Two Worlds or One:
Complementarity in the Dialogue between Religion and Science

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Abstract

In the dialogue between science and the spiritual, prior metaphysical commitments can radically alter the ground of discussion. I survey the effect of certain metaphysical commitments on the dialogue between science and religion, noting that commitments which appear to favor some sort of dualism, entailing a strict separation between the realm of science and the realm of the spiritual, seem to be the most successful in preventing an anti-realist interpretation of either religion or science. And yet dualism has the fatal flaw of making any connection between the scientific world and the spiritual world quite literally impossible, in addition to the fact that dualism is considered problematic in philosophy in general.

I argue that the principle of complementarity (as it is used in physics) would preserve the possibility of smooth connection between science and religion by allowing the spiritual and the quantifiable to exist in the same world, while at the same time preventing precise aspects of scientific relations and spiritual relations from simultaneously being in view. As one brings the mathematical relations of science into focus, deeper spiritual relation becomes unclear and vice-versa, on this view.

Complementarity has been invoked in the relation between science and religion before; however, it has been misapplied in some instances and has not remained true to the principle as it occurs in physics in other instances. I present a thoroughgoing complementarity which avoids these pitfalls. I also conclude that if one accepts the principle of complementarity, many of the perceived conflicts between religion and science can be viewed as violations of the principle.

Biography

David Montalvo graduated from Widener University with a B.S. in physics in December 1987, and has been teaching physics, science, and mathematics in the public schools since February of 1988. In August of 2001, he obtained his M.A. in philosophy from West Chester University. David has published articles in both Asian Philosophy and in The Physics Teacher, and he was the Associate Editor of, and a contributor to, Breaking Barriers: Essays in Asian and Comparative Philosophy in Honor of Ramakrishna Puligandla*, Hoffman and Mishra (eds.)*

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David's areas of interest include Asian philosophy and religion, philosophy of science, and philosophy of mind. He also enjoys creating webpages, and currently maintains (among others) the website for the PA State System of Higher Education Interdisciplinary Association for Philosophy and Religious Studies at http://www.sshe-iaprs.org, and a website for his students at http://www.mrmont.com.

Purpose

I argue that the application of the principle of complementarity, as it is understood in physics, to the relationship between science and religion would preserve the possibility of smooth connection between them by allowing the spiritual and the quantifiable to exist in the same world, while at the same time preventing precise aspects of scientific relations and spiritual relations from simultaneously being in view. As one brings the mathematical relations of science into focus, deeper spiritual relation becomes unclear and vice-versa, on this view. Complementarity has been invoked in the relation between science and religion before; however, it has been misapplied in some instances and has not remained true to the principle as it occurs in physics in other instances. I present a thorough-going complementarity which avoids these pitfalls. Although I do present some motivation and evidence for the complementarity view, I am not here attempting to prove that the relationship between science and religion is a complementary one; all I am attempting to do is to show that the relationship is a workable one if the principle of complementarity is defined as it is in physics.

First, I will discuss the viability of various ways of integrating scientific and religious views, pointing out the difficulty in preserving realist views of each. Before seizing on the principle of complementarity as an easy solution to the integration problem, I will attempt to clarify the principle as it occurs in modern physics. Next, I elucidate a relationship between science and religion which adheres to the principle of complementarity, and give examples of where that relation can go wrong before making some final, concluding remarks.

Models for the Relationship between Religion and Science

The advance of science and the explosion of physical knowledge it has created in the last centuries has inevitably lead to a perceived encroachment upon the authority of religious texts. Each, if taken to be a literal and complete account of how the world is, would seem to partially if not wholly exclude the other. It is not uncommon to find that a person accepts one only to the extent that the other is rejected.

Reductionism is often employed by those who take the scientific view to be complete. On the other side, fideism and anti-scientific arguments bolster the view that science can be marginalized in favor of a solely religion-based world-view. For those of us who wish to facilitate a dialogue between religion and science, and who believe that such a dialogue can be fruitful for both religion and science, excluding one view in favor of the other is not an option. We seek to integrate science and religion into one world view, not to eliminate one in favor of the other.

Integrating science and religion into one world view would seem however to imply that both science and religion are in some sense not a complete description of how the world is. Integration could, for instance, proceed on the basis of reinterpretation: one could re-interpret religious texts in a non-literal or even mythical fashion, or one could re-interpret scientific laws and relations to be merely instrumental in helping to calculate certain quantities. Although adopting this sort of anti-realist stance concerning either religious texts or scientific laws and theories does solve the problem of integration, it is something of a drastic solution. Either one

side or the other must admit that in essence all it has been doing is telling stories about how the world is that are not literally true.

A way around the re-interpretation scheme lay in making some sort of distinction between science and religion, such that each is preserved intact in its own realm. A seemingly straightforward way of doing this is to consider them applied to different tasks, for instance by arguing that science describes the "how" of things, while religion describes the "why". Science-as-description measures and calculates; it sets up relations and makes predictions about events as they unfold or have unfolded, but is mute when it comes to the meaning of it all. Religion, of course, seeks to provide just that meaning.

Unfortunately, such a simplistic distinction is bound to fail. It turns out that accounts of "why" can be given in terms of causal relationships, about which science has quite a bit to say. And religious texts for their part also contain historical accounts of how things came to be, which can be at variance with scientific accounts. Thus a simplistic how–why distinction is not a workable solution without some of the re-interpretation already referred to above.

A deeper separation might be made by consigning them to different realms of discourse altogether. Scientific assertions are confirmed or disconfirmed by altogether different phenomena than religious assertions. A closer look will reveal that these are actually two different approaches: one linguistic, one ontological. In the former case, scientific talk and religious talk are simply different language games, with different grounds for assertion and different grammars. In the latter case, two different worlds are assumed — one scientific and one religious.

Both of these fail as solutions, but for different reasons. Close examination of the linguistic solution reveals it to be not a solution, but a description of only one aspect of the problem. We could, after all, elucidate the grounds and grammars of scientific talk and religious talk, making note of commonalities and differences. But although it may facilitate communication, really this way of operating does not integrate religion and science, because lack of integration is not merely a function of language game differences: witness the fact that it is not unusual for one and the same person to participate in different language games at different times, depending on context. Thus, although there are differences to be found in the realm of language, uncovering and exhibiting the rules of the two language games does not necessarily integrate them, whatever else it might achieve.

The ontological solution is really a two-worlds argument, which constitutes a form of dualism considered problematic in philosophy.[1] If the scientific and religious realms are truly separate, then they have no common ground, and in fact no ground at all for disagreement — which is at variance with what we know to be true. Should we assume that in the world described in religious texts, for instance, physical law has no meaning? To be perfectly clear, this would mean *not* that physical laws are different or that they can be altered in ways we are not used to,

[1] Any introductory philosophy textbook will lay out the issues involved, however I strongly recommend Passmore (1961, 38–57) for his especially clear exposition of the problems inherent in two-worlds arguments.

but rather that the notion of physical law and science itself are *completely inapplicable* in religious discourse in order for there to be two truly separate worlds. If this kind of separation is unacceptable, then the two worlds must interact somehow. But if they do, there must be a connection between the two worlds, meaning that some thing or things must cross the line between the two worlds, and therefore there never were two worlds to begin with. There is apparently only one world, and science and religion both exist in it.

For those of us who seek to integrate science and religion into one world, any solution which invokes the complete separation of science and religion, even if it were workable, is not the kind of solution we are looking for. One solution that integrates science and religion into one world, and yet provides a measure of separation, can be had through the principle of complementarity. One often finds science and religion described as complementary in the literature, but often one finds upon further examination that what is really meant is either a kind of reductionism or a two-worlds argument. Complementarity is a notion born of modern physics; before discussing it as an option in the religion–science relationship, I will first describe it as it occurs in physics.

Complementarity in Physics

Inconsistencies between experimental data and classical physics in the early part of the last century forced a reconsideration of some of our most fundamental ideas about the applicability of everyday concepts to the world of the very small. Although classical physics presents us with a very good fit for most all of the data available to the world of meterstick, timer, and spring-scale measurement, its application to the microworld quickly became problematic as new data about the behavior of and interaction between electromagnetic waves and electrons became available. The crisis which ensued was resolved with the formation of a new mechanics.

Although quantum mechanics seems to have found its way into the literature on many subjects, not the least of which being religion and philosophy of religion, it remains a very technical mathematical theory referring to a hitherto unsuspected world very different from the world of our usual experience, which classical physics seemed to have completely accounted for. Classical physics is essentially a mathematical refinement of our macroworld experience, and thus fits in well with our own semi-refined concepts of how that world works. In contrast, the mathematical relations in quantum mechanics often defy easy interpretation in terms of everyday notions, forcing us to abandon to some extent the classical models that have worked so well in the macroworld when trying to understand what is going on in the microworld.

The now famous Heisenberg indeterminacy relations exemplify the difficulties.[2] In theories of the macroworld, there is no difficulty in simultaneously specifying the position and momentum of an object through measurement. In the microworld, Heisenberg showed through a thought-experiment that this was in principle impossible—that any interaction which would enable us to know the position more precisely would necessarily disturb the value of the momentum. As one comes into focus, so to speak, the other must go out of focus.

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[2] My thanks to Anthony Nicastro for suggesting “indeterminacy” as a more accurate translation for *umbesstimheit*, the word originally used by Heisenberg. The translation one usually finds is “uncertainty”.

Niels Bohr thought that these relations were part of a greater principle: the principle of complementarity. Experiments which would determine one set of variables to a high degree of precision necessarily are unable to determine another set of variables to a high degree of precision; these pairs are now known as canonically conjugate variables. This inability is encoded into the very mathematics of standard quantum theory.[3] The paradigm examples are often drawn from wave-like behaviors and particle-like behaviors. In a double-slit interference experiment, a beam of electrons sent through a barrier with two openings will produce an interference pattern (a wave property), as long as no apparatus is placed to measure which of the slits the individual electrons passed through (a particle property).

It is as if all microworld entities have two complementary natures, both of which are necessary to a complete physical description of them, even though they are not simultaneously demonstrable to arbitrary precision. It is possible, however, for a single experiment to exhibit both wave-like and particle-like behavior of things like electrons;[4] thus it best not to think of complementarity as simply a logical relation as it is the geometrical definition of complementary angles as two non-overlapping angles which complete a right angle. In other words, the principle of complementarity should not be though of as entailing a sharp dividing line between the measurement of wave-like and particle-like behavior. "Wave" and "particle" here refer to macroworld models which are suggestive of ways of measuring and relating phenomena. In its most exact formulation, the principle of complementarity really refers to precision in the relationship between measurable quantities, a relationship that entails not sharp discontinuities but rather the progressive loss of precision in measuring or predicting the value of one variable as another is measured or made predictable with increasing precision. Another way of putting it is that wave models and particle models predict sets of behaviors at opposite ends of a range of possible precision. There are many possible indeterminacy relations predicting this kind of behavior between canonically conjugate variables, and all are instances of the application of the greater principle.

Bohr felt that the principle of complementarity had applications beyond physics, and indeed it has often been co-opted into descriptions of the relationship between science and religion.[5]

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[3] It is encoded in the form of non-commuting operators in the standard theory. On the other hand, a generalized theory has been espoused by de Muynck (2000) which, he argues, although it allows non-ideal simultaneous measurement of complementary variables, it does remain faithful to the principle of complementarity.

[4] For instance, it is possible to perform the double-slit interference experiment sending one electron through the double-slit apparatus at a time. Although individual and localized spots appear on the screen corresponding to the arrival of the individual electrons, the interference pattern appears as more and more spots are registered. The experiment was performed by Merli et al. (1976).

[5] Bohr (1958, 26) for instance proposed a complementarity between thought and feeling.

Complementarity in Religion and Science

Rather than extensively critique individual views that have been advanced, I propose to discuss what a thorough-going complementarity between science and religion — one that would remain faithful to its origins in physics — would look like. This somewhat brazen behavior is, I think, justified by the fact that the principle of complementarity has been invoked by some to justify the assignment of science and religion to separate realms, and by others to try to tie those realms together. In the former case, there is a basic misunderstanding of the applicability of complementarity to their programme. As has been mentioned, separating the two into non-overlapping realms is not what the principle of complementarity entails in physics.[6] In the latter case, there is often a basic misunderstanding of the relationship between complementary quantities as they occur in physics, resulting in a kind of reductionism, which is not possible in a true complementarity.[7] In any case, the misunderstandings are deep enough to warrant a complete enunciation of what the principle really entails.

Before proceeding further, it is in order to specify what we mean when we say "science" and "religion". This task is quite tricky; it will not do to define them merely as complementary and be done with it. For that matter, defining them as unitary things must viewed with suspicion. Care must also be taken not to simply define their domains as complementary without saying what those domains are.

Within the great variety of experience, it is possible to quantify some phenomena to some degree of accuracy, but not others. At the very base, the practice of science aims to set forth mathematical relationships among the quantities obtained by measurement. Those mathematical relationships, insofar as they can be precisely written to correspond predictively and retrodictively to measured phenomena, I take to be at one pole of the complementarity I wish to describe.[8]

Obviously, science is more than the sum total of these mathematical relationships, including as it

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[6] MacKay's (1974a and 1974b, among many others) approach is of this kind. In essence, he takes complementarity to be a logical relation more akin to complementary angles in geometry. Austin (1976) in fact classes his approach as a two-worlds argument.

[7] This is Polkinghorne's approach in spite of his use of the word "complementary" (1998, 50), as is evident from his persistent attempts to find "room" in physical theory for an active God who should be continually involved in the unfolding of the universe. Compare Schroedinger (1958), who notes that we have only attained the mathematical–physical picture that we have of the world by removing everything personal from it. It should therefore occasion no surprise, Schroedinger thinks, that a personal god is missing, just as we are also missing from the physics picture of things. There is simply no variable defined for the conscious observer in, for example, quantum mechanics — in spite of the sometimes alleged role of consciousness in measurement. All that is really required is a measuring apparatus, which is the maximum extent to which observation is represented mathematically in the theory.

[8] This includes statistical relations as well as deterministic ones, as long as there is a sharp correspondence between prediction (or retrodiction) and measurable phenomena.

does practices, a collection of heuristics, rough principles by which theories are judged, models, social organization, and more. But it is for precisely that reason that I do not place the expansive notion of science at one pole of the complementarity: the scientific approach as a whole is far too broad for our purposes. What we require is an extreme end where all ambiguity is completely distilled away until all that is left is the symbolic, mathematical representation. To mathematically specify a relationship is to make precise a numerical relationship, which necessarily distills away much of the original experience connected with the phenomena that were originally quantified.

In our experience, for instance, sound can range from very high to very low pitch. Pitch is measured and quantified as frequency, which specifies the number of vibrations per second. In sounds where one frequency is measured to be double the other, the experience of the sound is similar, and we say that the two are the same note, one octave apart. What should be emphasized is that when we pass through descriptions of relationships like the following:

S1. The two sounds are similar, but one has a higher pitch.
S2. The two sounds are the same note, one octave apart.
S3. The frequencies of the two sounds are related by a factor of two.
S4. $f_1 = 2f_2$.

we have distilled away the essence of the original experience in order to arrive at an unambiguous mathematical relationship between measured quantities. In contrast, as we pass from S4 back to S1, the relation becomes less exact, but also more experiential. I do not take the position that there are definite levels of description, however I do maintain that for any phenomenon which can be measured and thus quantified, the least ambiguous relationship it can have will be mathematical, but that at the same time, in making the relationship unambiguous, our experience of the original phenomenon has been partly abstracted away. The reductionist might thereby conclude that pitch reduces to frequency, but we allow ourselves no such conclusion in our commitment to exploring complementarity, which stems from our desire to find a possible world-view which preserves the facts of our experience which are somewhat removed from those mathematical relationships.

On the other hand, statement S1 does contain the seed of the mathematical relationship S4, ambiguous though S1 may be. Statements such as S1 are thus somewhere in the middle of the range between the two complementary poles I hope to set up, one of which is the pole of unambiguous mathematical relationship.

What is at the other pole? It must be the unambiguous, non-mathematical relationship inherent in the experience to which no measurable quantity corresponds, perhaps embodied in the experience of gnosis, of grace, of enlightenment, or of oneness, as they are approached through prayer, fasting, or meditation.[9] These experiences are typically non-verbal, although they may leave one with quite a lot to say afterward. Proceeding toward this pole places us in immediate, unambiguous relation with God or the universe or nothingness. As we return from this pole, we

[9] I do not mean to equate gnosis, grace, enlightenment, and oneness; I merely wish to indicate that the complementary view is open to all of the major religions.

have revelation, moral understanding, and aesthetic value. Of course, religion encompasses more than just this pole, just as science encompasses more than just mathematical relationships. There are most likely social structures, religious texts, traditions and more which shape religious experience.

The two poles, pure mathematical relation and pure spiritual relation form a true complementarity in that they cannot be simultaneously had with arbitrary accuracy. Here we must take the meaning of the word accuracy in its usual sense of "hitting the mark", rather than its more limited numerical sense. Rough examples of the relationship abound. The Buddhist practitioner knows that logical, mathematical thinking is a stumbling block on the way to enlightenment, although it can be a normal part of everyday functioning. On the other side, the theoretical scientist does not include unquantifiable relationships in mathematical descriptions of reality. We may succeed in specifying the brain-states of the meditating person, however we find that the relationship one finds in meditation is nothing like the mathematical relations of action-potentials in the brain; they are complementary.

Two points bear mentioning. First, because the complementarity is defined in terms of mathematical and spiritual relationship, there is no need to find some way of classifying phenomena into either religious or scientific categories. It should be obvious that one and the same phenomenon is capable of parallel description, but that bringing one kind of relationship into focus necessarily blurs the other in experience and in description, if the two are truly complementary. Just as in physics where one single experiment cannot simultaneously measure, for example, the position and the momentum of an electron both to high degrees of precision, one cannot have both the spiritual relation and the mathematical relation simultaneously in view and expect both to hit the mark. The principle of complementarity entails that one can switch between them in description and experience, but one cannot combine them into one experience or description without loss of precision on one side or the other. The experience side of the complementarity is evident in the path to enlightenment example I gave earlier where thinking logically is a stumbling block. The corresponding descriptive complementarity is inherent in the previous example of brain-state and Buddhist descriptions of the aims of meditation.

The second point is that because the complementarity is defined in terms of relations which constitute only a part of religion and science, the two are free to meet and intermingle in the middle of the range of experience. Relationships in the vast middle between the two poles can vary widely in their proximity to each pole. Consider the following statements.

S5. The sun is yellow.
S6. Murder is wrong.

S5 lies somewhat closer to the mathematical relation pole, while S6 lies somewhat closer to the spiritual relation pole. Each can be made less ambiguous by approaching the appropriate pole: the former through translation into frequencies of electromagnetic radiation, the latter through prayerful contemplation. On the other hand, each contains seeds of the other pole: the sun can have religious significance, just as murder has physical significance. Discussion of this aspect of the complementarity in religion and science is continued in more detail in the next section.

A Correspondence Principle

In setting up this complementarity, we have avoided consigned religion and science to different realms. Of course, as one gets close to the mathematical pole, the immeasurable relationship (between self, God, emptiness) evaporates, just as when one approaches the spiritual pole, measurable relationships diminish to insignificance. But in the vast middle ranges between the two poles, the two must meet and form a seamless whole which is the world of our experience. It is in this way that the principle of complementarity has built into it a sort of correspondence principle: in order to approach one pole, one must abandon the other, and necessarily one will have to pass through the middle regions where ambiguity reigns, but there should be no sharp discontinuities.

It is for this reason that we find that the vast majority of the religious process is imbued with physicality. Although there is no repeatable recipe for achieving enlightenment in Buddhism or in the Hindu *ñana-marga* (way of knowledge), there are definite, almost scientific procedures which one follows for meditation. Likewise in the Jewish, Christian, Moslem, and Hindu *bakhti-marga* (way of devotion) traditions, there are typically procedures for prayer and sacrament, and yet one would hesitate to say that God is present only because one follows the procedures.

The scientific process is likewise imbued with spiritual tendencies. There is, for instance, the faith that the mathematical rules which govern measurable phenomena are ultimately simple, or at least are no more complex than need be. Moreover we find a strong moral undercurrent of honesty in reporting evidence to be very highly prized in science.[10] Also significant is the fact that our guesses concerning the mathematical form of physical laws are suggested by models which are themselves not strictly mathematical, and which are often informed by an aesthetic sense of the mathematics involved. Where different models produce equivalent mathematics, one chooses the model which most fruitfully leads to the discovery of new laws, thus one cannot easily escape the requirement of extra-mathematical considerations in science.[11] There is room as well in our complementary scheme for the scientist who passes from the aesthetic appreciation of the symmetry of the mathematical relations to a deep religious appreciation of physical law.

On the complementary view, disputes between science and religion historically have arisen to the extent that the complementarity has not been recognized and respected — that is to say, to the extent that it has been assumed that the types of relationships represented at each pole can simultaneously be specified to arbitrary accuracy. To assert that God created humankind, but not through the processes of evolution, for instance, ignores the complementary relation that exists

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[10] It may be argued that this is merely pragmatic in the attempt to attain accurate mathematical relationships. Yet if it were only pragmatic, the reaction to blatant falsification of data would also be pragmatic, and would not occasion the feelings of antipathy that it often does in the scientific community.

[11] Richard Feynman (1965, 50–53) cites three formulations of gravitation which yield equivalent predictions, but which come from very different considerations: the Newtonian action-at-a-distance model, a local field model, and a minimum principle model. The first is a dead end as far as physical law is concerned, and thus has been discarded.

between the spiritual pole and the mathematical pole. Such an assertion purports to cross the ranges of ambiguity from the spiritual pole to the mathematical pole with the spiritual description of the relation intact. In actuality, when one reaches the mathematical pole, one finds the mathematical relations of genetics and the statistical relations of natural selection well-established. Likewise, the Zen master should laugh at the person who insists that the mathematical relations of quantum mechanics somehow completely account for what goes on during enlightenment, as is sometimes alleged in the popular literature.

Reductionism itself may well be another example of bold disregard for this complementarity. To say that what exists must reduce to what can be represented in the mathematical relations of science is again to assume that mathematical relations can be dragged across the vast range of ambiguity between the mathematical and the spiritual with mathematical content intact. Compounding the folly is the assumption that the spiritual pole can thereby be eliminated altogether, in favor of the mathematical relations of science. Adherence to the principle of complementarity in the relationship between science and religion allows no such assumption.

Now it may happen that religious texts, as well as the writings of some famous scientists seem to violate this complementarity. Here we must be firm in our use of the principle of complementarity. Literal, physical interpretations of religious texts, as well as reductionistic interpretations of physical theory must be treated as equally mistaken if one takes the complementary view seriously.

Concluding Remarks

We cannot expect to integrate science and religion by creating separate worlds for them, nor by taking one to fully account for the other. There is one world in which they coexist, and there must be a smooth transition between, even an intermingling of the two. Complementarity provides a framework for the kind of relationship that exhibits that smooth transition, but only at the price of assigning one particular aspect of science — the mathematical relationship — and one particular aspect of religion — unquantifiable spiritual relationship — to opposite poles of the complementarity. The price of complementarity is our inability to specify mathematical relations and ultimate spiritual relations simultaneously, and expect both to hit the mark. What we gain, however, is a unified world in which science and religion interact and intermingle in the vast ambiguous regions between the two complementary poles.

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