

The given as gift: Creation and disciplinary abstraction in science

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Abstract

If the God of the Bible is creator of the universe, then it is not possible to understand fully or even appropriately the processes of nature without any reference to that God. If, on the contrary, nature can be appropriately understood without reference to the God of the Bible, then that God cannot be the creator of the universe, and consequently he could not be truly God... To be sure, the reality of God is not incompatible with all forms of abstract knowledge concerning the regularities of natural processes, a knowledge that abstracts from the concreteness of physical reality and therefore may also abstract from the presence of God in his creation. But neither should such abstract knowledge of regularities claim full and exclusive competence regarding the explanation of nature and, if it does so, the reality of God is thereby denied by implication. The so-called methodological atheism of modern science is far from pure innocence. It is a highly ambiguous phenomenon. And yet its very possibility can be regarded as based on the unfailing faithfulness of the creator God to his creation, providing it with the inviolable regularities of natural processes that themselves become the basis of individual and more precarious and transitory natural systems.

1. Introduction

This statement by Protestant theologian Wolfhart Pannenberg [1] helps to set the context for the question posed in the present paper. It goes without saying that abstraction, the consideration of a thing or an aspect of a thing apart from the totality of its meaning or context, for methodological or disciplinary purposes, is necessary and legitimate in scientific research. Indeed, such abstraction is made possible by the Christian understanding of creation itself. The creator God in his generosity grants to the creature its autonomy, a law (*nomos*) proper to its own (*autos*, “self”) nature. At the same time, as Pannenberg suggests, the relation of the creature to the creator God is *sui generis*, by virtue of its utterly foundational character: rightly understood, creation in Christianity is *ex nihilo*.¹ If God is the source of my being and the being of all else, then relation to God is just so far *given with* and

¹Creation *ex nihilo* does not imply “creationism”. An absolute origin of being is not incompatible with evolution, though which theory of the latter is most adequate need not occupy us here [2, 3].

constitutive of being.² Indeed, as Aquinas says, “God is in all things, and innermost” [4]. This means that that relation cannot but accompany each being everywhere and at every moment and indeed from its deepest depths.

The reality of God as creator implies a distinction, further, between God and the world that shapes the nature of the distinctness among cosmic entities. Creation implies an openness in each thing to the Creator who makes them be in their beginning and all along the course of their existence.³ This inherent openness of each thing to the Creator implies an openness of each thing to all others. Creation, in a word, implies a universe: a “turning” of all things toward a “one”, a unity established by virtue of the common relation to God in which all things participate.⁴

Again, this constitutive relation of the creature to God, with its implications as sketched, does not eliminate the autonomy of each creature but indeed makes that autonomy possible even as it gives autonomy its original and proper meaning. The relation to God that *establishes the creature in its own being* is truly *in* the creature. It follows that each entity is independent in its being and acting even as this independent being and acting, which at every moment is given by God and received by the creature, just so far bears the constitutive feature of *openness from and toward God*, and indeed from and toward the universal community of creatures under God.

This Christian understanding of creation thus has two consequences relative to scientific abstraction. On the one hand, it renders possible and legitimates the study of an entity⁵ (x) in itself and just so far without explicit reference to its relation to God and other entities. At the same time, it requires that this abstraction, rightly conceived, take account of each entity’s constitutive relation to God as origin and end and indeed to the universe of creaturely entities implied by their common relation to God. Any rightly conceived abstraction, in other words, needs to take account of the qualitative “difference” that is always already operative in x by virtue of x’s constitutive relation to God and others (non-x).

The upshot is that abstractions in science are not and can never be indifferent to the reality of God or a universe under God. Each abstraction in science will imply, even if unconsciously, some conception of the unity or identity of the thing abstracted relative to God and to the

²Cf. the Compendium of the Social Doctrine of the Church, no. 109: “The likeness with God shows that the essence and existence of man are constitutively related to God in the most profound manner. This is a relationship that exists in itself, it is therefore not something that comes afterwards and is not added from the outside”.

³Cf. Aquinas on conservation in being: “Now God causes this effect [of being] in things not only when they first begin to be, but as long as they are preserved in being; as light is caused in the air by the sun as long as the air remains illuminated”.

⁴On the interconnectedness of things, cf., for example, Marco Bersanelli’s contribution in [5].

⁵“x” as used in this paper refers to both a “part” or “particles” of a being and to a whole being – that is, to whatever is the object of abstraction. “Non-x” refers to whatever is left aside in one’s abstraction: other “parts” of a being, a being in its concrete wholeness, other beings, God.

universal community of beings. The God-world distinction as disclosed in the act of creation shapes the primitive nature of all distinctions and hence all abstractions in the cosmos. Indeed, every distinction and abstraction *most basically* is a sense of the God-world relation.

I propose to show this in terms of those scientific abstractions conceived as “merely disciplinary” in nature. It is commonly assumed that problems of reductionism in science (positivism, empiricism, mechanism, and the like) would be avoided if the practitioners of science simply observed the limits specified by a science’s particular mode of abstraction. Such problems would be avoided, so the argument runs, were it recognized that science does not claim to exhaust the intelligibility of an object in the integrity of its existing being: were physics or biology, for example, to remain just physics or biology and not venture onto the terrain of philosophy or theology. While recognizing the important sense in which this is of course true, my paper argues that such a claim, nevertheless, is governed by an idea of abstraction needing further differentiation, and just so far instantiates a *petitio principii*.

Abstractions and distinctions, which involve separating x or pulling it out or excluding it from the web of relations to non-x that characterize x’s concrete existence at any moment,⁶ necessarily evoke the notion of limit: of a boundary that sets x off from non-x. This idea of limit, even if intended to be only disciplinary in nature, will inevitably carry some tacit conception of what (non-x) lies beyond the limit of x: some tacit conception of the relation of x to non-x, and just so far some conception also of both x and non-x. The idea of limit presupposed in any abstraction of x from non-x, will imply, in a way that makes a difference already from within the limit that constitutes x in its methodologically abstracted state, some tacit conception of x relative to the existence and nature of God and a universe of beings under God (non-x): in a word, some ontology of creation.⁷

Insofar as this is so, claims to avoid reductive science by appealing to the idea of abstraction as methodologically limited require ontological qualification as a condition of their being soundly argued. Indeed, the assumption that the idea of limit can be empty of or neutral toward ontology itself embeds a hidden ontology rightly termed mechanistic. Such an ontology implies a reductive view of God, of the universe, and indeed of the identity of the abstracted

⁶*Abstrahere*: to pull from, drag away, take out, exclude; *distinguere*: to divide or separate.

⁷The term “ontology” as used in the present paper indicates a metaphysics that opens into a metaphysical (“natural”) theology, in a sense indicated already by Aristotle. The term is understood just so far to bear definite implications for what Christians understand to be revealed theology. As a “logic” of “being” (ontology), it is understood, further, to include in its most basic terms the “logic” of the whole person in his encounter with the totality of things. Finally, as my introductory remarks make clear, the ontology of creation affirmed in this paper is understood to be a Christian ontology of creation, even as Christian faith itself is understood to enable and indeed to require even as it reconfigures the meaning of this ontology’s *autonomy as an ontology*. Cf. in this connection the statements of Joseph Ratzinger/Benedict XVI in [6]: “Only when it takes up the cause of philosophy does [faith] remain true to itself”. “A philosopher who really gets to the bottom of things can never rid himself of the goad of the question of God, which is the question regarding the origin and goal of being as such”. The “*analogia entis* is simply a term for the ontological option of Catholic theology, for its synthesis of the philosophical idea of being and the biblical conception of God”.

entity itself. The claim that an abstraction in science, even if conceived as a temporary-strategic abstraction, can be neutral toward an ontology of creation, in other words, effectively contradicts what is entailed in the constitutive relation of x to God and to other entities, in favor of a mechanistic sense of this relation and thereby reveals that abstraction to be reductive. The present paper proposes to clarify how this is so.

As these introductory remarks make clear, my proposal presupposes a definite understanding of the Christian doctrine of creation and thus of a definite ontology as implied by this doctrine, and I will have more to say about this understanding later. It is important to see at the outset, however, that, although I take this ontology to be true, acceptance of this truth is not necessary to sustain the burden of the argument in the limited form advanced here. It suffices for my argument only that it succeed in showing that abstractions in science, even those made with purely disciplinary intentions, cannot avoid assumptions bearing on the meaning and truth of the Christian understanding of creation, *already from inside these abstractions in their limited disciplinary character*.

My proposal is developed in terms of the notion of the given as gift, which I take to lie at the heart of the ontology of the Creator-creature distinction affirmed in Christianity. The argument unfolds in five stages: first, an exposition of an argument that defends what is commonly considered a legitimate methodologically limited abstraction in science, in a way that means to avoid reductive views of science; a description and evaluation of mechanism, and of modern and postmodern ways of conceiving scientific abstraction in light of mechanism; a description of what I take to be the implications of the Christian doctrine of creation's ontology of gift relative to the problem of mechanism, and of modern and postmodern views of scientific abstraction; finally, a sketch of an idea of abstraction in science by a twentieth-century scientist/philosopher of science that I take to be consistent with this ontology of gift.

In a word, the overarching purpose of my reflections is to indicate, in terms of an ontology of gift, the significance for the form and content of human knowledge of the way the limit that constitutes disciplinary abstraction is understood: that is, whether a researcher's methodology embeds an objective logic of wonder or, to the contrary — and perhaps quite apart from his subjective intentions — a logic of mechanistically-conceived technological power.

2. Methodologically limited abstraction in science

Carlo Lancellotti, a mathematical physicist from the City University of New York, defends in [7] a non-reductive notion of science. Science, he says, in its proper understanding is “an essentially contemplative activity”, a “discernment of harmonious structures hidden in the workings of the cosmos”. Noting what are obviously many “ambiguous” factors in play, he nevertheless says that, based on his own experience as well as the testimony of many

great scientists, “the ultimate motivation that has led to the triumphs of western science is essentially esthetic”. He cites Henri Poincaré:

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living. Of course I do not speak here of that beauty that strikes the senses, the beauty of quality and appearances, not that I undervalue such beauty, far from it, but it has nothing to do with science; I mean that deeper beauty coming from the harmonious order of the parts, and that a pure intelligence can grasp.

Such an understanding of science, Lancellotti says further, “presupposes certain crucial metaphysical assumptions, many of which originated from the Judeo-Christian tradition, and chiefly from the biblical doctrine of creation”.

Lancellotti acknowledges that a “positivistic mentality [...] is still prevalent in many sectors of academia”. Many scientists nevertheless are able “to glimpse the inadequacy of a dogmatic positivism, simply because the guiding light of their work is not just some set of raw experimental data (the notorious ‘facts’). Rather it is the discovery of unexpected and beautiful structures in the fabric of nature that seem to point to a deep, mysterious design which ultimately is always beyond the grasp of human intelligence”. Furthermore, he says, it is important to be aware that there has been a trend in physics over the last century toward “dematerialization”. That is, in the eighteenth and nineteenth centuries, physicists were more likely to argue that “the role of mathematics in physics was just to describe the laws of motion of solid, ‘positive’ material bodies, where materiality was taken to be a primitive, self-standing notion”. In the twentieth century, however, this “naive notion of ‘matter’ has gradually dissolved into more and more ‘immaterial’ mathematical structures. When a physicist is trained to identify elementary particles with complicated and abstract mathematical objects, he/she will easily start wondering what is ultimately real, and will become open to the notion that there is an ‘ideal’ side to reality”.

The main points of Lancellotti’s argument, in sum, are three: first, science is originally “born as the contemplation of harmonious mathematical/organizational structures that seem to be embedded in natural reality”. Secondly, “it is not coincidental that historically this endeavor started in cultures marked by Judeo-Christian ideas”. Indeed, Lancellotti says that “it is hard to imagine a conception of the universe more favorable to the birth of science than one in which the cosmos is brought out of nothingness by a loving Logos, who at the same time transcends the whole universe and is the immanent source of its being and rationality”. According to him, it could even be argued that “the birth of science was, in fact, largely the fruit of a Christian imagination of the cosmos”. Finally, Lancellotti argues that “even today true science in some ways rebels against its more reductionist interpretations”.

Relative to the issues raised in my introduction, then, Lancellotti acknowledges that scientism (which he defines as “the presumption that rationality coincides with empirical sciences”) and reductionism (which he defines as “the ideology that every aspect of being can be ‘analyzed down’ to physical mechanisms”) are among the greatest threats we face today. His claim, however, is that these pathologies stem from certain *philosophical* attitudes that “are not *intrinsically* related to science, although they often accompany it in a parasitical fashion”. They are extra-scientific, and thus have nothing to do with science *per se*.

Professor Lancellotti bases his case for this conclusion on the notion of abstraction in science. Human reason, he says, is “capable of looking at reality according to different modes of abstraction”. “The word abstraction”, he notes, “derives from the Latin root *abstrahere*, which literally means ‘to pull from’ or ‘to take out’”. The scientist thus pulls or takes out certain aspects from objects “by applying to experience appropriate ‘categorical selections.’ For instance, physics abstracts from real existing beings one very specific aspect: spatial and temporal extension, and these only inasmuch as they can be measured by comparison with appropriate measuring instruments”. “Every object”, he says, “comes to us with a ‘form,’ which makes it recognizable to intelligence and is the starting point for every further analysis... The process of abstracting the manifold, harmonious structures that can be discovered in nature is completely contingent on the preliminary perception (or imagination) of a world of forms that offer themselves to our intelligence ‘gratis,’ a priori [relative to] our constructions” (5). The problem occurs only when the “abstraction is not recognized as such and claims to exhaust the intelligibility of the object” (5). It is this failure that is “the root cause of scientism [...] and reductionism [...]” (5).

The burden of Lancellotti’s argument is thus that the problems regarding dogmatic positivism and reductionism in science are not, properly speaking, scientific problems. Though science does rest on metaphysical assumptions, and although the ones often associated with modern science have been empiricist and mechanist in nature, he says, such assumptions are “not at all intrinsic to [science’s] inner workings” (5). These assumptions “can and must be changed, but this change will not necessarily impact what scientists do *as scientists*” though it may in some cases affect the direction of future research and will in any case affect what scientists do as “amateur philosophers, [...] social reformers, and high priests of secular humanism”, and the like.

The decisive point for Lancellotti, then, is that “at the core of science lies a method ‘dictated by the object,’” and that the problem regarding dogmatic positivism and reductionism has to do rather with what he calls “the moral dimension of the dynamics of knowledge”. What needs to happen, for example, is that “the human heart be ‘wounded’ again by the beauty of the cosmos”. Only this will enable the researcher to break through the walls of ideology and not allow his reason “to close upon itself but to open itself up to the infinite mystery of being. This is the rebirth of reason in its full breadth that [former Pope Benedict XVI]

called for in Regensburg: a return to the original position of openness and wonder in front of Being in all its dimensions”; and “it has been the Christian experience that this ‘redemption’ of reason can only happen as a fruit of the encounter with the beauty of Christ”.

I cite Lancellotti’s article at length because it states in clear and strong terms what is needed regarding a non-reductive science, while framing nicely the issue which I nonetheless wish to qualify further, that of the rightful mode of abstraction in science. I agree with Professor Lancellotti’s rejection of positivism and reductionism, that these are a function properly of philosophical judgments (tacit or otherwise) and are not intrinsic to the study of the natural world but rather have been superimposed on it during a particular historical period. I agree that abstraction is legitimate and necessary for the proper practice of science. I agree that the method of the scientist is rightly to be dictated by the object and that, if the logic imposed by the object is followed, the scientist will not necessarily in his practice bear out what may be his originally “bad” philosophical presuppositions, which may not be explicit or reflective. I agree that the undertaking of science in principle may rightly be seen to derive from the biblical doctrine of creation. I agree that contemporary science needs a rebirth of reason in its full breadth, opening itself in wonder to being in all its dimensions and indeed in its infinite mystery.⁸

My question, then, bears on the nature of abstraction, and its relation to what Lancellotti calls “the moral dimension of the dynamics of knowledge”. The heart of Lancellotti’s argument lies in the claim that, as long as “abstraction is [...] recognized as such” by the researcher, and thus is not taken by him or her “to exhaust the intelligibility of the object”, the problems identified as empiricism or mechanism will be largely avoided.

What Lancellotti’s argument is resisting, in other words, is a reading of the relation between philosophy and science that would make the practice of science too much a function of the scientist’s philosophical assumptions. What he is affirming is that “bad” philosophical assumptions do not *determine* the scientist to reductive practice and that, indeed, in the end they may not even be very significant for that practice: if one practices rightly follows faithfully a method dictated by the object, the moral-affective-aesthetic dimensions of the dynamics of knowledge will guide one to a non-reductive view of the thing.

Again, I agree with the intention of Lancellotti’s argument, the important burden of which is both to secure the legitimate autonomy of science and to propose a broader conception of reason. The problem on which I wish to focus begins to emerge, however, as soon as we recognize that every appeal to the limit(s) of scientific abstraction, including Lancellotti’s

⁸It is important perhaps to note here, though the point will be mentioned again in my own ontological reflections later, that mystery as Lancellotti is rightly intending it here is a matter of an excess of *intelligibility*, that is, of what contains intelligibility precisely *in* its excess. The point, then, is that opening to the infinite mystery of things is reasonable, not a matter of what contradicts or simply eludes reason — of the irrational or the “mystical”.

own, already, *eo ipso*, embeds a philosophy, an implicit ontology (and indeed theology) of creation; and that his own appeal to limit, with its implied ontology, needs just so far to be further qualified, relative to culturally dominant ways of conceiving this limit that would in fact undermine the intention of his argument. It should be emphasized that the task of clarification indicated here is understood as a distinct albeit *integral* part of what is involved in *following faithfully a method dictated by the object*: what Lancellotti rightly sees as the moral-affective-aesthetic dimension of the dynamics of knowledge will always *simultaneously anticipate, and in some significant sense always-anteriorly* even if only unconsciously be mediated by, a distinct philosophy, or ontology of creation.⁹

Thus, according to what is perhaps the most widely held view in today's academic culture, whatever is to be added to x from beyond the limit of x as abstracted for disciplinary purposes can be safely added "later", in a manner that presupposes a simply external relation between x as originally abstracted and what is left aside in that abstraction. The limit of x is just so far conceived in terms of an original indifference, hence closure, of x toward what lies beyond and thus transcends x. Such indifference thereby (implicitly) denies that what lies beyond or transcends this limit makes a pertinent difference to x already from inside x's abstracted limit as x. The problem, I wish to argue, is that this prevalent understanding of the limit involved in disciplinary abstraction in science presupposes a mechanistic ontology. Indeed, it is itself already a distinct expression of this ontology.

Lancellotti's argument appeals to the idea of limit as such, and thus leaves this dominant view of abstract limit philosophically unqualified, in a way that implies that an appeal to the idea of limit is or can be innocent of an ontology. He then emphasizes the moral-affective-aesthetic dispositions necessary to sustain the researcher in his respect for the limited nature of abstraction and in his wonder before the whole of being. But this way of proceeding does not take account of the sense in which the idea of abstract limit is already and in principle

⁹The larger context for the argument I am introducing here presupposes a reading of Thomas Aquinas on three main points: (1) regarding the mutual internality of intellect and will in the unity of each human act [4]; (2) regarding what may be termed the ontological weighting of each human act, due to the fact that reference to being, as the first object of the intellect, is implied in every human-conscious act; (3) finally, regarding what is termed the "real distinction" between *esse* and *essentia* that fundamentally structures every (created) being, a distinction that implies an openness from within the core of every being to a Creator-Source and indeed to all other beings (*esse commune*). These three presuppositions undergird Aquinas's view (echoing Augustine) that man knows and loves God implicitly in all that he knows and loves — in each of his conscious acts [8]. On these points I am indebted in different ways especially to the work of Etienne Gilson, Hans Urs von Balthasar, and Ferdinand Ulrich. And indeed I take the three points also to be presupposed in and to undergird the argument of Luigi Giussani's "The Religious Sense" [9], an important book for the problem of reductive conceptions of human consciousness in our time. The upshot of these points for my argument, then, is that there is no act of freedom that does not always already presuppose an act of intelligence (and vice versa), even as this act of intelligence-freedom is most basically ontological-theological in nature. The burden of my argument, of course, is not that every scientist needs to work out his implied ontology for himself, which would be impossible given the demands of his academic preparation and of his work, but only that it is important for him to be aware that ontological-theological assumptions are always already operative in, and helping to shape, his scientific abstractions. The argument of John Paul II's encyclical *Fides et Ratio* has very much in mind the philosophical claims that are often embedded in the practice, and hiddenly shape the conclusions, of the sciences, especially the social sciences.

fraught with ontology, and indeed, in the current cultural situation, with a mechanistic ontology that reinforces the very reductive science Lancellotti decries. In order to answer adequately the question his paper poses — how to renew (scientific) reason in its full breadth — his argument thus requires further qualification.¹⁰

Here, then, is the neuralgic issue evoked by Lancellotti and urgently needing today to be clarified, at least from the point of view of a Christian ontology of creation: not simply whether wonder and beauty have an important place in the intentions of scientists, but whether on the contrary they are *integral to the logic of scientific abstraction and the order of the world properly understood*. It is just this view of wonder and beauty as pertinent to, indeed as primary within, the objective order — both the given causal order of things and the method of scientific knowledge — that the mechanistic ontology dominant in today's culture denies. We must take account of all that is implied in this denial if we are to enable a fuller and more adequate science, *precisely as science* — which is to say, if we are to sustain the main burden of Lancellotti's own argument.

Thus, in a word: Lancellotti is right that recovery of the full breadth of reason in science entails renewal of the knower's openness to the beauty of the cosmos. My purpose is to secure

¹⁰Let me stress that all of this is not to deny what Lancellotti insists is the crucial importance of the moral-affective-aesthetic dimension of the dynamics of knowledge in avoiding reductive science. I take that as given. *It is to say, simply, that this dimension of the dynamics of knowledge is properly located within, and indeed is a response to, the ontological order of things*. Reductive science is a matter not only of an inadequate "subjective" disposition but *also-intrinsically* of a faulty notion of the ontological order of things, which must therefore be clarified as an integral part of recuperating properly those very dynamics. As implied by what is stated in the preceding footnote, this does not mean that one's always implied view of order will *determine* one's freedom, such that an anticipation of a reductively-conceived ontological order will lead necessarily to reductive scientific practice. On the contrary, the relation between freedom and (ontological) intelligence is *mutually* internal, and freedom and intelligence are therefore always mutually "causal", with each having its own distinct priority within this mutuality [10]. It is for this reason, then, that the practitioner of science is able to be, and indeed, as Lancellotti points out, in the case of the best scientists almost always is, better in his or her practice than his or her (mechanistic) theory logically allows. The point is simply that each act of freedom is mediated by some view of ontological order, and this view of order just so far, even if only unconsciously, will always *dispose and shape* — *without determining* — one's scientific practice (which remains simultaneously also a matter of freedom). As will become clear below, the history of mainstream science in modernity itself testifies abundantly to this fact.

Note, in light of the foregoing, the statements of Marco Bersanelli in his contribution "Wonder and knowledge: scientific investigation and the breadth of human reason", in the present volume: "Every cognitive process involves the entirety of our person: reason and affection"; "In order to account for what we know about the universe through science, it is necessary to broaden our notion of what we normally mean by reason. Affective elements, not separable from our intellectual abilities, are essential for the onset and duration of any scientific enterprise". Again, Bersanelli says that the scientist at his best is moved by the great questions of existence: for example, "for an astronomer at work, the fundamental questions on the origin, destiny and meaning of the universe are not an object of his research in the same way as are the telescope and instrumentation he is using or the quasars he is trying to observe; but those ultimate questions are continuously sustaining his deep motivations: they are not 'elsewhere' with respect to his scientific work, rather, they act as silent and powerful engines moving his desire to know and understand" (16). Apropos of these statements of Bersanelli, whose paper was not yet available to me in the original writing of the present paper: my purpose is to indicate the ontological foundations and significance of (1) a reason expanded to include wonder *precisely as integral to the proper functioning of reason as such*, as well as (2) a scientific method expanded to include openness to the great questions *precisely as integral to the proper functioning of that method in its scientific objectivity*.

the ontological-cognitional foundations of this assertion by examining, in light of the Christian doctrine of creation, the sense in which this renewal will have to involve *also-simultaneously* a transformation of the *intelligence* enabling one to see this beauty as a matter truly of the *order of things*.

Indeed, without the further ontological qualification entailed in this transformation of intelligence, the prevalent mechanistic idea of scientific abstraction, which excludes from the *inner logic of science* as science the very features Lancellotti (rightly) insists are characteristic of science in its fullest realization, will be left intact. These features will continue to be viewed as they have commonly been viewed in modern academic culture: as essentially *extra-rational, extra-scientific* additions to science.

Note that what I am proposing does not deny a necessary distinction between philosophy/theology and science. What it denies is only that this necessary distinction should be construed to mean that the abstractions proper to science, in form or content, *can be separated from*, and thus *remain empty of and not always already-shaped by*, some notion of being, man, and God.

3. Mechanism

In general terms, then, the mechanistic idea of abstraction implies on the part of the researcher, whatever his intention to the contrary, a method that emphasizes the primacy of controlling power in its quest for the intelligibility of the object. Such control is predicated on the possibility of an exhaustive intelligibility of things, and of its inner logic seeks such an intelligibility. This dynamic for exhaustive intelligibility presupposes and indeed demands that the object be accounted for in terms of “parts” related externally, via forceful movements that are in principle deterministic and thus exactly measurable or calculable. This, on the mechanistic view—which gives way of its own logic to a technologicistic view of nature and knowledge—is what makes up the order of things that is properly accessible to reason. What is not ordered in this way is considered not to be properly a matter of reason and hence science (whether one conceives the discipline as engaging reality only within a certain boundary/limit or not), however important it may be for human life in other respects. Causal activity in x that arises from within x , for example—which is to say, genuinely interior causes (such as form and finality) that just so far elude reduction to forces exerted from outside x —resist the determinism and just so far the kind of exhaustive intelligibility sought by mechanism, and hence are excluded from the purview of science.¹¹

¹¹Cf. in this connection the works of David Bohm [11, 12, 13, 14, 15]. Fundamental to Bohm’s argument is the claim that “uncertainty” in the behavior of “things” as affirmed in the dominant interpretation of quantum physics does not really overcome mechanism, but rather leaves it intact, albeit now as a matter of “statistical probability”. Bohm’s lifelong concern was in fact to show that the “uncertain”, or non-mechanical, aspects of things were manifestations of what was truly order, even as the idea of order needed thus to be expanded to include integration of explicit-mechanical and implicit-non-mechanical features. Without implying complete agreement between Bohm and Bersanelli regarding their respective conceptions of order (for example, with

In historical terms, what is presupposed here in the mechanistic view of abstraction is a Cartesian understanding of distinction, coincident with a Baconian understanding of knowledge as an act primarily of power. Reason as exercised in science, on this understanding, is rightly seen to be primarily *technological* in nature,¹² in the sense that its logic is primarily intent, not on seeing or understanding *x* as it appears but on controlling the intelligibility of *x* as exhaustively as possible in order to produce things as efficiently as possible. What is not controllable in this fashion may be important in other respects, but it is not pertinent to reason in its properly scientific exercise.

How does all this translate in terms of the problem of disciplinary abstraction in science? How the disciplinary limit of each science is to be conceived will depend, of course, as Lancellotti points out, on how the limit of the abstraction proper to that science is conceived. As I have already suggested, according to a dominant contemporary view, whatever is to be added to an object (*x*) from beyond the limit of *x* as abstracted for disciplinary purposes can be safely added later, in the manner indicated above. The limit of *x* is thus conceived in terms of an *original indifference, hence closure*, of *x* toward what (non-*x*) lies beyond, hence transcends, *x*. Such indifference thus implicitly denies that what lies beyond or transcends this limit makes a pertinent difference to *x* already *from inside* *x*'s abstract limit as *x*.

This notion of limit presupposes a Cartesian understanding of distinction. Distinction for Descartes is conceived in terms of the straight lines proper to geometry as he studied it. Straight lines enable clarity. How so? By virtue of what is (as conceived by Descartes) a line's *externality* – its purely abstract externality. A line so conceived establishes a limit that externalizes the relation between *x* and non-*x*, thus enabling *x* to be and to be known without any admixture of non-*x*, and vice versa. Hence we have the mechanistic idea of limit as simple closure of *x* to non-*x*, and vice versa. Further, considering that matter is commonly defined primarily in terms of externality, we see that Descartes's mechanistic idea of limit is in fact a mechanistically-materialized idea of limit.¹³

respect lineto quantum physics), the burden of Bohm's work as just stated is nevertheless entirely consistent with Bersanelli's statements in "Wonder and Knowledge": "Chance and order: both collaborate to [yield] the aesthetic dimension of nature as we know it. Nature offers to us a feature that may be even more elegant and fruitful than the stability of the laws of nature on one side, and the novelty of unpredictable events on the other: the indissoluble unity of the two. Perhaps both chance and order need to be understood as manifestations of a deeper reality" (9). And again: "Nature blossoms in its beauty and diversity from a delicate interlacing of symmetry and symmetry- breaking, of laws and unpredictable events, of order and chance". Strictly speaking, Bohm's point, which, again, I take to be in agreement with the burden of Bersanelli's statements here, is that what is usually conceived as *chance* is in fact a matter of genuine order, albeit of a qualitatively different, and enlarged, sort of a "manifestation of a deeper reality".

¹²The term "technology" as used here thus presupposes its modern form, which is to be clearly distinguished from (premodern) Christian or Greek *techné*. The point is important, of course, because the burden of the argument I am proposing is to secure a *kind of technology*, albeit one informed by a sense of creaturely gift. What this means will be clarified as we proceed.

¹³In Scholasticism, matter in its ordinary as distinct from "primary" sense is defined in terms of "parts outside of parts"; and in Hegel, matter is defined in terms of "what has no center within itself". But the crucial point is that, for both the Scholastics and Hegel, though in importantly different ways, matter as it actually exists always bears an interiority given it by form (Aristotle) or spirit (Hegel). It is in this light that we judge Descartes's matter to be at once purely abstract (i.e., not matter as it actually exists) and a

What is crucial to see here, then, is that this Cartesian understanding of limit as mechanistically-externally conceived indifference, hence closure, of x to non- x operates decisively within what is at once the method of knowing and the content of knowledge as described above. A logical (not necessarily intentional) primacy of controlling power in quest of exhaustive (fully clear and distinct) intelligibility on the one hand, and forcefully-causally related discrete bits of information or “stuff” on the other hand, are indissolubly linked: mechanistic method and mechanistic content are but two sides (“subjective”- cognitional and “objective”- causal) of the same coin, of the same mechanistic materialism.

Of course, this mechanistic-externalized idea of limit in one’s scientific abstractions allows for a certain kind of openness in the method and content of one’s knowledge. A researcher rarely takes his abstraction to exhaust the intelligibility of the object (x) simply. On the contrary, he typically recognizes that there is always more to find out about x . Indeed, that is just Lancellotti’s point. But let us ponder what openness to this “more” means. On the Cartesian view just described, such “openness” signals little more than an anticipation that the intelligibility of x will require the ongoing addition of further x ’s, each of which, or indeed all of which as summed, remain exhaustively intelligible in principle. Fuller understanding of x comes only from the external addition of more x ’s, all of which bear *the same logic as x in its principled mechanistic character*. Such addition is thus but the ongoing extension of a limit still conceived simply as closure, a limit that thus still presumes a relation of indifference of x to non- x in x ’s originally constituted abstract limit as x . Such “openness”, in a word, retaining the basic features of mechanism, is rightly termed reductive, not genuine openness at all.¹⁴

On the other hand, a researcher still assuming the dominant Cartesian categories may in fact

“materialistic” reduction of the proper meaning of matter.

¹⁴Such openness may be termed a “bad” infinity consisting of endlessly summed, mechanistically-conceived, intelligible objects. See the recent New York Times editorial “The Cons of Creationism” (June 7, 2008) for an example of the false form of science’s “openness” based on the dualistic-reductionistic notions of science and of the nature of things that the present article calls into question: “The trouble is, a creationist system of science is not science at all. It is faith. All science is ‘naturalist’ to the extent that it tries to understand the laws of nature and the character of the universe on their own terms, without reference to a divine creator. Every student who hopes to understand the scientific reality of life will sooner or later need to accept the elegant truth of evolution as it has itself evolved since it was first postulated by Darwin. If the creationist view prevails in Texas, students interested in learning how science really works and what scientists really understand about life will first have to overcome the handicap of their own education.

Scientists are always probing the strengths and weakness of their hypotheses. That is the very nature of the enterprise. But evolution is no longer a hypothesis. It is a theory rigorously supported by abundant evidence. The weaknesses that creationists hope to teach as a way of refuting evolution are themselves antiquated, long since filed away as solved. The religious faith underlying creationism has a place, in church and social studies courses. Science belongs in science classrooms.

From the perspective of the argument advanced here, neither creationism nor evolutionism takes adequate account of the radical givenness of things, which is the source, simultaneously, of their autonomy, intelligibility, and mystery (each understood as directly proportional to the others). The “openness” of science, as conceived in the editorial, is in fact a form of closure, inasmuch as “further evidence” is tacitly conceived in exclusively mechanistic terms — and is otherwise not pertinent to scientific reason.

be open to a non-x bearing a character different from that of x, a non-mechanistic character. It is essential here, however, that non-x be anticipated to make a difference to x already from within what is taken to be x's proper intelligibility and limit as x. Failing this, non-x will be seen to make an important addition to x, but at the expense of being judged not to be properly intelligible, and hence not properly an object of knowledge or a matter of reason, at all.¹⁵ The result in this case, in other words, is a dualism that leaves mechanistic limit in place as the proper form of intelligibility and thus of rationality, even as it allows for something lying simply beyond this limit and hence beyond what is intelligible and rational in the strict sense. An openness that is dualistic in this sense, in a word, remains reductive, in the sense that it still presupposes the equivalence of intelligibility and mechanistic limit even as it seeks to add something that is simply beyond both.

Note, then, that it is irrelevant whether the researcher here, in conceiving the limit characteristic of abstraction to be a matter of simple closure, understands this closure in a (would-be) purely disciplinary sense that would anticipate an eventual releasing of that closure in another context. The crucial question, rather, bears on how one conceives "eventual releasing of closure". The crucial question, in other words, is whether, in his merely strategic abstraction of x, the researcher takes x to be open *here and now, from within its very limit as abstracted, to a "more" implying an order other than that of x, and whether this "more" thus makes a "difference" to x already in its nature as abstracted, even if the abstraction is only for disciplinary purposes.* Failing this, we are left with what will be merely a swinging back and forth of reduction and dualism in the relation between the abstractions characteristic of the various disciplines.¹⁶

The burden of my argument here, therefore, is that, to move successfully beyond a reductive sense of limited abstraction in science, and thus also beyond the dualism that presupposes this reduction, one must go to the roots of mechanism as such, as expressed in the primacy of methodical power and the quest for exhaustive (fully clear and distinct) intelligibility in terms of forceful-causal relations among discrete entities. One must go to the roots of knowledge as a mechanistically-conceived technological act.

Before commenting on the vast influence of the mechanistic understanding of abstraction in

¹⁵Note that the problem indicated here is not overcome simply by appealing to two different kinds of knowledge. This would simply beg the question: two different kinds of knowledge, *eo ipso*, share in something called knowledge, and if so, they bear some unity that just so far characterizes the inner form of both kinds of knowledge. This, then, is just the dilemma forced by mechanistic assumptions: if knowledge, then mechanistic; if not mechanistic, then not knowledge. It should perhaps be pointed out again here that the burden of my own argument is not to deny but to affirm a plurality of ways of knowing, —*e.g.*, philosophical and scientific— that is, while reconfiguring the conventional terms in which the relative unity and distinctness of these ways of knowing (the disciplines) are conceived in the contemporary academy.

¹⁶It is important to see, then, that reduction and dualism, in their very opposition, remain mirror images of each other: because and insofar as both are governed by the same Cartesian logic of limit as simple-external closure. Here, then, is the root of what is commonly the *confusion simultaneous with fragmentation* among the contemporary academic disciplines.

modernity, it is important to consider briefly a significant alternative way of conceiving the openness of x to what lies beyond its limit as x : what may be termed a “postmodern” reading of abstraction. We have noted how the intelligibility of x can be conceived as exhaustive by virtue of what may be an endless addition of further x 's. The relevant point now is to notice what is implied in the qualifier “endless”. Endlessness entails a kind of *infinity*, in such a way as to redound back upon the intelligibility of x from the beginning and thus in each of its instances. The result, on the postmodern reading, is an undercutting of the stability, hence intelligibility, of x in its identifiable limit as such. For the openness of x on this alternative is seen to signal an openness *here and now* and from within x to a quasi-infinity of additions, each of which would introduce a (possible) difference to x in its original intelligibility as such. The intelligibility of x , in short, would be *essentially elusive*.

This postmodern view clearly rejects mechanism insofar as the latter implies a primacy of controlling power and determinism and exact measurability and calculation, all of which are necessary for the exhaustive intelligibility of an object. Indeed, this second view draws attention to an openness to infinity, and thus infinite openness, inherent in every object.¹⁷ Nevertheless, the relation of this alternative view to mechanism is complicated. For postmodernity, the infinite depth and breadth of a “more” that is implicit in x —the infinite relativity of x to non- x —implies a kind of infinity that is empty of intelligibility insofar as intelligibility bears mechanical features. The infinity of a “more” in this sense, which makes a difference to every instance of x , is thereby taken to be destructive of x in its (would-be stable) intelligibility as such. x 's putative intelligibility as x in the end is “nihilated”, dissolving into a kind of infinite nothing, or unending difference.

From the perspective of the argument proposed in the present paper, this postmodern view, despite its obvious fundamental challenge to mechanism, does not really question the link of the intelligibility of x with the mechanistic identity and exhaustive determinism and controllability of x , even as in a basic sense it of course rejects both mechanistic identity and exhaustive determinism and controllability. The crucial point, in other words, is that postmodernity, continuing to assume this link, understands x 's inherent openness to infinity to signal not so much a density as an absence of intelligibility, construing the thinker's lack of completely controlled intelligibility as a simple absence of intelligibility in the strict sense. Mechanistic order is thus rejected in favor of what eludes intelligibility, even as mechanistic order is still presumed to be the necessary condition of intelligibility. In a word, the order of reason strictly interpreted retains its mechanistic character, even as this order is now a target of deconstruction. Postmodernity thus repeats in its own way a modern dualistic form of reductionism [16].

¹⁷As Professor Nancy Cartwright suggested in the discussion at San Marino Symposium, postmodern thinkers like Michel Foucault, for example, share an openness to infinity with Christianity. I will clarify later the distinct sense of openness to infinity entailed in the Christian doctrine of creation. See also Prof. Cartwright contribution in this volume.

As I will show later, neither modernity's mechanistic idea of intelligible limit nor post-modernity's infinite going-beyond of intelligible limit suffices to overcome the problem of the reduction of reason in science from the point of view of an adequate Christian ontology of creation. But before turning to this task, it is important to see the vast *intellectual-ontological* revolution that has been wrought in modernity by what we have described as a mechanistic-materialistic idea of abstraction in science.

4. Scientific abstraction

To this end, we offer a description of the dominant stream of science in modernity, drawing on the work of twentieth-century Jewish philosopher of science and especially of biology, Hans Jonas. At the heart of methodical abstraction as commonly conceived in modern science, argues Jonas, lies a "theoretical manipulability", a manipulability that he takes at once to presuppose and to anticipate a mechanistic, or reductively technological, view of order in the cosmos. But let us see how [17, 18, 19].

Jonas suggests that the modern scientific revolution "was a change in theory, in world-view, in metaphysical outlook, in conception and method of knowledge". He states that the scientific revolution did not "at first —and for a long time— concern itself with the realm of practice", that indeed modern science "started mainly with the astronomer's reform of *cosmology*, and the cosmos, the stellar universe, does not lend itself to manipulation". And thus "technology, historically speaking, is the delayed effect of the scientific and metaphysical revolution with which the modern age begins". Jonas emphasizes, however, that this effect was scarcely "accidental":

The very conception of reality that underlay and was fostered by the rise of modern science, i.e., the new concept of nature, contained manipulability at its theoretical core and, in the form of experiment, involved actual manipulation in the investigative process. Not that Galileo and others undertook their experiments with practical intent: their intent was to gain knowledge; but the method of knowledge itself, by the active intercourse with its object, anticipated utilization for practical ends [...] Technology was thus implied as a possibility in the metaphysics, and trained as a practice in the procedures, of modern science.

Thus "the present global technological situation of man has itself a metaphysical side to it besides the more obvious practical one. The meaning of the technological revolution is thus part of, indeed the completion of, the metaphysical meaning of the scientific revolution".

Jonas characterizes as follows what he takes to be three important developments in the wake of Galileo's new conceptualization of motion: "The first is the geometrizing of nature and consequently the mathematization of physics". Descartes had raised this to

*the dignity of a metaphysical principle when he split reality into the two mutually exclusive realms of the *res cogitans* and the *res extensa* - the world of mind and the world of matter: the latter is in its essence nothing but "extension"; therefore nothing but determinations*

of extension, i.e., geometry, are required for a scientific knowledge of the external world.

“Secondly, the program of an analysis of motions necessitated a new mathematics, of which Descartes’ analytical geometry was only the first step”.

Thirdly, the conceptual analysis of motions permitted an actual dissociation of its component parts in suitably set up *experiments*: it thus inspired an entirely new method of discovery and verification, the experimental method. It must be realized that the controlled experiment, in which an artificially simplified nature is set to work so as to display the action of single factors, is *toto caelo* different from the observation, however attentive, of “natural” nature in its unprocessed complexity, and also from any nonanalytical trying out of its responses to our probing interventions. It essentially differs, in one word, from experience as such. What experiment aims at --the isolation of factors and their quantification-- and is designed to secure by the selective arrangement of conditions, *presupposes* the theoretical analytics we have described; and it repays theory by its results.

Turning to the task of evaluation, Jonas says that the innovation in modernity’s (Newton’s) theoretical revolution in dynamics was not originally about the principle of causality *per se*, but about the idea of change. However, “the altered conception of what constitutes a change, i.e., an effect, naturally reacted on the conception of what constitutes a *cause*”.

Now, “change” had been redefined as acceleration of mass, and to this its primary form all (phenomenally) other kinds of change --such as qualitative change-- must be reduced. Accordingly, “cause” is redefined as that which imparts (or resists) acceleration – i.e., as force, whose sole effect is acceleration (or its negative), and whose magnitude is precisely measured by the amount of acceleration it imparts to a given mass: and to this, its primary form, all (phenomenally) other kinds of ‘causes’ must be reduced.

Jonas notes what he calls the “extraordinary physical as well as metaphysical consequences” that follow from this conception of cause. “First of all, with the quantifiability of all changes in nature, the cause-effect relation has become a quantitative relation, namely that of strict quantitative equivalence of cause and effect [...] Consequently, any physical state can be represented as a determinate configuration of masses and forces from which the next state follows necessarily and --more important-- can be computed rigorously by a calculus of the represented magnitudes, if all of them are known”. Negatively put, this implies “the denial of the possibility of any nonphysical, e.g., spiritual, cause intervening in the physical course of things”. This “new metaphysics of science” clashed with “our most immediate and common experience (*viz.*, that we are authors of our actions from purpose and design)”, and relegated “this basic experience to the realm of mere appearance”.

Furthermore, in addition to eliminating any reasonable account of “the causal efficacy of *human purpose*”, this new metaphysics of science sets aside



end-causes of any kind – i.e., teleology as such which, in whatever attenuated analogy of striving and satisfaction it is conceived, must share with human purpose a transmaterial, quasi-mental aspect. That Nature is devoid of even the most unconscious bias toward goals, and of the formative power to serve it, that final and formal causes are struck from its inventory and only efficient causes left, follows simply from the principle of quantitative equivalence and invariance in cause-effect relations which is the distinguishing mark of the “determinism” of modern science... [This determinism] means that always and only the immediate antecedent determines the next instant, that there are no long-term trends toward something, but only a transfer of the mass-energy sum from moment to moment, and the vis a tergo of this propagation - in short, no pull of the future, only the push of the past.

Here, then, are the summary implications Jonas sees for the fostering of a reductive technological attitude that has become prevalent in our time:

What has neither will nor wisdom and is indifferent to itself solicits no respect. Awe before nature’s mystery gives way to the disenchanting knowingness which grows with the success of the analysis of all things into their primitive conditions and factors. The powers that produce those things are powerless to impart a sanction to them: thus their knowledge imparts no regard for them. On the contrary, it removes whatever protection they may have enjoyed in a prescientific view. The implication this has for man’s active commerce with the equalized manifold is obvious. If nature sanctions nothing, then it permits everything. Whatever man does to it, he does not violate an immanent integrity, to which it and all its works have lost title. In a nature that is its own perpetual accident, each thing can as well be other than it is without being any the less natural. Nature is not a norm (which to Aristotle it was) and a monstrosity is as natural as any “normal” growth). Furthermore, if nature is mere object and in no sense subject, if it is devoid of “will”, then man remains as the sole subject and the sole will. The world, after first having become the object of man’s knowledge, becomes the object of his will, and his knowledge is put in the service of his will. And the will, of course, is a will for power over things. The heavens no longer declare the glory of God; but the materials of nature are ready for the use of man.

In addition to these “spiritual” aspects of the new science that showed its intrinsic readiness for a reductive technological attitude, Jonas says that there were also more technical aspects that pointed in the same direction: for example, “the role of analysis and that of experiment”.

The analysis of any complex phenomenon into its simplest geometrical, material, and dynamical factors is tantamount to finding out how even the most sophisticated natural entity that comes about –is brought about– from the collocation of primitive components. But knowing how a thing is made of its primitive elements leads of itself to knowing how one can make it up oneself out of those elements. The passage from analytical knowledge to making, i.e., to providing the requisite components and manipulating them so as to secure the desired results – the passage, in short, from analysis to synthesis is open on principle whenever the former is completed in a given case. And so is the passage from experiment as a means of knowledge to applied science as a means of use. Practice in the service of theory, which is what experiments are, is readily converted into theory, in the service of practice, which by now most of “science” almost automatically becomes.

Further, then,

with the advent of molecular engineering man assumed a more sovereign role, involving a deeper meddling with the patterns of nature – indeed a redesigning of such patterns. We

now are in an age where, by imposed dispositions of molecules, substances can be made to specification – substances nature might produce but in fact does not produce. Man steps into nature's shoes, and from utilizing and exploiting he advances to creating. This is more than merely shaping things. Artificiality enters the heart of the matter¹⁸ with its new, synthetic substances, [this technology] introduces things unknown before into daily use and thoroughly refashions the habits of consumption.

Needless to say, these statements can be qualified and elaborated much further. In their main lines, the patterns he describes are familiar to us. Although I find Jonas's portrayal of modernity to be brimming with profound insights, my purpose in offering it here is not to argue its truth but simply to indicate the significant sense in which the method of abstraction in science and a definite conception of order in the universe mutually imply one another.

Jonas makes clear how this is so in mainstream modern science and the culture shaped by that science. The primacy of what he terms "theoretical manipulability" in modern science implies a method whose logic is primarily that of controlling power with respect to the object of study, a power that tends toward completeness insofar as this method of science itself innerly anticipates effective utilization for practical or productive ends. But such a method, *eo ipso*, presupposes and leads to conceiving the order of the universe as one that lends itself to this kind of control: namely, mechanistic order. This order construes entities in terms of external identities initially, and most basically, closed to one another, the sum of whose (external-forceful) interactions with one another can then, at least in principle, be exactly measured. "Theoretical manipulability", in a word, is a reductive way of conceiving the knower's relation to the world that itself already instantiates a definite-reductive notion of being, man, and God. Indeed, "theoretical manipulability" itself expresses what is but the cognitional version of an order consisting essentially of external-forceful relations – here between the subject-knower himself and the object known. My argument is that this reductiveness can therefore be overcome only by transforming "theoretical manipulability" at once as a mechanistic method of abstraction and in its presupposed and anticipated mechanistic ontology.

Note that what is most relevant here is not primarily a matter of the scientist's intention. As Jonas points out, for example with respect to Galileo, the issue is not whether a scientist approaches the object with the intention simply of seeing or understanding an object, which is granted in the case of Galileo. The pertinent issue concerns rather the presence or absence of genuine theory (contemplation, wonder) *into the very logic of the method* followed by the scientist in his quest for intelligibility.

What is relevant to recognize, then, is that the interlocking of mechanistic abstraction and mechanistic ontology is not undone simply by insisting on a disciplinary limit for mechanistic method, which in the end amounts to a form of question-begging. The question is whether the scientist, in his abstractions of *x* --whether these are assumed to be limited methodologically

¹⁸Jonas of course does not object to artifice as such. On this, see the further comments below regarding nature rightly understood as itself inclusive of artifice.

or not— takes *x* to be embedded in, and shaped from within by, a non-mechanistic order in which *x*'s mechanical properties are given both their stability and their proper intelligibility as such. The scientist whose primary cognitional logic is that of theoretical manipulability, and hence of mechanism --even if these are intended to be strictly limited methodologically-- just so far denies this kind of primordial embeddedness. The inevitable result is some variant of modern monolithic or dualistic reductionism in what one takes to count as science and hence knowledge in the proper sense. Or again some variant of postmodernism, which repeats the modern problematic albeit from the opposite direction.

Jonas refuses both of these alternatives. He critiques modern science and its reductively technological sense of abstraction with the aim of *integrating* scientific rationality into a broader --and more ancient-- rationality, which remains rational and includes mechanical order even as it transforms and transcends the mechanistic notion of order. He affirms the necessity and legitimacy of technological progress, even as he sees the urgency of its integration into this broader rationality.¹⁹ He insists that the task today is not merely to *add* something extra-rational and extra-scientific, which is to say, something purely willful-moral or affective or aesthetic, to a dominant cognitional-ontological order conceded to be legitimately mechanistic. On the contrary, he understands that such a response merely repeats the dualistic form of mechanistic reduction that lies at the source of modernity's problematic technologizing of ontology in the first place.

My simple point with respect to any appeal to the limited nature of disciplinary abstraction as a means of avoiding reductive science is that such an appeal needs to be qualified in light of these claims by Jonas regarding the nature and implications of abstraction as conceived in the dominant stream of modern science -- and indeed the dominant patterns of modern thought.

But this leads to the concluding stages of my own proposal: first, to show how a Christian ontology of creation takes up Jonas's task of integrating the now mechanistically conceived features of order in scientific rationality into a broader conception of order and scientific rationality; second, to offer an example from within science itself of this broader conception of order and rationality.

5. Ontology of gift

In an important lecture at the University of Regensburg in September, 2006, former Pope Benedict XVI addressed the theme of "Faith, Reason, and the University" [20]. Western thinkers tended to fasten on one main point of the lecture, that which concerned dialogue with Islam: that the Christian God has revealed himself as *logos* and thus as reason and

¹⁹See in this connection Jonas's critique of Heidegger in "The Phenomenon of Life" [18], the burden of which, relative to my point here, is that "no philosophy of nature [that is, no causal understanding of things in a proper sense] can issue from Heidegger's thought".

word. This reason, as love, “is creative and capable of self-communication, precisely as reason”, and God therefore acts with reason, and not simply “willfully” or arbitrarily. Equally important, however, was Benedict’s insistence from the other direction that reason rightly understood opens organically to God. Benedict pointed out that a restriction of science to the mathematical and the empirical elements of things, along with a restriction of demonstrable or certain truth to verification or falsification through experimentation, led to a conception of method that excluded the question of God as *eo ipso* unscientific or pre-scientific.

Benedict intended his lecture to initiate a dialogue, in other words, not only in the direction of Islam but also and equally importantly in the direction of the West and its universities. On the one hand, he affirmed that it is the nature of God to be “reasonable”, in the face of the problem of a terrorism often justified in the name of God and religion. At the same time he insisted that it is of the nature of reason rightly understood to open to the question of God, that the question of the “divine” (*das Gottliche*) should not be excluded from the universality of reason, in short, that the measure of what is to count as scientific should not be restricted to a certain conception of the mathematical and empirical. In a word, Benedict insisted that reason bears an intrinsic-logical movement toward God, and he did so expressly in the face of the problem of the Western university, which, he said, has in recent centuries harbored a reason or science that is deaf to God and relegates God to the realm of the merely “subjective”.

Benedict concludes by saying that “modern scientific reason with its intrinsically Platonic element [by which he means to refer to matter’s intrinsic rationality] bears within itself a question that points beyond itself [...] Modern scientific reason quite simply has to accept the rational structure of matter and the correspondence between our spirit and the prevailing rational structures of nature as a given, on which its methodology has to be based”.²⁰

What does Benedict’s proposed “expansion” of scientific reason imply for the question posed in this paper?

(1) Above all, it presupposes a definite doctrine of creation. Creation is an act of love, which means that creatures come into being through an act of giving: to be a creature is to be a gift. Since creation, on the Christian understanding, is *ex nihilo*, the creature’s being as such is constituted as gift [22]. Benedict’s theology echoes that of his predecessor, John Paul

²⁰Cf. also the Benedict’s statement: “the correspondence between [the] structures [of mathematics] and the real structures of the universe . . . implies . . . that the universe itself is structured in an intelligent manner, such that a profound correspondence exists between our subjective reason and the objective reason in nature. It then becomes inevitable to ask oneself if there might not be a single original intelligence that is the common font of both of them. Thus, precisely reflection on the development of science brings us toward the creator *Logos*. The tendency to give irrationality, chance and necessity the primacy is overturned . . . www. Upon these bases it again becomes possible to enlarge the area of our rationality, to reopen it to the larger questions of the truth and the good, to link theology, philosophy and science between them in full respect for the methods proper to them and of their reciprocal autonomy, but also in the awareness of the intrinsic unity that holds them together” [21].

II, who stated that it was opportune today to “turn anew to those fundamental words that Christ used, that is, the word ‘created’ and to the subject ‘Creator,’ introducing [...] *a new criterion of understanding and of interpretation* that we will call ‘*hermeneutics of the gift*’. The dimension of gift is [...] at the very heart of the mystery of creation..” [23].

What is entailed by the original nature of the creature as gift, relative to the problem of disciplinary abstraction in science? To prepare us to respond to this question, I begin with a brief description of some of the main features of creaturely entities in their nature as at once gifted and autonomous.

The crucial point, as already indicated in the introduction, is that the relation to God that *establishes the creature in its own being*, and indeed that implies a shared relation of each creature with all other creatures, is truly in the creature. What the creature most basically is, is a being-given. This being-given that is constitutive of the creature implies a receiving on the part of the creature that is just so far also constitutive. What is it that is being-given to, and being-received by, the creature?

A participation in the self-diffusive generosity of God as good. As Aquinas says, *bonum est diffusivum sui*: it is the nature of the good to diffuse or give itself.²¹ The basic truth about the creature, therefore, is its goodness. Or indeed, drawing on the classical language of the “transcendentals” employed by Aquinas (and developed further by twentieth-century theologian Hans Urs von Balthasar), we should say that God’s act of creation is at root a creative *communication* to creatures of a participation in the truth of being as an order of goodness and beauty.²² What the creature receives most fundamentally in the act of creation is thus a share in this communication, in the giving characteristic of God’s creative act. In saying that these features of receiving and giving are constitutive of the creature, we mean to say that they are characteristic of both the being (*ens*) and the first and most basic act (*agere*) of the creature [24, 25, 26]. This receiving-giving, in other words, which is immediately also a giving-receiving, characterizes not only what the creature is but what the creature always already, at the most basic level, *does*.

Each creature, then, in the most primitive structure of his being and acting is a recipient of gift, in relation to God and to others. This is not a matter of passivity, but simply a recognition of the fact that the creature’s acting with respect to the other is at root responsive to the other. The creaturely act is first *contemplative or theoretical*:²³ what it first (ontologically, not temporally) does in relation to the other is receive the other (or more fully stated, receive itself in receiving the other). The creaturely act first “lets the other

²¹Thomas Aquinas in [4], referring to Dionysius, *The Divine Names*, iv. This does not mean that creation is necessary, but that what God does freely in creating necessarily expresses the generosity proper to his goodness.

²²Cf. the dictum common to many theologians in the patristic era of the Church: “*pulchrum est splendor veritatis*”.

²³From the Greek “*theorein*”, to look at.

be” in its givenness as such. This letting be, as a response to being, which, as created, is good and beautiful, is an act of wonder. Letting be and wonder, in other words, are but the *subjective-cognitive forms of participation in the objective nature of being as gift* [27]. Which is to say, letting be and wonder are themselves, already in their theoretical character as such, distinct forms of participation in gift-giving.

Further, the creaturely act is characterized at once by immanence and transcendence. Immanence, in the sense that the relation to God and others that is constitutive of the creature presupposes the creature’s capacity to receive the other within itself, and the creature is just so far marked by *interiority*. Transcendence, in the sense that the relation to God and others that is constitutively (hence continuously) given to and received by the creature presupposes the creature’s openness to an other who is always already “beyond” the self. Immanence and transcendence in the creature cannot be dissociated: they are dual aspects of the same act. Each creature bears within itself as gift an excess signifying the presence of a transcendent other-giver. This excess we may term mystery, and, given that the creature’s constitutive openness is to the whole of being, to all other creatures inside openness to God, this mystery lying at the heart of every creature opens to infinity. It is crucial to see that this openness to infinite mystery, as always already bound up with the original identity of the creature, is just so far integral to the intelligibility proper to the creature in its very identity as such, and indeed, further, that infinity is itself just so far seen, in its character as *infinite*, to be inclusive of intelligibility.

Important also is the statement of Aquinas: “As the soul is wholly in every part of the body, so God is wholly in all things and in each one”. [4] As the spiritual writer Dom Eugene Boylan elaborates: “The pattern of the whole is found in each of its parts, and in fact the parts are only incorporated into the whole by being made conformable to the whole.”. [28]. What this means, in terms of the ontology of creation, is that the parts of things have their being as parts only in relation to the whole and thus as participatory in the pattern or image of the whole, and this in three analogically-conceived senses: most basically in relation to God, but also in relation to the whole being of which they are a part and to the universal community of beings with whom each being shares a common relation to God.²⁴ Every “part” of being in the cosmos, in a word, is structurally a “part” of a greater whole, and thus always already constituted in community, analogically-conceived.

There are many more features that could be adduced in describing the structure of creaturely being, of course, but this will suffice for purposes of our theme. Three qualifications will help to clarify the sense in which these features are constitutive and thus present in every creature

²⁴The difficult question of how, precisely, the whole or wholeness indicated here is to be articulated is beyond the purview of the present reflection. Suffice it to say, in light of the classical-Thomistic philosophical tradition, that the idea of an analogical wholeness of things implied in the texts cited involves articulations, *inter alia*, of the notions of substance and form (soul) and esse, each in relation to the others and to God. In this connection, see [3]. See also the discussion below regarding the rightful meaning of identity or limit in terms of the ontology of creation.

all the time.

First of all, we normally associate acts of receiving and giving with human being, rather than with all of creaturely being, including sub- or non-human being. Though of course features such as giving and receiving and wonder and interiority are – among the beings of the creaturely cosmos – uniquely characteristic of human beings, the Christian doctrine of creation entails some genuinely analogical sense of generosity that reaches throughout the entire order of creation.²⁵ Every creature qua creature, for example, is receptive of relation to the Creator, and this receptiveness just so far presupposes an interior capacity enabling the presence of the other within each creature. It is the rhythm of receiving-giving/giving-receiving that is affirmed in the insistence of John Paul II and Benedict XVI that the idea of gift, or love, analogically conceived, lies at the heart of creation and indeed of creaturely reason.²⁶

A second difficulty: the foregoing comments appeal expressly to the Christian doctrine of creation, and the features I have described might thus be set aside as convincing only to those who share the Christian faith. The burden of my argument, however, is that the Christian doctrine of creation itself, rightly conceived, carries an ontology: a distinct understanding of worldly being. The Christian doctrine of creation implies a metaphysics that opens of its inner dynamic into what Aristotle long ago identified as a theology. This claim, to be sure, demands elaboration, which nevertheless must await another forum. What I have been presupposing here is simply that the Christian doctrine of creation bears a distinct ontology which *eo ipso* carries the implication that the features of gift such as those noted above *are really present in things*, and that it is thus possible in principle for all reasonable beings, and not only Christians, to recognize these features. Indeed, the ontology carried in the doctrine of creation implies that all human beings necessarily will grasp these features, even if only confusedly. That doctrine also implies, of course, that the full depth and breadth of such features will be recognized only in faith. The further point, then, in light of Benedict XVI's Regensburg address, is that the accessible traces of gift, of their inner dynamic, bear sufficient implications of the presence of God that the question naturally arises regarding whether he

²⁵See the argument of Kenneth L. Schmitz regarding the need for a recovery of a metaphysical, and not merely anthropological, kind of interiority within created entities [29].

²⁶See in this connection the statement of Karol Wojtyła (John Paul II), in which he signals subhuman creatures' structural aptness for being taken up by and into the gift-giving of humans: "[C]ulture . . . forms a kind of organic whole with nature. It reveals the roots of our union with nature, but also of our superior encounter with the Creator in the eternal plan, a plan in which we participate by means of reason and wisdom . . . There exists in nature, or the world, an anticipation of . . . human activity and a radiation of humanity through praxis. There is also in nature, or the world, a kind of readiness to put itself at our disposal: to serve human needs, to welcome within it the superior scale of human ends, to enter in some way into the human dimension and participate in human existence in the world" [30]. Such a position is in fact implied by what is termed John Paul II's "theology of the body". Cf. also here Bersanelli's comments in "Wonder and Knowledge": "Every new insight recalls the secret friendship of the universe with us, and satisfies for a moment our 'natural desire for connectedness with the universe' (see also Linda Zagzebski, this Volume), normally unconsciously lived. In letting itself be more understood, the physical world shows an attitude of openness to us, and we perceive ourselves as destined to a relationship with everything. It is as though for a fleeting instant the appearance of things allowed a glimpse of an ineffable familiar face at the roots of reality".

truly exists and indeed what the nature of this God must be if the implied or “intuited” sense of being as gift is to be sustained. This *natural implication* of God’s presence in the beings of the world suffices for the rational character of what has been proposed.²⁷

Finally, it is also the Christian view of creation, rightly understood, that we do not live in a perfect or sinless world. Therefore it is not surprising that what is constitutively given as the nature of human being and cognition is historically weighted with disorder that obscures these in their original meaning. And again, nothing that has been said above implies that human beings are always fully aware of this primitively given nature of things. My claim, in short, is simply that what we have described does indicate the constitutive hence enduring natural structure of things²⁸ and thus something that, even if obscured or rejected or unwittingly ignored, still lies tacitly-implicitly at the heart of every instance of being or acting, and hence always resonates in the depths of experience, even if only confusedly and in the form of a restlessness for a generous way of being and acting.²⁹

In sum, my proposal, in light of Benedict’s theology, is that wonder lies embedded in the primitive structure of the human cognitional act, and that this act itself presupposes, and already signifies, a view of being as structurally *worthy or evocative* of wonder, hence as an order the causal meaning of which consists most basically in giving and receiving goodness and beauty. Which is to say, conversely: the primitive structure of being harbors a causal order of goodness and beauty which of its inner logic elicits receptive wonder as the most basic human cognitional act. The two are onto-logically inseparable: wonder and gift are the same reality viewed, respectively, subjectively and objectively. What human creatures do in a pre-eminent way³⁰—subjectively (cognitionally) and objectively (causally), in their relations to God and to one another—is to communicate this order of being as goodness and beauty.³¹

²⁷Cf. the view of Aquinas that every cognitive being knows and loves God implicitly in all that he knows and loves [8].

²⁸It is helpful to recall in this connection the Catholic understanding regarding the enduring integrity of nature: sin penetrates nature in an utterly profound way (however much this was insufficiently emphasized in modern Catholic theology); but sin does not thereby destroy nature in its basic order as created.

²⁹On the unity coincident with distinctness of *eros* and *agape*, see Benedict XVI, *Deus Caritas Est*.

³⁰And what all creatures do analogically.

³¹As discussed in [31]:

The Greek word for cause is a broad one, i.e., it doesn't initially have a univocal technical meaning. Used in a philosophical context, it indicates anything that accounts for a thing's being the way it is, that which is responsible for the how and why of a thing . . . Plato affirms that causality always occurs according to a model, which is another way of saying that what comes to be is not simply a self-contained entity, but a revelation or manifestation of something else: to say that the causal agent always makes according to a model means that agency is the communication of form. Causation is not, in other words, simply the bringing about of a thing or the setting of something in motion, i.e., an essentially formless event or activity, which may or may not subsequently give rise to something with form and therefore something intelligible . . .

To say that agency is the communication of form means that all of the things that come to be have the character of image—the Greek word, whence the English “icon”—or, in other words, that they reflect a meaning of which they are not themselves the source. It is crucial to see that there is no dualism here, as it were, between being and significance, as if things had a sort of opaque reality which subsequently indicated an intelligible content. To posit such a bifurcation would be to deny

(2) We turn to the question regarding the autonomy proper to the creature and his agency. As pointed out earlier, this autonomy is necessarily presupposed in the regularities of the processes of nature and thereby renders both possible and legitimate the abstract study of nature. The heart of the response to this question is already implied in the foregoing comments. Creation is something given unconditionally (*ex nihilo*). It is a gift that is really given over: what God gives to the creature is precisely the creature's *own being* as such. This of course means granting agency and power to the creature in (and for) itself. The crucial question concerns how this is to be rightly understood, given the above ontology of creation.

First of all, the movement from and toward God proper to creaturely being presupposes God's giving the creature to itself, and thus presupposes a creature that is just so far "in itself". The term for this is "nature", which may be characterized for our purposes as an origin that is given.³² The creature is original, as it were, but only and always as given by another, hence as always recuperative of an absolute origin that is from another.³³

the meaning of cause as Plato clearly intends it, namely, as the communication of form in the bringing about of a thing. We could say that, for Plato, ontology is semiotics. Being an image is what makes a thing real . . .

The form that is communicated by agency is necessarily a reflection of goodness. And, finally, insofar as this form most basically determines what a thing is, and is itself an imitation of the first cause, the gift of the being of each thing is at the very same time the gift of the ultimate purpose of each: namely, to be what it is by imitating in a particular way the ultimate source of all that is, i.e., by pursuing goodness. In a word, what would eventually be differentiated by Aristotle into three causes, appears first in Plato in its unity: the what of things is inseparable from their goodness, their purpose, and indeed their 'thereness.' For this very reason, goodness represents the paradigm of causality –the goodness at the origin of the cosmos, as we saw, is the 'best of all causes'– and thus all causes in the cosmos are, as causes, a reflection of goodness. Nothing is so causal, for Plato, as goodness and the beauty he takes to be essentially identical with it. . . .

To say that the presence of Beauty is the cause of beautiful things qua beautiful is simply to say that the sensible beauty we perceive in things is the intelligible form of beauty manifest in space and time; in other words, it is to say that sense experience is the expression of a meaning, that it has intelligible content, which, as intelligible, cannot simply be identified with the particularity of its manifestation . . . Physical objects, insofar as they are intelligible, are the expression of meaning, intelligible content, in a spatial and temporal mode. We can go further: there is, in fact, no content whatsoever in our sense experience that is not an expression of intelligible meaning . . . There is nothing in what we would call the 'physical' world that is not derived from form except its not being itself form, and this is simply a way of saying that the physical world is nothing but meaning made tangible.

The idea of causality as most basically a matter of the communication of meaning was held, albeit not in the same sense as in Schindler, by the late theoretical physicist David Bohm. It is important to see that such a claim is not, or not necessarily, an expression simply of "idealism". For a Christian, the foundation of this claim can on the contrary be found in the Gospel of John, whose Prologue states that in the beginning was the Word, the Logos of God, in and through whom everything was created. Insofar as all creaturely creativity (causality) images that of the Creator-God, this creaturely creativity communicates a "word": communicates a meaning and indeed what is always, in some significant sense, a natural participation in the wisdom of God. Cf. also here, and more generally in relation to the argument advanced in this paper [32].

³²Cf. Aristotle's definition of nature as what is in itself the source of movement and rest, as always already given, in the sense that, in their deepest order, the things of this world are eternally there. Of course, Aristotle's understanding of the character of nature's givenness relative to an ultimate Creator-giver differs profoundly from that affirmed in Christianity, even as both insist on the feature of givenness as essential to the idea of nature and its goodness.

³³Joseph Ratzinger/Benedict XVI repeatedly refers in this connection to what he terms the "filial" structure of creaturely being: see, for example, his *Jesus of Nazareth* [33], which shows how Christ, as the Son of the Father, reveals all of creation to be filial in nature: to be from another.

The point here bears emphasizing: the creature's characteristic "in itselfness", on the one hand, and its reference to another (God and others), on the other hand, are directly and not inversely related – as conventional liberal patterns of thought dispose us to assume. On the contrary, the whole of the thing in itself is related from inside to others, even as this constitutive relation to others presupposes the whole of the thing in itself as the "what" that is in relation.³⁴

Further, in giving creatures a nature, the Creator gives to each its own "substantial" identity. Each creature "possesses" a self-identity that is not that of other creatures – is different from the identity of all others. This is what at root makes possible what may be called the "mechanical" properties of creatures: properties, that is, which structure each entity as just so far outside the others and able to act on them from outside. Such mechanical properties provide an essential condition for what is each entity's legitimate external-forceful activity in relation to other entities.

What it is in each creature that accounts for its specific and indeed simultaneously individual identity is a difficult question that need not be addressed fully in the present forum.³⁵ It will suffice simply to indicate how "identity" as implied by a Christian ontology of creation contrasts with that sketched earlier in the name of Descartes. For the latter, identity is a matter first of external, mechanistically-conceived limit. The identity of *x*, in other words, is a matter of simple closure to non-*x*: the identity that distinguishes *x* simply divides *x* from non-*x*.

The ontology of creation as outlined, on the contrary, relativizes closure though not in a sense that attenuates at all the identity of *x*. Rather, what gives *x* its identity as *x* also relates *x* to another. The identity that is given to *x* and constitutes *x* as substantially "in itself" is at once *given to* and *received by* *x*.³⁶ As noted above, this implies in *x* the double movement of

³⁴It is the whole being in itself that is related from within to everything else, in relation to the Creator-God: cf. here Balthasar's claim that creatures themselves, rightly-analogically understood, are subsistent relations, in the image of the Trinitarian God [34].

³⁵Showing how "matter", form, and esse all perform in their own proper ways this function of determining, hence "closing", the identity of *x* all the while opening *x* intrinsically to non-*x* is a difficult task reaching beyond the purview of the present argument. Suffice it to say that each of these principles contributes to the "singularization" or "individualization" of a worldly being even as each simultaneously "universalizes" the meaning of that being. Each individual, in other words, is a kind of concrete universal (though in Balthasar's sense, not Hegel's).

³⁶Thus each creaturely being has a triplex character: (a) a "substantial in itselfness" that is at once (b) a receiving from the other and (c) a giving to the other: cf. footnote 44. The triplex character is crucial: a "third" –which is to say the substantial identity or unity of an entity– is what gives an entity the stable, enduring center whereby it can serve as both origin and end or resting place of the entity's movement from and toward an other. This stable, enduring center is at once the presupposition and the consequence (ontological, not temporal) of each entity's dual-dynamic relation to the other; without this stable identity, what we are terming the gifted character of being would necessarily dissolve into a purely processive, formless relationality which, as such, would just so far, however paradoxically, lack the capacity for its own participation –as gift– in the generosity of creation. The generosity implied in the double movement of giving and receiving can be sustained only in terms of a "third" principle, a "substantial in-itselfness" in and through which giving and receiving are brought into original-final unity. It is generosity in this sense, with its presupposition of

immanence and transcendence: of receiving the other within oneself even as this receiving is itself already a going out to the other. The crucial point, then, is that the very act by which x “in itself” is identified divides x from non- x and simultaneously-also relates x to non- x . Again, that which closes x to non- x simultaneously also reveals x to non- x (and vice versa). It is in this sense that I am proposing, in the name of an adequately-conceived Christian ontology of creation, that the limit that sets x off from non- x is, always and everywhere, a matter of relative closure.

(3) My simple but basic argument, in light of this, is that legitimate abstract limit in science always and in each of its instances remains a matter of relative closure, because being itself is always and in each of its instances, in its “substantial” as well as its individual identity, a matter of relative closure. This does not entail denial of the mechanical aspects, in method and in content, of abstraction; on the contrary, it is relation itself that establishes and just so far always secures these mechanical aspects. However, that relation, given above all by God but also by all other creatures in God, includes these mechanical aspects only as integrated within the logic of gift or love, in all the ways indicated.

The crucial point is thus that these mechanical aspects realize their true character as matters of being and knowing only by virtue of being integrated into love, a love that remains from its depths God-centered. The logic of integration is just the point.³⁷ Simply to affirm the importance of adding wonder to a scientific reason tacitly understood to be a matter primarily of manipulative control --and just so far to affirm the importance also of adding (God-centered) goodness and beauty to a cosmological order understood to be a matter primarily of externally-conceived efficient and material causes-- leaves intact just the fragmented, hence reductive, view of the mind and reality that an adequate ontology of creation calls into question.

Here, then, is the ontological reason why, in the words of Wolfhart Pannenberg, “it is not possible to understand fully or even appropriately the processes of nature without any reference to [...] God”: because the world’s relation to God is the *analogatum princeps* for every innerworldly distinction, even for those that are putatively purely methodological in nature. In a word, simple addition in construing the relation between any x and any non- x , in the method or content of knowledge, always implies an atheism that is far from pure innocence: it obscures the nature of the universe, draining from it its constitutive creaturely character.

“triplicity” –a dual activity that is always fruitful in the unity of a third— that seems to me demanded by an ontology that would affirm being as basically gift or love.

³⁷The term “integration” suggests a logic simply of continuity, while love and gift rightly understood just so far also demand the discontinuity entailed in relation to an other. That the latter is the case follows from what was stated above about the act that constitutes x as x , an act that divides as it simultaneously relates x and non- x . The upshot is that the idea of “integration” needs to be further qualified in terms of the distance (“divides”) as well as the nearness (“relates” or “unifies”) that are both characteristic of an integration that is one of love or gift. But this qualification is a task for another occasion.



The suggestion that the birth of modern science is the fruit of a Christian imagination of the cosmos, at the heart of which lies the cosmos's being brought into being out of nothingness by a loving Logos, while not untrue, requires substantial qualification in light of these ontological considerations. The doctrine of creation gives rise to and sustains the methodical abstract study of the cosmos even as such study enables efficient making. But, in doing so, this doctrine, rightly understood, demands a transformation of modernity's notions of both making and knowing.³⁸ Rather than dividing to conquer, the logos implied in this doctrine seeks rather to distinguish or separate in order to relate more profoundly³⁹ – this latter in a sense that includes while transforming what is meant by “division” and “conquering”. The Christian doctrine of creation thus insists that all methodical-scientific abstraction and all would-be efficient making be placed in the service of this separating in order to relate ever more profoundly, finally to enable participation in the Christological love that bears all of being in its return to God.

³⁸Cf. In this connection the comments of Adrian Walker:

Thomas, following Aristotle, says that finality is the ‘cause of causes.’ It is causality, then, in the analogatum princeps in which all other senses of causality participate, including efficiency. In fact, it is just this participation that distinguishes efficiency in the true sense, as communication of actuality, as generosity, from mechanical pushing and pulling. Or, to put it another way, Gestalt contains the principle thanks to which what we would think of as the mechanical aspects – pushing, pulling, etc. – derive their causal relevance and causal efficacy. For the ‘merely mechanical’ as such does not exist; it is an ideal limit that is never actually reached because there is always a form determining, hence giving reality to, the mechanical causes. Mechanical causes are causes only to the extent that they are never merely mechanical, but always already participate in efficiency-as-generosity thanks to form. Yes, pushing and pulling will contribute, but not by reason of being pushing and pulling simply, but by reason of their specification with respect to a goal, that is, as this particular pushing and pulling. The sculptor cannot sculpt unless the chisel impacts the marble, but the impact would not be a cause unless it produced a specific kind of impact, whose specificity derives from the idea of the statue.

This presupposes, of course, that meaningfulness is actually a basic feature of nature, one more basic in a way than even efficient causality insofar as it has a material dimension and unfolds over time. Indeed, it is because this is the case that conventional experimental science already lives tacitly from the perception of something like Gestalt. This is true not only in biology, but also, analogously, in chemistry and physics. Now, if this is the case, why should biology, or any other physical science, not admit thematization of the Gestalt as part of science, indeed, as the more important part of science than the experimental part more important because architectonic? Why should it not admit that Gestalt is the principle, middle, and end of experimental research?

True, the thematization of Gestalt would not be a particular experimental result or set of such results. Rather, it would be a way of returning all experimental results to the principle of their relevance and existence insofar as they are in any way causes. That is, it would be a way of re-reading their meaning in light of the whole. It would also work the other way around: It would include a re-reading of the meaning of the whole in light of the details. In fact, it would be mistaken to think of what is being proposed here as just another fuzzy holism . . . There is always as much to be learned from the bottom up as from the top down. In fact, the real unity of the whole is neither at the top nor at the bottom, with the universal or the particular, but in the interplay of both.

So the issue is: if meaning is basic in nature, even with respect to the mechanical aspects dealt with by conventional empirical science, then why should it not also be basic to the science of nature? Again, this may not be immediately “useful”, but why should it be, if the main business of science is in fact to understand the way nature is, and this is in fact the way nature is?” (From unpublished notes: “Thoughts on Evolution”, 2-3).

Cf. in this connection science as conceived by the following Refs. [35]. See also the work of skin pathologist Wallace Clark.

³⁹It is important to emphasize (again) here that the unity sought in Christianity always presupposes and promotes further differentiation: each creature becomes more itself as it grows more deeply into relation with God and other creatures. This again is the way of a unity that images the Creator-God whose unity is always already differentiated into an infinite Tri-unity.

(4) The upshot of the foregoing comments is thus that there is no need to set aside love in the scientific-abstract study of the world, even for disciplinary reasons. There is no need to set love aside because love, rightly conceived in its creaturely nature, accommodates the mechanical properties of things, albeit as integrated in terms of (God-centered) love and gift.⁴⁰ What such a science would look like is a profoundly difficult and comprehensive question, which I will address in the present forum only by citing the example of a twentieth-century scientist/philosopher of science --Michael Polanyi-- who advocated the practice of the sort of abstraction in science that seems to me consistent with the ontology we have set forth.

Before turning to this concluding task, however, it is important that we take note of one powerful objection to the need for the integration of ontology into science, in the sense advanced here: simply, that science with its dominant modern mechanistic idea of method and order has worked. But if it has worked, then this fact alone seems sufficient to demonstrate the “realism” of mechanism as a way of conceiving the order of things as intended by God.

One can scarcely exaggerate the profundity and complexity of the issues implied in this objection. Certainly the ontology sketched above anticipates that things conceived, analyzed, and experimented with, carefully and intelligently will “work”: the mechanical-forceful properties of things, after all, are really in the thing, are truly part of things in their identity and their behavior. For the present context, however, it will suffice to note only that any claim to justify modern science’s abstraction of the mechanical-forceful aspects of things in terms primarily of technological power, on the grounds that this abstraction has “worked”, remains just so far question-begging. Of course no one denies the vast successes of modern science,

⁴⁰Gavin D’Costa, in his recent book, “Theology in the Public Square” [36], engages (*inter alia*) the question of the unity of the disciplines in the writings of Pope John Paul II, focusing especially on the natural sciences. Reviewing the different ways in which the relation between theology and the natural sciences is commonly conceived today, D’Costa links John Paul II with what he terms a “harmonious direct implication model”, by which he means that theology bears direct implications for science, in a way that nonetheless accords science its legitimate autonomy. Although “harmonious” implies a consonance between theology and science, D’Costa says that priority must nevertheless be “given to theology because its ‘data’ are revealed”. Recognizing as D’Costa does the limitations of “models”, the present argument is in agreement with his position, with one important qualifier: namely, that what is termed a relation of “direct implication” between theology and science cuts both ways. The idea of creation as conceived in Christian theology demands some sort of reciprocal priority between theology and science, albeit a reciprocal priority conceived in asymmetrical terms.

Regarding the relation between theology and natural science, then: first, this relation is one of mutual implication, such that the exercise of each in its proper method always bears internal implications for the other. Each, rightly understood, needs to remain open to, and move toward, genuine integration with the other, in a way that both presupposes and demands the legitimate autonomy of each. The relation between theology and natural science, in short, is neither extrinsic after the manner of a kind of harmonizing “addition” of the results of their respective inquiries (“concordism”); nor is the relation properly deductive such that the “theories” of one are construed simply-necessarily as inferences of the other, in either direction. However, and this is the second point, the mutuality involved in this relation of harmonious or integrative implication between theology and science is not for all that symmetrical. Theology and science both make “normative” “truth-demands” on each other, differently: science, indeed science as always mediated by a distinct ontology, retains a “relative” priority, but within the “absolute” priority of theology. The relation between them, in a word, is genuinely mutual, while nonetheless asymmetrical. I do not think D’Costa would disagree with my qualifier here, as long as the “absolute” priority of theology is maintained, in the way suggested – but this need not be argued here.

for example, in medicine and medical technology. The simple but crucially important implication of the foregoing argument, however –for example, in light of what has been described by Jonas– is that the appeal to the practical effectiveness of modern science, even in the face of its obviously vast successes, still begs the crucial issue.

Such an argument invariably has built into it today the very fragmented patterns of thought needing to be challenged, if the idea of “it works” is to be assessed, as it must, in terms of an integrated view of reality as created by and destined for God. The burden of the above ontology of creation is that we cannot know the true meaning of “it works” except in terms of what is implied originally and finally by things’ integrity, relative to the ever-higher levels of being to which any given entity, or part of an entity, is related, up to God. We cannot know the true meaning of things without recuperating memory of what they are in their givenness as gifts, in their concrete reality as created by God. What needs to be pondered, not in spite of but precisely coincident with and from inside those successes, is the extent to which our highly mechanistic-abstract culture, in the logic of its academy, its economy, its politics, indeed of its scientific technology that englobes all of these, has assisted in reducing the meaning of things, of man, and of God, leaving man able to respond only in fragmented fashion to the universal ecology of being intended by God in his creation of the cosmos.⁴¹

Jonas has indicated some important aspects of what is meant here: perhaps most radically that, with the logic of modern mechanistic modes of abstraction, what has been set into place is a dynamic for the penetration of artificiality into the very core of the naturally given -- the naturally given by God. Jonas’s point is not that artifice is not integral to human culture, but that, in its prevalent mechanistic-technological form, artifice fails to integrate

⁴¹ Apropos of this, however, two comments: (1) In light of our argument regarding the order of gift as more basic than –while nevertheless including– mechanical order, we understand that any claim that artifice based effectively-exhaustively on the mechanical order “works”, eo ipso expresses a fragmented sense of “works”. In this case, “it works” can only signify what is at best an approximation, a matter of statistically frequent occurrence — that is, what is at best a fragmented part of the whole of what it means to “work”.

This may seem a less significant matter in the case of simple machines, since here mechanical properties do predominate — although even in the case of machines a richer causality than mere efficient causality obtains, with consequences for the “working” of the machine (i.e., not even machines can be accounted for in exhaustively mechanical terms). Nonetheless, the significance of reductive-mechanistic modes of conceiving and treating entities becomes more evident in the biological order. For further discussion of this point, see [27].

(2) The ambiguity of “it works” can also be shown in a broader cultural sense. One might say, for example, that a cell phone or a computer “works”: each effectively-technically enables some form of communication between human beings and fosters some form of knowledge and experience. But whether this means that either actually works in an adequate, fully integrated and thus non-question-begging sense can be answered only by considering what is meant by human communication and knowledge and experience in their integrity. What is the logic of communication toward which the cell phone is ordered, or the logic of knowledge and experience toward which the computer is ordered? Toward what habits of human communication and consciousness do the cell phone and the computer of their inner order as such logically dispose us? To be sure, much more qualification is needed than can be offered in the present forum. My point is simply that the assertion that a product of mechanistically-conceived artifice “works” can be truly assessed only in terms of the integrity of what the product is and is for – and in terms of the nature and destiny of the producers and users of the artificial in relation to other human beings, the cosmos, and God. For further discussion of this point, see [37].

itself into what is permanently —anteriorly given— as gift. Indeed, it is important to see here that, from the point of view of an adequately conceived Christian ontology of creation, and also in a significant sense from the point of view already of Greek thought, human artifice is itself part of nature. This is the implication, for example, of Aristotle’s treatise on the soul (*De Anima*), which is conceived as part of the science of nature. Artifice and nature thus should not, because in the most basic sense they cannot, be opposed to each other. The point of my argument is simply that modern technologistic (Cartesian, Baconian) artifice fails to recuperate itself from within the natural *giftedness* that it shares with the rest of creation.

Modern artifice, in other words, insofar as it is shaped by mechanistic patterns of thought, bears a technological logic that would of its inner dynamic overtake things in their origin: *in their original-natural givenness as created by God*.⁴²

The claim that the undeniably great successes of modern science, with its dominant modes of mechanistic abstraction, suffice of themselves to mute the demand for transformation needs to be pondered in light of the question of these successes’ reductive technological character. Needs to be pondered, that is, insofar as such successes would be measured in terms of fidelity to the ontology of creation carried in Christianity.

I conclude, then, simply by suggesting an alternative way of conceiving abstract limit in science, an alternative which I believe is consistent with the conception of limit entailed by the Christian ontology of creation outlined above. The cognitional theory is that of twentieth-century physical chemist and philosopher of science, Michael Polanyi [39, 40, 41, 42, 43, 44, 45].

6. Abstraction in science and anthology of gift

In contrast to the dominant mechanistic theory, Polanyi’s cognitional theory understands the abstract study of things in science to involve granting primacy to what is implied in an entity’s relation to ever greater and more comprehensive levels of reality.

The heart of his conception of knowledge lies in its notion of “indwelling”, together with the dual features characteristic of knowledge as an act of indwelling. For the idea of indwelling, Polanyi draws on how we know our own body. He says: “all extension of comprehension involves an expansion of ourselves into a new dwelling place, of which we assimilate the framework by relying on it as we do our own body”. We recognize, for example, that “when we attend from a set of particulars to the whole which they form, we establish a logical

⁴²Thus nature is no longer good qua given (*bonum qua ens*) but only good qua subject to human facere (*bonum quia factum*). It is helpful to recall here the root meaning of nature (*natura, physis*) as something brought into being through “begetting” and “birth”, hence as something whose origin is always-already given (as good). Cf. in this connection the statement of twentieth-century philosopher Gabriel Marcel, who says that the “human being who denies his nature as a created being ends up by claiming for himself attributes which are a sort of caricature of those that belong to the Uncreated [38].

relation between the particulars and the whole, similar to that which exists between our body and the things outside it [...] We may describe this relation by saying that the act of comprehending a whole is an interiorisation of its parts, which makes us dwell in them in a way that is logically similar to the way we dwell in our body". This implies a duality in each of our acts of knowledge. In the act of knowing things, we attend to the things, but from within our body – or again from within the framework on which we tacitly rely in our focus on things.

In sum, Polanyi's cognitional theory holds that "our explicit knowledge of a thing invariably relies on our tacit awareness of some other things". Polanyi says that the interplay of "detailing and integrating is the royal road for deepening our understanding of any comprehensive entity". This points him toward what is a main burden of his theory: that there is an indissoluble link between the logic of reason and the structure of reality. Thus he states, following the assertion just cited:

In saying this I have pronounced a key word. I have spoken of understanding. Understanding, comprehension – this is the cognitive faculty cast aside by a positivistic theory of knowledge, which refuses to recognize the existence of comprehensive entities as distinct from their particulars; and this is the faculty that I recognize as the central act of knowing. For comprehension can never be absent from any process of knowing and is indeed the ultimate sanction of any such act.

Thus Polanyi insists that "an adequate theory of knowledge must involve a true conception of man and the universe and be itself supported by it. The absurdity of the world view which a false ideal of knowledge has spread in our time may bear this out"

There are several further features implied in this notion of knowledge as indwelling with its duality of cognitional acts – its polarity within unity of each act of knowledge. Thus he says this notion addresses the problem raised by Plato in the *Meno*, regarding how our search for knowledge is always a knowing unknowing, as it were: the knower relies on a kind of tacit or implicit knowledge from which he attends in coming to an explicit knowledge of something. In this sense, all knowledge presupposes a kind of memory.

Furthermore, Polanyi says that his conception of knowledge as indwelling, overcomes a long-standing dualism between I-It and I-Thou kinds of knowledge. There is no dichotomy between the former and the kind of knowledge that consists in knowing persons – indeed, all the way to the person of God. In fact, all knowledge is like the knowledge of other persons. Indwelling thus is not a matter of feeling or sympathy (cf. Dilthey's *Einflussung*), and thus not a matter appropriate only for the humanities: there is no dichotomy between the *Naturwissenschaften* and the *Geisteswissenschaften* (natural sciences and the human sciences).

Polanyi says that each level of reality operates toward boundary conditions: in the sense that physics and chemistry, for example, are open to higher levels of reality that in fact "control"

these lower. He says that “what is most tangible has the least meaning and it is perverse then to identify the tangible with the real”. “The world view of Galileo, [therefore], accepted since the Copernican Revolution, proves fundamentally misleading”. Focusing on “part” of something to the neglect of an abiding subsidiary awareness of the greater whole or more comprehensive levels of which it is a “part” turns that “part” into an extrinsic aspect of an object without functional meaning (read: without relation to the higher levels in relation to which it has its true, or non-reductive, meaning). Thus Polanyi says that biological entities presuppose the law of physics and chemistry but are not determined by them. They are “comprehensive entities”, not mathematically definable. Regarding Descartes, Polanyi says that the Cartesian dualism of mind and body is eliminated when one sees that mind and body do not “interact explicitly” (e.g., after the manner of two discrete entities), but rather relate “according to the logic of tacit knowing”.

Polanyi points out the implications of his theory for the problem of the relation of science and religion, countering the view of some theologians who would insist that science can contradict religious teachings only insofar as religion makes statements that bear on physical events, as these theologians think it should not. On the contrary, knowledge leads organically to ever higher and more comprehensive levels of reality. We always know more than we can tell, and the focal dimension of knowledge never exhausts the reality it is seeking to know. Each level opens toward boundary conditions that require moving on to ever higher and more comprehensive levels of being. The structure of knowledge leads on to a panorama akin to Christian views of man’s position in the universe. Indeed, Polanyi states that the true logic of knowing is disclosed finally in the faith-reason scheme of St. Paul: no act of knowledge is never exhaustive, and the search for knowledge leads organically to the Pauline scheme:

[The subjects of divinity and the possibility of knowing God] lie outside my argument. But my conception of knowing opens the way to them. Knowing, as a dynamic force of comprehension, uncovers at each step a new hidden meaning. It reveals a universe of comprehensive entities which represent the meaning of their largely unspecifiable particulars. A universe constructed as an ascending hierarchy of meaning and excellence is very different from the picture of a chance collocation of atoms to which the examination of the universe by explicit modes of inference leads us. The vision of such a hierarchy inevitably sweeps on to envisage the meaning of the universe as a whole. Thus natural knowledge expands continuously into knowledge of the supernatural.

The very act of scientific discovery offers a paradigm of this transition. I have described it as a passionate pursuit of a hidden meaning, guided by intensely personal intimations of this yet unexposed reality. The intrinsic hazards of such efforts are of its essence; discovery is defined as an advancement of knowledge that cannot be achieved by any, however diligent, application of explicit modes of inference. Yet the discoverer must labor night and day. For though no labor can make a discovery, no discovery can be made without intense, absorbing, devoted labor. Here we have a paradigm of the Pauline scheme of faith, works, and grace. The discoverer works in the belief that his labors will prepare his mind for receiving a truth from sources over which he has no control. I regard the Pauline scheme therefore as the only adequate conception of knowledge.

In this connection, Polanyi repeatedly points out that hope and faith are part of the structure

of knowing, and he points out the continuity between his theory of knowledge –which involves assimilating a framework of meaning and dwelling within it the way we dwell within our body– and religious conversion. He suggests that the dynamic of knowing operates through attraction. He says that intellectual beauty is a sign of its contact with reality. He speaks of the need to accept nature as the cosmic home of man, in which he is both a child of creation and a bearer of prospects beyond his own range of control. The idea of self-determination, he says, is meaningless, and this should make us willing to see that the task of knowledge in fact involves a calling. Here, then, in a word, “is the close neighborhood of science and religion to which a revised theory of knowledge leads us”.

Thus we have in Polanyi a way of abstracting with a distinctive way of understanding limit: limit is relative closure, relative in a sense that implies openness, precisely from inside what is abstracted and the manner of its abstraction, to being through all of its ever more comprehensive levels, up to God. Pertinent to my argument, we can see how the way of abstraction and the order that obtains in reality interlock in his theory. Abstraction is a matter of relative closure because and insofar as things themselves are a matter of relative closure.

There are questions that might be put to Polanyi relative to the dominant mechanistic mode of abstraction and view of reality, in light of Jonas’s discussion of modern science indicated above and indeed in light also of the ontology of creation we have set forth.⁴³ It suffices for purposes of the present argument, however, simply to point out in conclusion how Jonas’s and Polanyi’s respective arguments serve to confirm what we have meant to argue here: which is that the idea of the limit implied in the disciplinary abstraction necessary for any scientific study of nature is never neutral with respect to what we have termed the nature of the given as gift, and thus to the nature of the giver of the gift — in short, to the question of creation and the Creator-God.

Polanyi’s insertion of an essentially tacit dimension into the heart of scientific abstraction involves rejection of the Cartesian idea of limit. Instead of simple external closure, limit becomes a matter of relative closure, a closure serving clearly to identify x in its difference from non-x all the while leaving each open from within to the other. Changing the nature of the limit proper to abstraction in science in this way may seem to some a trivial and easily

⁴³The themes I would propose for further reflection are three: (1) the relative priority of the explicit and the tacit in his cognitional theory; (2) the need for an account of his argument in distinctly ontological, as well as cognitional, terms, especially relative to the mutual relation between the mind and the structure of the cosmos as implied in that argument; (3) further exploration of the significance of his argument in its bearing on what he terms the “exact sciences”, as distinct from, say, biology, psychology, and sociology. I note this third question, for example, in light of the statement from “Personal Knowledge”: “I start by rejecting the ideal of scientific detachment. In the exact sciences, this false ideal is perhaps harmless, for it is in fact disregarded there by scientists. But we shall see that it exercises a destructive influence in biology, psychology and sociology, and falsifies our whole outlook far beyond the domain of science. I want to establish an alternative ideal of knowledge, quite generally”. I should say that I do not necessarily pose these questions for critical purposes, but primarily for the sake of further clarification and possible development of Polanyi’s argument.

negotiated matter. The burden of my argument, however, has been that carrying through this seemingly small change in science's method of abstraction will involve in its wake a reconfiguring of the idea of order in the universe, in its relation, finally, to the Creator-God.

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