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The Idea of Law in Science and Religion¹

For many, a central task of science is the discovery and formulation of the laws of nature. This characterisation of the scientific enterprise, although almost a commonplace today, is nevertheless of recent origin, more or less contemporary with the birth of modern science. It originated in the seventeenth century, when the leaders of the scientific revolution liked to describe their procedures as a break away from Greek science, as transmitted by the medieval scholastics. Laws of nature were introduced as a rival explanation of natural phenomena, which was meant to replace the Aristotelian categories. This article explores the characteristics of the modern concept of natural law, explains its possible biblical and theological roots and asks the extent to which this background can help us gain a renewed understanding of the scientific concept.

Keywords : law, science, religion, Newton, Boyle, occasionalism.

1. From Aristotelian natures to laws of nature

Laws of nature were introduced during the scientific revolution, in order to replace the Aristotelian concepts of substances and qualities, which up to that time had been used to explain natural order. The fathers of modern science thought that such explanations were seriously flawed. The older concepts were seen as obscurantist metaphysical constructs, allowing for no empirical control. The rhetoric against ‘occult qualities’ was such a common theme that it was even echoed in the literature of the time. In a memorable scene from *The Hypochondriac*, Molière describes how a medical intern is warmly applauded by his superiors after explaining the somnolent effects of opium by recalling its ‘virtus dormitiva’,² that is its capacity to make one sleep – which is no useful explanation at all. To explain the behaviour of things in terms of their ‘natures’, which we cannot explore empirically, appears as the medieval paradigm of obscurantism, from which the enlightenment of the new natural philosophy would free us.³

1 The article is based on a lecture given at the Faraday Institute for Science and Religion summer school in Cambridge, on 20 July 2006. I would like to thank Denis Alexander and Rodney Holder for having invited me, and Jason Rampelt for many helpful comments on an earlier draft. Two anonymous referees made helpful comments which allowed me to improve the text. The translation of the biblical texts is mine; Shannon Crawford assisted me with the exact wording in English.

2 The scene is situated in the Third interlude.

3 cf. Nadler, S. ‘Doctrines of explanation in late scholasticism and in the mechanical philosophy’, in Garber, D. & Ayers, M. (eds.) *The Cambridge History of seventeenth-century philosophy*, Cambridge: Cambridge University Press (1998), vol. I, pp. 513-552.

Rather than invoking substantial principles in order to explain natural phenomena, the new natural philosophers utilised legal metaphors. The writings of Robert Boyle provide us with interesting examples of this new approach. Take silver and its malleability. Boyle rejects the idea that a piece of metal is malleable by virtue of a substantial principle. The action of an outside agent (a hammer, for example) can just as easily rob the object of its malleability as another (fire, for example) can give it. Thus, malleability is not part of the nature of silver; but the behaviour of the metal is governed by natural law:

The accidents spoken of are introduced into the matter by the agents or efficient causes, whatever they be... And these accidents being once thus introduced into the matter, we need not seek for a new substantial principle to preserve them there, since, by the general law or common course of nature, the matter qualified by them must continue in the state such accidents have put it into, till by some agent or other it be forcibly put out of it and so divested of those accidents.⁴

Rather than attributing natural phenomena to the intrinsic nature of things, Boyle explains them in reference to the law laid down by the sovereign action of God.

In the same vein, Descartes replaces the scholastic concepts with the laws of nature in order to explain the presence of order in the world. This transition is particularly evident in his *Le Monde*, written during the early 1630s but only published after his death. In chapter 6 of this work, Descartes invites the reader to imagine a world for which matter allows a geometric description, but which would be entirely devoid of form in the scholastic sense of the word. The goal of this exercise is, of course, to convince the reader that such a world is not imaginary, but is in fact the very world in which we live. Yet, as Andreas Hüttemann observes,

the abolition of the ontological inventory traditionally used for the explanation of natural phenomena, such as real qualities and substantial forms, and the introduction of the geometric notion of matter, creates the problem of explaining the order and regularity in nature. The geometric objects of the Cartesian world move, but they move arbitrarily.⁵

The introduction of laws of nature serves precisely as a remedy for this problem; they secure the transition from 'Chaos, the most confused and tangled that the Poets could describe' to the harmonious world that we know:

For God has so marvellously established these laws, that while we had sup-

4 Boyle, R. *The origin of forms and qualities according to the corpuscular philosophy* (1666), in Stewart, M. A. (ed.) *Selected philosophical papers of Robert Boyle*, Indianapolis: Hackett (1991), p. 62.

5 Hüttemann, A. 'Chaos und Naturgesetz – Cartesische Probleme', *Zeitschrift für philosophische Forschung* (2002) LVI, 522.

posed that he creates nothing more than what I said, and even that he put in this neither order nor proportion, but that he composes Chaos, the most confused and the most tangled that the Poets could describe: they are sufficient to cause the parts of this Chaos to untangle themselves, and ready themselves in such good order, that they will have the form of a very perfect World, and in which one sees not only Light, but also all the other things, from the general to the particular, that inhabit this real world.⁶

Other scholars from the same period follow the same transition from substantial forms to laws of nature. Of course, Descartes' conviction that even mathematical laws depend on the divine will has remained the view of a minority, but others affirm just as clearly that the laws of nature express the exercise of divine omnipotence. Next to John Locke,⁷ for example, one must cite Isaac Newton, insofar as his adoption of this manner of designating the natural order serves as the definitive sign of victory over earlier concepts. At the beginning of his major work, the *Principia*, he writes: "The moderns, having rejected substantial forms and occult qualities, have undertaken to bring back the phenomena of nature to mathematical laws."⁸ Instead of giving an exclusively immanent explanation of movement, Newton emphasises that 'the motions which the planets now have, could not spring from any natural cause alone, but were impressed by an intelligent agent'.⁹

2. The idea of natural law in the Hebrew Bible

Without any doubt, European civilisation received the idea of created laws of nature from the biblical Scriptures, and in particular from their Hebrew section. It is therefore useful to present the biblical data in some detail, before going on to explore the new meaning that the long-known idea of created laws of nature took on in the seventeenth century.

From the very beginning, the Bible presents an objective order in nature. Already the first chapter of Genesis shows us the creation of a cosmos, of an ordered world. For example, the act of creation is structured in six days. The plants and animals are created each 'according to its kind'. The text particularly stresses the theme of separation: between light and darkness, sky and

6 Descartes, R. *Le Monde ou Traité de lumière* (1630?), in Adam, C. & Tannery, P. (eds.) *Œuvres de Descartes*, Paris : Cerf/Vrin (1909), vol. XI, p. 34f.

7 Locke, J. *Essays on the law of nature* (1663), Van Leyden, W., (ed.), Oxford: Oxford University Press (1954), essay I, pp. 108-110.

8 Newton, I. *Mathematical Principles of Natural Philosophy* (1687), Motte, A. (trans.), Cajori, F. (rev.), Berkeley: University of California Press (1934), Preface.

9 Newton, I. 'First letter to Bentley, 16 Dec.1692', in Horsley, S. (ed.) *Opera quae exstant omnia*, London: J. Nichols (1782), vol. IV, p. 431. cf. Jaeger, L. *Croire et connaître: Einstein, Polanyi et les lois de la nature*, Cléon d'Andran/Nogent-sur-Marne: Excelsis/Institut Biblique de Nogent (1999), p. 200f, and *Pour une philosophie chrétienne des sciences*, Nogent-sur-Marne/Cléon d'Andran: Institut Biblique de Nogent/Excelsis (2000), pp. 34-36.

earth, water and dry land. The divine word plays a particularly important role: ten times the account refers to the word which brings into being a structured creation. The act of creation encounters no obstacles, in stark contrast with other creation accounts of the time: whereas, in the Babylonian story, the world exists as result of a battle between the gods, the monotheism of Genesis shows us a creative work that doesn't meet with the least resistance, such that 'God saw all that he had made, and behold, it was very good' (Gen. 1:31). God's mighty work in creation led to an ordered universe.

The prologue of the gospel of John echoes the first chapter of Genesis by attributing the title *logos* to the Christ and thus highlighting his role in creation: 'In the beginning was the Word... Everything was made by him; without him, nothing was made' (John 1:1-3). In choosing this title for the Christ, the evangelist appropriates for him a term rich in connotation both in the Jewish and Hellenistic traditions. With regard to the Hebrew heritage, the expression allows the idea of creation by word to resonate with the theme of wisdom presiding over the beginning of the world (Prov. 8:22-31), as *logos* has a rich range of nuances and suggests 'word' as well as 'thought', 'discourse' as well as 'reason'. After the closing of the Hebrew canon, the Jews continued to reflect on the concept of creative wisdom, which Ecclesiasticus clearly demonstrates (Ecclus 24:1-22), as does a passage in the Rule of Qumran, which strangely resembles the opening of the gospel of John: 'By his knowledge everything came into being, and everything that is, he established by his thought; and without it nothing was made (I QS XI, II). As for the Hellenistic resonance of the expression, one must keep in mind that the stoics (who at the time had made a considerable impact on the entire Mediterranean basin) used *logos* to designate the universal Reason that animates and harmonises the world. Of course, the evangelist frees the concept of *logos* from any pantheistic connotation; the eternal wisdom, in the person of the Son of God, 'in-forms' the world.

The conviction of living in an ordered world resurfaces in other parts of the biblical canon. His faith in the God of wisdom gives the believer the assurance that he lives in an ordered world. The wisdom literature is particularly rich on this level. The Lord's first discourse to Job opens with the comparison of the act of creation with the construction of a building; he highlights the stability and precision of the divine work (Job 38:4-6). The solidity of the foundation of the earth is a recurring theme in the Psalms: 'The Eternal reigns; therefore the world is firm, it does not waver' (Pss 93:1; 96:10; cf. Ps. 24:2; 1 Sam. 2:8; 1 Chron. 16:30). In the midst of adversity, the believer finds consolation in the immutability of the natural order, guaranteed by God himself: 'Forever, Lord, your word is established in the heavens. Your faithfulness endures from generation to generation; you founded the earth and it holds firm. Because of your judgements, they remain standing even today; for the whole universe is your servant' (Ps. 119:89-91). The laws that the Creator gave to natural phenomena are even described quantitatively:

He determined the weight of the wind,

And fixed the measure of the waters.
When he determined a law for the rain
And a trajectory for the lightning and thunder,
He saw wisdom and rendered it manifest,
He established it and sounded it. (Job 28:25-27; cf. 38:25)

In the Bible one sees the order instituted at the time of creation applied to various domains. Astronomical phenomena are prominent in this regard; doubtless humans have been very much impressed by their regularity since the beginning of human history (Gen. 8:22; Pss 74:16-17; 136:5-9). But as we saw in the passage from Job, the meteorological phenomena obey laws as well, laws which depend on the work of the Creator. In addition, animals conform to certain rules in their behaviour (Jer. 8:7; Prov. 6:6-8; 30:24-28), as do plants (Matt. 24:32). This order extends even to things beyond the scope of natural science and which are generally studied in the context of human sciences: the very limits of the lives of peoples (Acts 17:26).

As among the peoples neighbouring Israel the sea symbolises the forces of chaos, several passages stress the limits imposed on the sea as well as the laws that even the waves must obey. Thus speaks Wisdom personified, in the book of Proverbs:

The Lord possessed me at the beginning of his activity, before his most ancient works...
When he made firm the skies, I was there, when he traced a circle on the surface of the abyss,
When he strengthened the clouds from above, when the springs of the abyss showed their power,
When he established his order for the sea, that the waters might not disobey his commandment, when he arranged the foundations of the earth.
Then I was before him, like a master workman; I was daily his delight, rejoicing before him always.

(Prov. 8:22, 27-30; cf. Jer. 5:22; 31: 35-36; Ps. 104:9; Job 26:10; 38:8-11).

To say that the sea is subject to the order instituted at creation is to affirm the universality of that order. Certain biblical passages explicitly express the conviction that the laws of creation are universal, such as Psalm 119, cited earlier: 'Because of your judgements, they remain standing even today; for the whole universe is your servant.' (Ps. 119:91; cf. Jer. 33:25; Ps. 148, using the process of enumeration).¹⁰

From these biblical data it follows that there is no conflict between God's sovereignty and natural order. The active omnipotence and omnipresence of

10 For a more complete examination of the biblical texts in favour of the objective existence of natural order: Jaeger, L. *Pour une philosophie chrétienne des sciences*, pp. 59-62, and *Croire et connaître: Einstein, Polanyi et les lois de la nature*, pp. 154-186 (with specific attention to the texts using legal metaphors).

God does not in the least endanger the created order. Certainly, as Creator, God retains complete mastery, such that the usual course of things can in no way limit his action. But even if going beyond the natural order remains possible, such a miracle has to be read against the background of a creation that is ordered and kept in existence as such. Thus it is unacceptable to see in the laws of nature nothing more than God's customs or habits, to reduce the natural order to mere series of acts that God performs with a certain regularity. As God is the sovereign Creator, in whom everything lives and moves and has its being (Acts 17:28), there is no need to suppress the creation's power to act in order to better celebrate divine sovereignty. Far from threatening the authentic existence of the created, the divine power provides its very foundation.

It is the very concept of creation which allows us to resist the antithesis between divine action and natural order. There is no conflict between God's power, His sovereign reign and the efficiency of natural law, as He Himself upholds the whole of creation. In the biblical world-view, the natural order expresses the divine faithfulness and wisdom. The work of creation testifies that the Lord 'is not a God of disorder, but of peace' (1 Cor. 14:33). The universality of this order springs from monotheism. As the Lord alone is God, nothing and no one is able to take away from his omnipotence. Whereas polytheistic gods are incapable of structuring the universe, since they are mere replicas of the world, the one true God unites in himself attributes that are often dissociated: he is simultaneously wise *and* powerful. Thus there is no obstacle that can keep him from instituting the order that he in his wisdom has determined. In this manner, recognising the transcendent God caused the biblical authors to 'understand the world as an ordered unit, linked in all its parts, as well as marked with the imprint of the same will'.¹¹

3. Universal laws versus intrinsic natures

The notion of creation, as present in the Bible, provides a relevant background for the understanding of the modern concept of laws of nature, as it was developed during the scientific revolution. Of course, the seventeenth century authors were not the first to take up the biblical metaphor of laws in connection with nature. It can already be found in some medieval and early modern authors. Similar expressions are even used by some stoic writers (especially in Latin). But the similarity of vocabulary does not necessarily indicate a fundamental agreement. Not only have we to wait until the seventeenth century before the expression of law becomes the customary way of designating the ordinary course of nature (whereas this sort of language had been rare up until that point) but in particular its sense has been profoundly altered. In the earlier sources, it suggested the orientation intrinsic to each species, whereas its

11. Eichrodt, W. *Theologie des Alten Testaments*, Göttingen: Vandenhoeck & Ruprecht (1961), vol. II, p. 71.

modern use indicates the universal order, imposed from without.¹² The transition from substantial forms to laws of nature was characterised by the abandoning of a hierarchical world-view. No longer were entities placed on a scale reaching from the lowest existing things to human beings, angels and up to the divine, each object following its own nature. Rather than explain the behaviour of things by means of the principles inherent and unique to each species, the new philosophers of nature adopted a concept of the world characterised by a fundamental asymmetry: between the Creator, on one hand, and the whole created realm, on the other. As a result, the same law could regulate all natural phenomena, which depend together on the divine providence.¹³

Alexandre Koyré (1882-1964), a science historian, summarises incisively the two concepts in the following terms: the medieval view puts forward a 'Cosmos: closed unity of a hierarchical order', whereas the modern view presents a 'Universe: open ensemble linked by the unity of its laws'.¹⁴ Others have expressed the difference between the two views in terms of the opposition between biological and artisanal concepts. For the Greeks, nature is an animal that generates its movement by an inherent vital principle. In the modern perspective, nature is the artifact of the Lord who assigns to creation the form He chooses.¹⁵ This difference in outlook is no theoretical speculation, without any practical consequences. It rather influences directly the type of natural science you aim at. First, if all things are created, they are in a sense all artifacts. Thus it would be inappropriate to exclude, as Aristotle would have it, the artifacts of the operation of ordinary laws.¹⁶

Secondly, the Aristotelian distinction between natural movement and violent movement must be abandoned. Aristotle held that each body in the universe has a fixed place which corresponds to its nature. If an entity finds itself

12 Beuttler, U. 'Das neuzeitliche Naturverständnis und seine Folgen', *Glaube und Denken* (2002) XV, 13 s.

13 Osler, M. J. 'From immanent natures to nature as artifice: the reinterpretation of final causes in seventeenth-century natural philosophy', *The Monist* (1996) LXXIX, 388-408 (p. 403), and Hampe, M. 'Gesetz, Natur, Geltung – Historische Anmerkungen', in Mittelstaedt, P. & Vollmer, G. (eds.) 'Was sind und warum gelten Naturgesetze?', *Philosophia Naturalis* (2000) XXXVII, 243-244. Joseph Needham thinks that the absence of the concepts of the divine Creator-Lawgiver and of imposed laws is one of the main reasons for the different direction in which science has evolved in China ('Humans Laws and the Laws of Nature in China and the West', *Journal of the History of Ideas* (1951) XII, 3-30, 194-230).

14 Koyré, A. 'Galilée et la loi d'inertie', *Études galiléennes*, Paris: Hermann (1966), p. 165. Van Fraassen, B.C. 'The theory of tragedy and of science: does nature have narrative structure?', in Sfondoni-Mentzou, D. (ed.) *Aristotle and contemporary science*, New York: Peter Lang (2000), vol. I, p. 31, uses for the new conception the metaphor of the "choreographed universe" ... through... the... laws'.

15 Collingwood, R.G. *The idea of nature*, Oxford: Clarendon (1945), p. 5; Foster, M. 'Christian theology and modern science of nature (I)', *Mind* (1935) XLIV, 446, 450f.

16 Milton, J.R. 'The origin and development of the concept of the "laws of nature"', *Archives Européennes de Sociologie* (1981) XXII, 193f.

separated from its 'natural' place, it will naturally try to return to this place. For example, heavy things naturally seek to approach the earth; once there, they remain at rest. Other phenomena break with this natural order; they are animated by a 'violent' movement. Only this second type of movement, against nature, demands a causal explanation requiring the intervention of an exterior agent, the 'motor'; whereas natural movement simply proceeds from the nature of the object. Modern physics has abandoned the Aristotelian distinction between natural and violent movements; it considers instead that the ensemble of kinematic phenomena is ruled by the same universal laws of mechanics. Such a perspective resonates with the vision of a created world, submitted in its entirety to the providential action of God. The Bible does distinguish orders of events; but the distinction is not between natural and violent, but between the order of creation and the order of redemption. It follows that the ordinary course of things encompasses that which Aristotle calls natural and violent movements; only the miracles are put aside, since they do not come under general providence, but rather play a pivotal role in the history of redemption, which aims at restoring that which evil has destroyed in the created world.

Thirdly, in the perspective of laws assigned to nature, it becomes possible to envisage global constraints. It is often not noticed that one needs such global rules in Newtonian mechanics. For example, it is necessary to postulate the conservation of energy for the whole universe, in order to secure determinism.¹⁷ It is more obvious that physics, from the seventeenth century on, relies on forces of interaction that depend on the relative distance between two objects. Both such concepts were unimaginable to Aristotle, for whom every change needed to be explained in terms of properties of entities considered individually. For substantial forms are based on the place in itself and on the inherent properties of things. They are individual categories; external circumstances and global constraints cannot intervene in this context.¹⁸ Needless to say all of these diverse facets of the new perspective were essential to the elaboration of the modern approach to physics in the seventeenth century. Thus, it is not possible to do modern physics based on the old Greek notions of substantial forms. Natural laws are indispensable.

4. The new experimental method

It is important to reflect upon one particular aspect of the new concept based on universal laws. The idea of creation implies that natural order is no longer seen as necessary, but as freely willed. It is the result of free divine action, whereas Aristotelian forms are linked to the essences of things and are there-

17 Van Fraassen, B.C. *Laws and symmetry*, Oxford: Clarendon (1989), pp. 2-5, 257f.

18 Cassirer, E. *Individu et cosmos dans la philosophie de la renaissance* (1927), Quillet, P. (trans.), Paris: Éd. de Minuit (1983), p. 223.

fore necessary. Boyle writes, for example: 'The laws of motion, without which the present state and course of things could not be maintained, did not necessarily spring from the nature of matter, but depended upon the will of the divine author of things.'¹⁹ Newton's writings reflect a very similar conviction: the divine action in nature is contingent. Thus, he writes: 'The world might have been otherwise then it is... Twas therefore noe necessary but a voluntary & free determination yt it should bee thus.'²⁰ In this way he opposes his rival Leibniz's approach to nature, which he judges unduly rationalist. Roger Cotes, who oversaw the publication of the second edition of *Principia*, is a spokesman for Newton's point of view, when he writes in the preface that the laws of nature proceed from the free will of God; they demonstrate 'many traces indeed of the most wise contrivance, but not the least shadow of necessity. These therefore we must not seek from uncertain conjectures, but learn them from observations and experiments.' He who would claim to deduce the sciences rationally 'must either suppose that the world exists by necessity, and by the same necessity follows the laws proposed ; or if the order of Nature was established by the will of God, that himself, a miserable reptile, can tell what was fittest to be done.'²¹

These quotations show that Newton's empiricism is closely linked to the idea of freely willed creation. In contrast to other concepts of the world's origins, creation lays the emphasis on divine sovereignty and omnipotence. God can do all that he pleases. It follows that the natural order is not necessary but contingent. God was under no obligation to create the world, nor to give it the form that he decided to give it. As a result, purely rational speculation cannot discover the laws that rule nature, as if all creation were merely a question of pure logic. Man must not lose touch with nature if he is to discover the order that God freely decided to create:

The element in nature which depends upon the *voluntary* activity of God, is incapable of becoming an object to reason, and science therefore must depend, in regard to this element, upon the *evidence* of sensation. The reliance upon the senses for evidence, not merely for illustration, is what constitutes the empirical character peculiar to modern natural science; and

19 Boyle, R. *Christian virtuoso: shewing, that by being addicted to experimental philosophy, a man is rather assisted than indisposed to be a good Christian*, (1690), in Birch, T. (ed.) *The works*, London (1772), vol. V, p. 521. This does not stop Boyle from saying that the creation follows from the infinite wisdom of God, and from referring to divine ideas in this context: the 'almighty power [of God], still accompanied with his infinite wisdom, did at first frame the corporeal world according to the divine *ideas* which he had, as well *most freely as most wisely*, determined to conform them [the different parts of the universe] to' (*A free enquiry into the vulgarly received notion of nature*, sec. IV, *Selected philosophical papers*, p. 190).

20 In an unpublished manuscript, quoted by Davis, E.B. 'Newton's rejection of the 'Newtonian world-view' : the role of divine will in Newton's natural philosophy', *Science and Christian Belief* (1991) 3 (2), 117.

21 *Mathematical Principles of Natural Philosophy*, pp. xxxii, xxvii.

the conclusion follows that only a created nature is proper object of an empirical science.²²

But liberty does not necessarily imply arbitrary will; the divine sovereignty is not blind despotism. God creates with wisdom, in such a way that human beings can discover a natural order, which appears coherent:

It is Christian to ascribe to God an activity of will, but it is not Christian to deny to God a theoretical activity or to ascribe to him a *blind* activity of will. It is a consequence of the Christian doctrine of creation that the created world must contain an element of contingency, not that it must be nothing but contingent.²³

Science depends on both elements: experimentation *and* reflection. Only their union can give birth to the scientific understanding of nature. Thus the biblical world-view, with its central notion of creation, provides the framework for the experimental method of modern science. Therefore it is not surprising to see that, for Newton, the idea of freely willed creation helped him to adopt the modern methodology of empirical science. A similar case can be made for medieval nominalists, who are in many respects decisive forerunners of the scientific approach of modern times.²⁴ Thus not only can we detect a conceptual link between the idea of creation and the pivotal role of experience in modern science, but we can also see that the biblical world-view had a major impact on the thinking of some of the influential figures in the emergence of modern science.

5. Beyond laws?

Although the replacement of substantial forms by laws constituted an impor-

22 Foster, M.B. 'The Christian doctrine of creation and the rise of modern natural science', *Mind* (1934) XLIII, 464s. Foster's thesis on the link between the idea of creation and empirical science has triggered an ongoing debate. For an introduction, see Wybrow, C. (ed.) *Creation, Nature and Political Order in the Philosophy of Michael Foster (1903-1959): The Classic Mind Articles and others, with Modern Critical Essays*, Lampeter (Wales): Edwin Mellen Press (1992). The most relevant criticism, in my view, is that Foster, in order to show how the concept of creation really operated in early modern science, limited himself to a conceptual analysis, without paying enough attention to historical details (cf. Davis, E.B. 'Christianity and Early Modern Science: The Foster Thesis Reconsidered', in *Evangelicals and science in historical perspective*, Livingstone, D.N., Hart, D.G. & Noll, M.A. (eds.), Oxford: Oxford University Press (1999), pp. 75-95). Recent scholarship has supplied historically rigorous accounts. While confirming the importance of religious convictions for the elaboration of modern science, it has shown the complexity of historical developments (cf. Brooke, J.H. 'Natural law in the natural sciences: the origins of modern atheism?', *Science and Christian Belief* (1992) 4 (2), 83-103; Harrison, P. 'Voluntarism and early modern science', *History of Science* (2002) XL, 63-89).

23 Foster, M.B. *op. cit.*, (22), p. 468.

24 Duhem, P. *Le système du monde: histoire des doctrines cosmologiques de Platon à Copernic*, Paris: Hermann (1954), vol. 6: *Le reflux de l'aristotélisme, les condamnations de 1277, passim*; Grant, E. 'The condemnation of 1277, God's absolute power, and physical thought in the late Middle Ages', *Viator* (1979) X, 211-244.

tant step in the elaboration of the interpretive framework of modern science, one must recognise that the concept of law is not without its difficulties. The problem of laws said to be *ceteris paribus* (that is, valid ‘all other things being equal’) can serve as an example of the sort of difficulties one encounters. The majority of laws (perhaps even *all* laws) that we know today are idealisations. They do not describe situations that occur in real life, but rather apply to very specific experimental conditions, ‘ideal’ as it were, and, even in this rarefied context, typically include approximations. They are only true *ceteris paribus*, all other things being equal. To give an example: the law of Coulomb stipulates that two electrified spheres will approach each other with an acceleration inversely proportional to the square of their relative distance – as long as nothing bars their way, and atmospheric resistance is left out, and they are not magnetised, and they are not too close to each other so that atomic forces can be disregarded, and so on. Given the diversity of the disregarded perturbing factors, it is impossible to compose a complete list. One may therefore wonder how ‘All *F* are *G ceteris paribus*’ differs from ‘All *F* are *G*, except in the cases where *F* is not *G*’ – which is hardly an enlightening affirmation! One solution to the problem is to consider that the laws hold true only for idealised objects and situations. But then the reasons for which the laws of science permit us to orient our activity in real life become mysterious, for concrete applications invariably imply less than ideal conditions. Another more promising solution to the problem of finding a satisfactory formulation of *ceteris paribus* laws, is the introduction of the concept of disposition. A disposition describes the tendency to do a particular action or to act in a certain way. The disposition is thus present even in situations where other factors perturb its actual operation. If the law is about dispositions, it can be valid even in circumstances where the activation of the disposition is blocked.²⁵ Other philosophers remain sceptical of dispositions, seeing in them nothing but the analogy of the true, but trivial, explanation of the somnolent effects of opium by invoking its ‘virtus dormitiva’.

In deciding on the pertinence of dispositions, their explanatory force is not the only element to be taken into account; one must be certain that they are able to be adapted to the interpretive framework of modern science. According to Alan Chalmers, dispositions merely express the conviction, implicit in all scientific work, that natural objects are able to act. He endeavours to show that the proponents of the new science had, in fact, turned to the same idea: while Robert Boyle fiercely defended the idea that laws are imposed from without, he was not true to this conviction in the actual development of his science. Thus he did not hesitate to employ dispositional properties, such as the acidity or

25 e.g. Cartwright, N. *Nature's capacities and their measurement*, Oxford: Clarendon (1989), *passim*; Chalmers, A.F. ‘So the laws of physics needn't lie’, *Australasian Journal of Philosophy* (1993) LXXI, 196-205; Hüttemann, A. ‘Laws and dispositions’, *Philosophy of Science* (1998) LXV, 121-135; Lipton, P. ‘All else being equal’, *Philosophy* (1999) LXXIV, 155-168; Woodward, J. ‘Realism about laws’, *Erkenntnis* (1992) XXXVI, 181-218.

elasticity of air, in the descriptions of his experiments.²⁶ In fact, he explicitly conceded that description in terms of laws of motion is incomplete: it 'gives us but a very defective *idea* of *nature*, since it omits the general fabric of the world and the contrivances of particular bodies, which yet are as well necessary as local motion itself to the production of particular *effects* and *phenomena*.'²⁷

As the modern concept of laws emerged from the vision of the world as created by God, the question arises whether dispositions can be reconciled with creation. In answer to this question, it is very important to observe that, according to the biblical view, divine sovereignty should not be opposed to the creatures' power to act, where the power to act is a certain kind of disposition inherent in the things themselves. As the creative act is constitutive of the creatures, the fact that they receive everything from God is the very reason for their capacity to act. The radical dependency of the creatures on their Creator provides the very basis of their causal powers. Thus there is no point to clinging stubbornly to the alternative: that either something acts according to its nature, or else it follows a law imposed upon it by an external authority. The notion of creation allows us to harmonise promulgated laws and inherent natures. For the law given by the Lord is precisely what makes its nature; divine action is not exterior to the creature, but rather constitutes its very being, as Calvin asserts:

All species have some secret conduct, according to which their nature requires it, as if they obey a perpetual statute to which God has constrained them and thus that which God once decreed, flows and carries along as from a voluntary inclination.²⁸

Thus occasionalism, as put forward, for example, by Nicolas Malebranche (1638-1715) and George Berkeley (1685-1753), cannot claim to be biblically grounded.²⁹ The sovereign exercise of God's will does not annihilate created causal powers, so that it is wrong to consider that the only efficient action is divine. The opposition between laws imposed by sovereign decision and the inherent natural order is foreign to the biblical view. The two poles – divine action and established order – are mutually dependent and cannot be understood separately; therefore, the biblical authors often evoke them side by side, without suggesting the least conflict (Jer. 5:22-24; Ps. 119:89-91; Job 26:5-14; 38:4-39:30). The Dutch Reformed theologian Gerrit Berkouwer pertinently summarises the biblical concept of natural order as sustained by God, when he writes:

26 Chalmers, A.F. *What is this thing called Science ?*, Buckingham: Open University Press (1999), p. 220.

27 Boyle, R. *A free inquiry...*, sec. II, *Selected philosophical papers of Robert Boyle*, p. 181.

28 Calvin, J. *Institution de la religion chrétienne*, (1560), Cadier, J. & Marcel, P. (eds.), Genève: Labor et Fides (1955), I, XVI, 4, p. 151.

29 cf. Collins, C. J. *The God of miracles: an exegetical examination of God's action in the world*, Wheaton (IL): Crossway (2000), p.29 ss, 107 ss.

The problem of first and second causes is not experienced as a real difficulty... Israel, too, knows of conception and birth, of streams that go to the sea, and of the cycle of nature. But this knowledge does not stifle her 'Thou, O Lord'. In her knowledge, she still looks to the living God, the Unchangeable. This is no primitive religious naivete that later is sloughed off with increase of intelligence. 'The voice of Jehovah cleaveth the flames of fire. The voice of Jehovah shaketh the wilderness;... the voice of Jehovah maketh the hinds to calve' (Ps. 29:7-9 ASV). This is Israel's understanding of natural events. For Israel's eyes are trained on Him.³⁰

Clearly it is not by chance that the idea of creation has played a decisive role in the formation of the modern concept of natural laws. We find it in Descartes' thought, where Descartes was one of the key figures in elaborating the modern concept. In fact, Descartes shows on this point the influence of Augustinianism, which precisely emphasises the harmony of the two poles of the biblical vision. The philosopher wrote on 15 April 1630 to Mersenne, that mathematical truths are created: 'God established these laws in nature, in the same way as a king establishes laws in his kingdom.' What is more, God put them in our souls, 'as a king would inscribe his laws on the hearts of all his subjects, if he were able to do it'.³¹ In a letter, to Newcastle in April 1648, Descartes compares these innate ideas to 'graces'; they are given to us gratuitously.³² In the Augustinian view, grace does not constrain man, but it impregnates his will, in such a way that he seeks salvation. In the same way, providence has nothing to do with a capricious and unpredictable rule but rather finds expression in the stability of the natural order.

Nevertheless, the Aristotelian natures do not regain establishment in a created world. It is true that divine action is constitutive of the creature, in that the laws established by God compose, as it were, an integral part of the 'nature' of the creature. But these laws do not ensue from this nature, as was the case for substantial forms in Aristotelian-inspired science. As result it follows that man cannot rely on his reason alone to discern natural order. He must instead 'go and see' that which God freely decided to create, which corresponds with the empirical approach favoured by the new science. It remains true, however, that the Lord 'is Author of the essence as well as of the existence of creatures'.³³ To see in natural laws an exterior constraint, arbitrary and unrelated to the nature of things, would maintain an antinomy that has no place in the biblical world-view.

30 Berkouwer, G.C. *The Providence of God*, Grand Rapids (MI): Eerdmans (1952), p. 86f.

31 The letter is quoted in *Discours de la méthode : suivi d'extraits de la Dioptrique, des Météores, de la Vie de Descartes par Baillet, du Monde, de l'Homme et de Lettres*, Rodis-Lewis, G. (ed.), Paris: Flammarion (1992), p. 61 s, n. 1.

32 The letter is quoted by Lecourt, D. 'Loi (Epistémologie)', in *Encyclopædia universalis*, corpus, 1985, tome 11, p. 204.

33 Descartes, Letter (to Mersenne ?), 27 mai 1630 (?), *Œuvres de Descartes*, vol. I, p. 152.

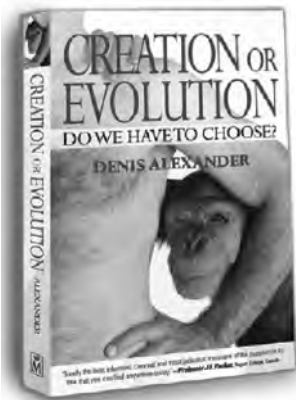
The vision of the world as creation thus allows the re-evaluation of the concept of natural laws and constitutes a promising starting point for the development of a solution to problems that are implied by the notion of law, despite the many advantages offered by this modern concept. As for the idea that laws are only valid *ceteris paribus* (that is to say, in absence of perturbing factors), this theological framework authorises the recognition of the causal powers of natural agents, without falling back into a necessitarian concept which would fuse the properties and the essence of a thing. That the idea of creation only furnishes the interpretive framework and that the epistemological analysis of *ceteris paribus* laws remains to be achieved, in no way invalidates the pertinence of theological reflections. To expect to find a philosophical account revealed *ipso facto* by the doctrine of creation would be to confuse religious discourse and philosophy. However, the writings of several protagonists of modern science testify to the fecundity of the interpretive framework which the scholar finds in his religious vision of the world.

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Historians of science and of religion, philosophers, theologians, scientists, and others from various geographical regions and cultures have addressed numerous aspects of the relationship between religion and science. Even though the ancient and medieval worlds did not have conceptions resembling the modern understandings of "science" or of "religion", certain elements of modern ideas on the subject recur throughout history. The pair-structured phrases "religion and science" and "science and religion" To what extent are religion and science compatible? Are religious beliefs sometimes conducive to science, or do they inevitably pose obstacles to scientific inquiry? The interdisciplinary field of "science and religion", also called "theology and science", aims to answer these and other questions. It studies historical and contemporary interactions between these fields, and provides philosophical analyses of how they interrelate. This entry provides an overview of the topics and discussions in science and religion. Section 1 outlines the scope of both fields, and how they are related. Section