and chief defender of the Cartesians of Paris, Régis answers the criticisms of Daniel Huet and Jean-Baptiste Duhamel; his last work was a defense of the compatibility of faith and reason.

Their extensions and retoolings of Descartes give their work an interest beyond that of documenting the reception of his philosophy. Like us, they find themselves engaged at times in rational reconstruction. They rearrange arguments, they decide what a true Cartesian ought to say in response to new questions. Compared with us they have two advantages. They are writing just decades after Descartes’ death, and they do not know what is to come. They do not know that Newtonianism will sweep away their falsehoods and replace them with truths. Régis, though he disclaims any concern to be original, in fact elaborates positions that struck some of his contemporaries as both un-Cartesian and pernicious. Y. M. André, in his Vie de Malebranche, warns his reader against the “false Cartesianism” of Régis: “his metaphysics is filled with erroneous maxims that sap the foundations of all the science”, his moral philosophy “is horrible in all its parts”, and “in a word, no Escobar, no Banné has carried laxity so far”: (quoted in Malebranche 1960, 17/1:248). Even by the standards of the time, this is harsh. Indeed Régis, amid paraphrases and almost verbatim borrowings from Descartes, the Port-Royal Logic, and Rohault, offers propositions that, if not un-Cartesian, do play up radical tendencies in his predecessor’s thought. So much so that his opponents did not shrink from invoking the dread name of Spinoza to impugn them.

In what follows, after a brief account of the careers of Régis and Rohault, I take up three topics: divine power, ideas and the vision in God, matter and the void. I do so in preference to a survey of positions. Such may be easily found elsewhere. I aim to show that not only for those interested in the outward face of Cartesianism but for those interested in its evolving, sometimes disputed content the systems of Rohault and Régis merit study. Because Rohault’s Traité

de physique is mostly concerned with physical questions, I devote the greater part of this essay to Régis. Not only is his work more wide-ranging, but his controversy with Malebranche and his genuine, if sporadic, originality give his views broader interest for historians and philosophers alike.

## 1 Teacher and student

Rohault was of that generation for whom the new science, not yet present in the universities, was acquired by self-study (Rohault 1718, “Præfatio”, p.a4v; Clair 1978, p.25; in what follows I draw on Clair’s excellent bio-bibliography and the earlier work of Mouy). He was born at Amiens in 1618 to a family of merchants. His early education, no doubt Aristotelian, was at the Jesuit collège of Amiens. By 1650, the year of his marriage to Nicole Filasssier, he had relocated to Paris as a “professeur des mathématiques”. An office of contrôleur des bois for Paris, purchased in 1649, and properties at Les Halles provided his modest income (Clair 1978, p.26).

Though the precise date of his conversion to Cartesianism cannot be ascertained, by 1655 Rohault had begun his famous conférences, which met on Wednesdays at his residence on the Rue Quincampoix not far from Les Halles. At these gatherings, attended by the scientific and on occasion the social elite of Paris, and by foreign visitors like Huygens, Rohault treated physical questions of all sorts. Each session began with a lecture of about an hour, and continued with a discussion of questions and objections, all in a “peaceable and gentlemanly [honnête]” manner. Some lectures included demonstrations; one auditor’s notes imply that graphic figures were displayed or circulated (Clair 1978, p.52). Contemporaries judged Rohault to be an able expositor, a bit pedantic perhaps, and on occasion pugnacious (Clair 1978, p.46, 48). Their reports show that Cartesianism owed a great deal to his seventeen years of teaching.

Rohault’s first wife died in 1663. Claude Clerselier, Descartes’ literary executor, seeing in Rohault the future champion of Descartes, determined that his daughter Geneviève should marry him. This despite the displeasure of Clerselier’s family at a mésalliance with a man who, though of “fort honnête famille”, was of mediocre station—and the reluctance of the prospective son-in-law himself. Nevertheless Clerselier, who wanted the marriage “out of consideration of the philosophy of Descartes”, persisted, and the two were wed in 1664 (Baillet 1696, 2:241–2). Rohault thus became an intimate of the keepers of the flame. When Descartes’ remains were translated from Stockholm to Paris in 1667, he was among those invited to the ceremonies (Baillet 1696, 2:442).

Rohault published little until the year before his death in 1672. The Traité de physique was, however, essentially complete in 1663; from it was published in 1664, in the first French edition of Descartes' Monde, a treatise on fever. In the preface to the Traité Rohault writes that he decided to publish because defective copies of notes from his lectures were being circulated (Rohault 1671a, p.[xxvi], Rohault 1718, “Præfatio”, a4v). The Traité was an immediate success. Within five years, it enjoyed nine printings (one pirated) and four editions; its last edition in French was in 1730. Latin translations, the most notable that of Samuel Clarke, appeared from 1674 to 1740. John Clarke's English translation of his brother's Latin first appeared in 1723. The Traité thus enjoyed some currency for over fifty years.

Clarke's translation was a battleground between Newton and Descartes, and in successive editions, the dissent at the bottom of the page grew ever more prominent. Rohault's work, thus inoculated, became “the standing Text for Lectures [at Cambridge]”; its annotations became “the first Direction to those who are willing to receive the Reality and Truth of things in the place of Invention and Romance” (Clarke 1738, 1:ii). Reality and truth sometimes leave Rohault but one or two lines per page. Seldom has the proverb traduttore traditore been so well exemplified. Nevertheless, Clarke's interventions (admittedly on crucial questions like the essence of matter, the void, vortices, gravity, and light) leave much of the work untouched—most of the sections on terrestrial phenomena (the rainbow excepted) and almost the whole section on the human body. The now polyphonic work remained for many years the basis for teaching in England and elsewhere.

Rohault's other works did not fare so well. His Entretiens sur la philosophie, published without his consent in 1671 from one of the copies then circulating “in secret” (Rohault 1671b, p.107), defend Cartesian doctrine on transubstantiation and the animal-machine. They deserve study, especially now that Clair has made them available. A posthumous collection, edited by Clerselier, of works on geometry, physical questions, and fortification, was published in 1682 with just one subsequent edition (though the Mécanique was published separately as late as 1723).

Among those converted to the new philosophy was Régis, some fourteen years younger and like Rohault from the provinces (Mouy 1934, p. 145–147). He was educated in theology at the Jesuit collège at Cahors. Arriving in Paris to complete his education, he attended Rohault's lectures. He showed enough promise that Rohault sent him to Toulouse to disseminate the new science, which he did, very successfully, there and elsewhere. On his return to Paris in 1680, he took up the mantle of Rohault, again with great success. But the King's confessors, having “most hideously depicted” the new philosophy to him, persuaded the King to order Harley, the archbishop of Paris, to end the teaching of Cartesianism. After just six months, Régis gave up

his lectures. The King’s confessors “were charmed to see the authority of Aristotle confirmed by that of the King” (André in Malebranche 1960, 17/1:247). Ten years of negotiation, and a loosening of strictures on Cartesianism, had to pass before Régis’s Systeme could be published. Like Rohault’s Traité, it was a success. Régis’s later works include defenses of Cartesianism against attacks by Huet and Duhamel, and a last work exhibiting the concordance of reason and faith (L’usage de la raison et de la foy, 1704). In 1699 Régis, along with Malebranche, was finally admitted to the Académie des Sciences; poor health prevented him from attending its séances. He died in Paris on 7 June 1707.

The careers of these two Cartesians exhibit a pattern of which other examples are easily found. Those who underwent conversion to the new philosophy were said to be—and felt themselves to be—transported from obscurity to clarity, from darkness to light. They entered a new universe. However much we may now wish to insist on continuity, the new science did come as a revelation to some—especially to those whose education was Aristotelian, and whose discovery of the new science came during or not long after their years in school. Rohault picked it up on his own; Régis had the benefit of entering an established circle of adherents. Both were able to attain prominence in Paris and elsewhere as exponents of the Cartesian science. That Cartesian science was rentable is significant. Gassendi’s philosophy, even as digested by Charleton and Bernier, did not enjoy the same success. Philosophers tend to ignore such differences. Reception is messy, noisy, unjust; and one has only to read Bayle’s Nouvelles de la république des lettres to see that “Cartesianism” designates no fixed point, no permanent body of doctrine enshrined in a collected works. It is instead, until its definitive supersession by Newton and Locke, an arena of controversy, disputed titles, and fluid conceptions yet to be frozen into idealities like “rationalism”.

## 2 Divine will, eternal truths, the laws of nature

Régis’s Descartes is a thoroughgoing voluntarist. God is “perfect thought”, or, in more customary language, “a substance that thinks perfectly” (Régis 1690, 1:86). He is perfectly simple, admitting of no intrinsic distinction. His understanding and will, therefore, do not differ from each other or from their operations. Régis can happily take over the Thomist formula that God is pure act (89). Hence there can be no priority of the understanding over the will. It is a mistake to suppose (as Malebranche does) that God, in creating the world, contemplated his own essence as if it were “the fecund source from which he could draw forth [...] every sort of reality and truth, whether that which regards the simple possibility of things, or that which

regards their existence”. God is not “being in general”, not the infinite ground of possibility. On the contrary: “for a thing to be conceivable to God, it is absolutely necessary that it receive from his will the degree of truth and reality that it possesses”. Otherwise it would enjoy, at least in its being possible, an independence from God which is “repugnant to the nature of a perfect being”.

Possibility and impossibility come to be by the free decree of God, which is simply his will in act. Possibility, in Régis’s usage, applies to “modal beings”, that is, to “substances themselves” modified in various ways (1:102). Extension in general, for example, is not a modal being, but every extended thing is. Before the divine decree, there are no substances, hence no modal beings, hence neither possibility or impossibility (save the logical impossibility of contradictions). Possibility, in short, resides in things.

The eternal truths likewise do not exist prior to the divine decree. They are, as Descartes said, created. Materially, an eternal truth is nothing but a modal being; formally, it is the act by which the mind conceives that modal being. “For example, extension and three sides are the matter of a geometric triangle, and the action by which the soul considers the three sides as existing in extension is its form” (1:178). Formally, therefore, the eternal truths do not exist apart from the minds that consider them. Materially, they “suppose actually existing things”; they “consist in the substances that God has created” (179). Those substances are not eternal. Only the uncreated is eternal. Neither, therefore, are the truths that subsist in them. They are not eternal, but only immutable: “substances may always be compared, and God has willed that all souls should be determined to conceive the same truth when they compare things in the same manner”. Their immutability is not absolute but dependent (180).

By the same token there is no order antecedent to creation. “I see quite well that a certain order that till now I regarded as preceding the decree, and serving as a rule for [God’s] conduct, is a pure fiction of my mind”. It was based on a false analogy between my own will and God’s. My own will must follow the order established by God. But God’s will is his decree, it is that order. Nothing antecedent to the decree has, to use Malebranche’s phrase, “the force of law in regard to God himself” (Malebranche 1960, 3:138).

Régis here faithfully follows out the implications of Descartes’ 1630 letters to Mersenne—the locus classicus for the doctrine of the creation of eternal truths. If we consider God “before” creation (since God exists always in actu, ‘before’ denotes priority in essence, not in time), his perfection consists in his power alone, in the dependence of all things on him (Régis 1690, 1:86). For Malebranche, on the other hand, God’s perfection includes not only power or will but representation. God “includes in himself in an intelligible manner the perfections of all the beings he has created and can create, and it is by those perfections that he knows the

essence of all things” (Malebranche 1960, 3:136). Were Régis’s God to contemplate himself before creation, he would encounter only his own necessary existence, not, as Malebranche supposes, the essence of all that is and can be.

The dispute between Régis and Malebranche descends to earth in their treatment of monsters (see Roger 1971, p.400–403). Malebranche’s God, whose general volitions follow the rule of order, has established certain laws governing the actions of matter. Those laws apply in particular to the action of the imaginations of mothers upon their fetuses. The result is that sometimes the offspring will be deformed. God foresees that such events will occur when he establishes the laws of nature. But foresight does not imply intention. “Having formed the design to produce an admirable work by the simplest ways and to bind all his creatures each with the other”, God executed his plan despite the imperfections in individuals that inevitably would follow upon it (Malebranche 1960, 3:483). Though the first animals of each kind, created by particular volitions of God, must have been well-formed, after that generation becomes the affair of material causes operating according to laws. The bodies of the descendants of Eve and Adam, well- or ill-formed, are the objects only of general volitions. “God by the laws of nature does not will the making of one animal alone, he wills a world”. A world in which, as it happens, monsters occur; this by the demand of order (3:90; see also 339–340).

Order demands nothing of Régis’s God. Simplicity is a requirement imposed on the study of nature by us, not by God. It cannot be, then, that God, observing order, creates the world by way of general volitions which cannot but lead to imperfection in particulars. He is not like a king “who governs a kingdom through general laws because he has not the power to lead each of his subjects himself”. No distinction can be made, in fact, between general and particular volitions. Régis strongly suggests that even to speak of volitions in the plural is repugnant to divine simplicity. Fair weather and foul, however contrary, “are two effects of one and the same volition” (Régis 1690, 1:92).

In agreement with Arnauld, Régis holds that it is no use to say that “God produces Monsters, though he would rather that there weren’t any, but is obliged to produce them to satisfy the simplicity of the Laws of nature” (Réflexions philosophiques, quoted in Roger 1971, p.401). Those laws are nothing other than God’s will itself. To hold that he does something in accordance with them that he would rather not is contradictory. Instead we must say that if God created the germs of all living things at once (a claim argued for elsewhere by Régis), then “there is nothing in the world, save moral evil, of which God is not the author”, nothing he does not produce himself “in a positive manner”. The underlying thought, a radical but not unreasonable extension of claims made by Descartes, is that the very idea of natural evil presupposes



ends in the act of creation. But there are no such ends. A theodicy of natural evil is superfluous.

### 3 Ideas

The mind, like God, is a thinking substance, but imperfect, mutable and finite. One mutation undergone by the mind is its acquisition of new powers in union with the body. Régis denotes by the term esprit or ‘mind’ finite thinking substance considered simply as such. The mind modified by union he calls âme or ‘soul’ (Régis 1690, 1:113). Only the soul is capable of sensing, imagining, experiencing the passions, moving bodies. Apart from the body the soul retains only its power to conceive spiritual things and to love God (1:269–270).

There is every reason to suppose, then, that the mind can think of bodies only when it has one. Indeed the idea of extension in general is essential to the soul. That idea comes to it not from the senses or the imagination or from comparing ideas of sense, but from its own nature: that is, from its being a thinking thing modified by union with an extended thing (1:158–159). It is impossible, Régis says, that “the soul should perform any function in its quality of being a soul without perceiving of itself as it performs [the function] that it depends on the body it animates” (161). Everything that makes us actually and specifically human depends on the body, and to operate as human entails the perception of that dependence.

Every idea has an “exemplary” cause, which considered precisely is nothing other than what it represents (1:77). The term cause exemplaire, borrowed from Scholastic classifications of causes, and ultimately from Platonism, typically denotes the model or plan of a thing, considered not as an end but as an efficient cause in the mind of its maker. “Such are in general all the objects on which God forms the ideas of the soul, which represents them” (1:77). Note the direction of fit: ideas are formed on the basis of their actual causes. It is possible that the same applies to God himself. If before creation he is pure will, then the act of making bodies will be at the same time the act of knowing them. Our actions are subordinated to the ideas God has given us; God’s actions are subordinated to no pre-existent conception.

Descartes took it to be unproblematic that there are two orders of being: in reality and in thought. The sun in my perception is the sun itself existing in the manner of a thing thought: an objectum (Descartes 1964–1991, 7:387; see also 102–103). Malebranche preserves the distinction. In Descartes’ conception, however, the order of thought is instantiated both in God and in human minds; for Malebranche it exists in God’s mind alone. Our idea of extension is a divine idea which, by an act we must accept on faith, he made real in the world around us.



Régis does not deny that there is an order of thought. He appeals to that order in his version of Descartes' causal proof of the existence of God. But so far as ideas of body are concerned, he approaches a kind of direct realism. To think of an extended thing is to be modified by that thing in a certain way, or to be modified by a material impression left by that thing in the brain. Hence, where bodies are concerned, there is no need for an order of thought antecedent to the union of body and soul. The soul may as well acquire the idea of extension (which includes the ideas of its modifications) through the union itself.

Régis was therefore bound to reject one of Malebranche's most celebrated theses: the vision in God. When the soul is occasioned to think of the Sun by way of vision, and thus comes to think of a sphere, that thought consists in its being united with a spherical portion of the idea of extension, or "intelligible" extension, in God. Malebranche argued the claim at length in the Recherche, again in the tenth Éclaircissement, and once more in the reply to Régis that I will discuss below. Régis, mentioning, as he rarely does, his contemporary Malebranche by name, attempts to refute the arguments of the Recherche.

First of all, Malebranche writes, God acts in the simplest ways. The simplest way for God to reveal bodies to our understanding is to will that the soul "should see what is in its midst, namely God's own essence, which represents all bodies" (Régis 1690, 1:185, paraphrasing Malebranche 1960, 1:338). Moreover, the vision in God "poses a genuine dependence between God and the soul"; the soul depend on God not only for its existence but immediately for its perceptions too. But the soul, says Régis, could see bodies in God only by virtue of being united with God. That union cannot be the union of two bodies, nor that of two minds, or of a body and a mind. Those sorts of union require mutual interaction; but the human mind does not act on God. What remains is only the weaker union of cause and effect, which must be reciprocal. God is of course united with the soul in that way as cause to effect, but "only insofar as he has created it and conserves it and produces in it all its ideas and sensations in his capacity as first cause" or as the exemplary cause of the idea of a perfect being; and the soul of course has no causal effect on God (Régis 1690, 1:185).

The vision in God is supposed also to explain our manner of thinking about particular things. "When we would like to think of something in particular, we direct our view first toward all beings and then apply ourselves to the consideration of the object we wish to think about" (Malebranche 1960, 1:340). Hence when we desire to see various beings one by one, "it is certain that all beings are present to our mind". That can be true only if God himself, who "includes all things in the simplicity of his being", is present. Régis does not take issue with Malebranche's phenomenology. The ideas of all extended things must indeed be confusedly present to the mind. But "their presence is nothing other than the very idea of extension that

God has put in the soul in uniting it with the body”. Moreover if God included all beings, those beings would be “integral parts” of God. God would not be utterly simple. He would be composed of those beings “as a watch is composed of wheels and springs” (Régis 1690, 1:187).

The only end in divine action—Malebranche here takes up a traditional claim—is God himself. Hence not only the love but the knowledge God has given us must “bring us to know something in him; for all that comes from God can only be for God” (Malebranche 1960, 1:342–343). All that we love we love through the “necessary love we have for God”. All particular loves are determinations of that love. So too all we know we know by way of our “natural knowledge” of God, and all our ideas are “limitations of the idea of God”.

Régis does not reject the traditional claim. But he does reject the consequence. “In order that God should act principally for himself, it is not necessary that we should see bodies in God” (343). It suffices that we see them in our own ideas so long as doing so disposes us to praise God. If, as Malebranche holds, the ideas of bodies are inseparable from the idea of God, that is not because they are limitations of it but because God has given us, through our intercourse with bodies, the idea of extension in general, of which ideas of particular extended things are limitations. Régis is careful to note that by ‘extension in general’ he means not the abstract idea of extension, which exists only in thought, but the indefinitely large space of which every individual body is a portion. Rather than a vision in God we have a vision in bodies themselves.

Malebranche’s reply, which I will not discuss, succinctly restates the argument for the vision and then answers each of Régis’s objections. What is significant in their exchange is best brought out not by looking back at Descartes, but forward to Hume and Kant. Order provides Malebranche with an criterion of intelligibility, on the basis of which human reason can arrive at a priori conditions governing the created world. We know, for example, that God prefers souls to matter, that he acts in the simplest ways, that the distribution of grace must be just, even by our lights, if only we understood well enough the underlying reasons. If, on the other hand, as Régis would have it, the divine understanding is blank before creation and the accompanying decree, then divine nature—the only necessary existent—sets no conditions at all on the laws of the world. What remains is: experience, by which we learn the laws of nature; the conventions by which human beings out of the state of nature chose to govern themselves according to their natural good; and revelation, our sole source of knowledge for the laws of Christian society (for this, see the moral part of Régis’s Systeme). There is one exception. Divine immutability places, as it did for Descartes, a formal constraint on God’s execution of his decree. From this the basic laws of natural change may be derived. But even their content is subject to God’s free creation of the essence of body, which we come to know (as in Spinoza)

by way of its constant presence in our perception. If the function of God in seventeenth-century philosophy is to function as a repository for the a priori conditions of scientific and moral knowledge, then for Malebranche that repository is rich and full; for Régis, it is all but empty.

#### 4 Matter and the void

The principles of natural things, according to Rohault, are matter and form (Traité, 1c6; Rohault 1718, p.19–20). The first part of the Traité, after preliminaries on ideas, words, and method, is built around that distinction. Rohault is not endorsing the hylomorphism of the Schools. Matter and form are admissible only if correctly understood. Matter, or the substrate of change, is extension, space itself. Form, or that by which one natural kind is distinguished from another, is figure, without which no part of space can be conceived.

It is true that if matter is extension, that heat and cold and other sensible qualities do not exist in things, as Aristotle thought, but only in the mind (1c7no2, 1c2no41–43; Rohault 1718, p.21, 11). Form, if it is figure, exists in things but is no substance. Cartesian matter and form suffice to explain natural change, and do not exceed the limits of clear and distinct perception. The real accidents and substantial forms of the Schools are excrescences. Physics has no use for them; and theology must attend to physics.

Matter, being space, is divisible and impenetrable; moreover there can be no vacuum. These are for Rohault immediate consequences of the Cartesian conception. I will consider them in turn.

1. Divisibility. There is no difference in nature between the parts of matter and the whole. Hence if the whole is divisible, so too are the parts. Even if every actual or potential part of matter must be conjoined with others, none depends on any other for existence. It was within God's power to have made some particles "of a sort that nothing in universal nature could make capable of division" (1c9no2; Rohault 1718, p.29). But the indivisibility of those particles would owe everything to God's will and nothing to the nature of matter. The only difficulty, then, is to determine "into how many parts a certain portion of matter may be divided". The answer, argued geometrically and empirically is: indefinitely many.

But some might hold it absurd that a part of matter should be indefinitely divisible. A small cube could then be sliced so finely as to cover the Earth. Rohault replies that the objection arises from a failure of imagination: but reality easily exceeds its limits. The experience of lens makers shows that an ounce of gold, which in the shape of a cube will have a base of about one-sixth of an inch, could be flattened or drawn out to cover about 160,000 or even 320,000

times that area. If merely human tools can accomplish so much, Rohault concludes, we must not dare to put limits of the power of God.

The estimates above are painstakingly calculated by Rohault, as if to enlist the reader's assent by their precision and vividness. Moreover, we see that, knowing the density of gold and the desired thickness of leaf, one can calculate in advance the amount of gold required. No doubt the craftsmen whom Rohault was in the habit of observing had rules of thumb for such things. But Rohault is beginning to turn that craft into applied science—admittedly not profound science, but still worth noting as a small instance of the transformation of technè into technology.

2. Impenetrability and solidity. Every part of matter is impenetrable per se. But some macroscopic bodies are solid, some liquid. It is surprising, in view of the controversy recorded in the correspondence of Descartes and More, that neither Rohault nor Régis devotes more than a few lines to impenetrability. The argument they give is already in Descartes. A cubic foot of matter, Rohault writes, “already has all that is necessary to such a magnitude”; it does not seem that another cubic foot could be added without its becoming two cubic feet. Parts of matter—regions of space—are individuated by their termini. Parts with the same boundary are not two but one (Traité 1c7no6; Rohault 1718, p.22). The argument is sound. But the conclusion follows only if parts of matter are indeed regions of space and nothing more.

Solidity, for a Cartesian, is first of all resistance to motion, especially to touch. A solid is a body that “consists in parts at rest among themselves so that their connection and continuity is not interrupted by any intervening matter” (1c22no9, Rohault 1718, p.110–111). Clarke replies that mutual rest is neither sufficient nor necessary. Quoting Newton's Optica (Newton 1730, p.388–389), he argues that particles cohere “not by rest (which is, rather, Nothing) but by mutual attraction”, an attraction which, Newton admits, can hardly be conceived. The hardness of a body depends on the mutually contiguous area of its particles. On the basis of that and some further assumptions on the situation and movements of particles, Newton and Clarke propose to explain elasticity, malleability, friability, flexibility, and melting.

Newton's hypothesis is closer to the truth than Descartes'. Solids do cohere by the mutual attraction of their constituents. But Newton and Clarke's explanations are hardly less inventive than the Cartesians'. Their methods are similar: a collection of phenomena is gathered (Descartes and Rohault are as avid as any avowed Baconian). It is explained according to principles supported in part by a priori arguments, in part by retrodution, in part by refutation of alternatives. The difference would seem to be first, that Newton does not observe the requirement that the concepts employed in natural philosophy be clear and distinct; second, that mathematical

control of the drawing of consequences from physical models, and the experimental control of experience by which to test them, are more extensive and secure.

3. The void. If space is matter, no part of space can be empty. “To ask if there is space without matter is the same as asking if there is matter which is not matter” (Régis 1690, Phys. 1pt1c3, 1:285; Rohault, Traité, 1c8no1, Rohault 1718, p.26). Not even God can produce a void. But since Rohault, like other Cartesians, is loath to place any limit on divine power, he contents himself with saying that what we would “conceive”, if God were to annihilate the matter in a chamber without allowing any new matter to enter, is that the sides of the chamber would then be contiguous. So Descartes himself had said in the Principles. Régis, less cautious, says that God’s power cannot include that of producing “the Philosophers’ void”. Because it includes a “manifest contradiction”, it “cannot be the effect of a genuine power”. We take nothing away from God by denying him the power to bring about the impossible.

The impossibility of a vacuum is part of what Lakatos would have called the “hard core” of Cartesian physics. The Cartesian, having adopted the position, seeks then to answer objections and to explain the phenomena consistently with it. For example: it does no good to assert that if God annihilated all the matter in a chamber then what remained would be space without solidity. Space cannot, as we have seen, but be impenetrable (Régis 1690, 1:285). Instead one must explain only why in some regions of space the matter therein does not affect our senses. But for that purpose one may invoke the subtle matter already needed elsewhere.

By the time Rohault was writing the Traité, the scientific world was replete with experiments on the void. Rohault devotes over a dozen pages to the experiments of Torricelli, Pascal, and others. He himself was the inventor of a two-chamber device, the “chamber de Rohault” (Rohault 1718, p.69 and Tab. 1, Fig. 7, Mouy 1934, p.129).

The horror vacui of the Philosophers he dismisses outright. It is as if someone were to account for the movement of wood from the provinces to Paris by invoking a “fear of cold”. This is to give a final cause where an efficient is required (Rohault 1718, p.53). By the 1660s, however, the horror vacui was a dead horse. Cartesianism had more formidable opponents. Rohault considers in some detail the Torricelli experiment. A tube, at least 31 inches long, and full of mercury, is inverted and placed in a bowl. The column of mercury will descend until it is about 29 inches high, leaving a space at the top. That space was said by some to be a void.

Rohault must disagree. The space cannot be empty. It is indeed devoid of ordinary air (aer crassus). But the place of that air is taken by subtle matter.

(i) It is not empty. Rohault “empiricizes” a conceptual argument of Descartes. If heat is applied to the top of the tube, the mercury will descend. That must be because it is pushed down by something expanding within the empty space. Since nothing has no properties, noth-

ing cannot be pushing the mercury down. So there is something there. Moreover, if the space were truly empty, then light could not traverse it: yet we do see things through the top of the tube. Clarke rejects both arguments. The second relies on a false theory of light; the second implies not that the space is full but only that it contains some subtle matter or mercury vapor (Rohault 1718, p.61).

(ii) It contains no air. Birds and mice inserted into the empty space die. Flies become dormant. Moreover, if in inverting the tube one allows a little air in, one will see it rise through the mercury bit by bit, and the column of mercury will descend more slowly. But if no air is admitted, the column will drop suddenly, and nothing will be seen to pass through it. The space at the top is therefore not replenished with gross air.

(iii) It is filled with subtle matter. This is transmitted only through the pores of the glass (which it must have to be transparent). The pores of mercury are too small. One proof of this is an experiment of Wallis. If one takes care to purge all the air from the mercury (Wallis says that this is not easy), and then inverts a tube of airless mercury, a column of even sixty inches can be made to stand without descending. According to Rohault, the explanation is that the mercury prevents any subtle matter from entering. Clarke devotes a long note to refuting Rohault's account. Rohault "labors in vain" to explain how subtle matter enters the empty space. Subtle matter is, like the other Cartesian elements, entirely imaginary (Rohault 1718, p.107). The mercury column stands not because there is no subtle matter pushing it out, but by mutual attraction between the particles of mercury and those of the tube.

I emphasize the empirical aspect of Rohault's physics in part to dispel the myth of Cartesian inattention to experience. Rohault insists on the importance of experiments. There are, he writes, three kinds: the "simple use of the senses", the trial and error practiced by chemists, glassmakers, goldsmiths, and other craftsmen; and finally those experiments which, after reasoning from the natures of things, one gathers "in order to show whether [one's idea] is false or correct". If we understand the nature of a thing, we ought to be able to draw out new and unforeseen effects from our idea of it (Rohault 1718, p.a1r).

Note the imperative. Science ought to generate reasoned experiments. Newton himself could hardly have described its dynamic better. Why then did the Cartesians fare so badly? Part of the answer undoubtedly lies in their relative neglect of another emerging imperative. The reasoning by which consequences are drawn to be tested must be controlled by mathematics. Descartes' assertion, for example, that the fineness of the particles of a fluid decreases the resistance felt by bodies moving through it can be evaluated quantitatively (Newton 1730, p.365–369). Kepler's laws ought to be derivable from the vortex theory (as Fontenelle admitted, trying vainly to do so). Rohault is not averse to calculation. But a comparison his contem-

poraries Newton, Huygens, and Leibniz shows how unmathematical the Cartesians remained; their hypotheses were thus prone to refutation not just by experiment, but by physical arguments exhibiting their absurdity.

Another part of the answer can be summed up in the word hysteresis. Rohault and Régis propound the new science. Yet old habits persist. Like their counterparts in the Schools, they write textbooks. Like them too, they become (despite Rohault's advice) increasingly content to rationalize adverse experiments thrown up by their opponents. Overwhelming evidence does lead them to give up some of Descartes' own positions. But on the whole, and especially with respect to such questions as the essence of matter, their attitude is that of apologists. Others—Spinoza, Malebranche, Cordemoy—who began as Cartesians gave up or overturned key parts of their inheritance. But for Rohault, bound not only intellectually but personally to Descartes' guardian, Clerselier, and for Régis, his successor, Descartes' legacy was, it would seem, too dear.

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