

Scales and Hierarchies: Implications for Science and Religion

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Science and religion are both still close to their beginnings, with no ends in sight. Science and religion are both destined to grow and change in the millennia that lie ahead of us, perhaps solving some old mysteries, certainly discovering new mysteries of which we yet have no inkling.

-Freeman Dyson.¹

Introduction

A number of authors have reflected upon the fact that scientists study nature in particular ways, at particular scales, while theologians talk about the “Whole” or the “All.” Ian Barbour (1988) compares four ways in which one can conceive of scientists and religionists interacting: in Conflict, in Independence, in Dialogue, and a fourth group he labels Integration.² Barbour recognizes that adherents of these various approaches confront the problem of locating religion vis-à-vis science. Even religionists and scientists who reject the possibilities of grand synthesis between science and religion must still give an account of religion and its persistence. An outright reductionist like E. O. Wilson, who labels religion an error to be outgrown by maturing humanity, gives it a place within the evolution of the species. His predecessors, David Hume and Sigmund Freud, also sought to explain how religion emerged and how it should be overcome. Speaking for many atheists, Freud announced that his discipline, Psychoanalysis, had only one great enemy, Religion, because religious claims pertained to the human psyche, the object upon which Psychoanalysis centers. At this psychological level, which Barbour calls the most important religiously, is the human experience of brokenness and loss, redemption and healing (p. 44).

While some people might feel content with locating religion only at this level (the “meso” level as we describe it below), others are not: “But the centrality of redemption need not lead us to belittle creation, for our personal and social lives are intimately bound to the rest of created order” (p. 45). Our intellectual passions cannot tolerate boundaries upon

¹ Freeman J. Dyson (2002). "Science & Religion: No Ends in Sight." *New York Review of Books*. Volume 49, Number 5 · March 28, 2002. <http://www.nybooks.com/articles/15220>

² “Ways of Relating Science and Theology.” In: *Physics, Philosophy, and Theology: A Common Quest for Understanding*. Eds. R. J. Russell, W. R. Stoeger, G. V. Coyne. Notre Dame, IN: Notre Dame University Press, pp. 21-48.

essential questions: How does it all fit together? This is a metaphysical and a theological question of ancient pedigree. With the rise of the sciences it has evolved: How do scientific truths, derived from all the disciplines, impinge upon these truths about human experience?

As we enter the twenty-first century, we face questions of incommensurate discourses within the sciences and between cultural self-understandings grounded in rival revelations such as those that animate Islam and Christianity. Incommensurability in the sciences typically becomes a problem only for those caught in border disputes; for most scientists most of the time, the issue is remote from their professional tasks and concerns. However, within the human sciences and more so within religious claims about Human Being, incommensurability may lie at the center of friction. At their most dangerous, such frictions develop into conflicts that threaten to become religious wars. The rise of economic and demographic globalization is itself a form of unification. With it has come the merging of discourses about essential human values, from the nature of economy and justice, to the role of women inside and outside the home and in the new, global economy. With this unification, we see ideological fractures appear in areas as critical and sensitive as human rights and the very conception of shared humanity.

If we have not yet secured a grand synthesis within physics, nor between physics and chemistry, nor within the biological sciences, nor at the interface between, say, biology and physics, or psychology and economics, it is hardly surprising that we have no synthesis ready to hand upon which we can align our diverse religious traditions. And the question of a synthesis between the sciences and religion looks all the more remote. Yet here, as in the other instances, we cannot afford to accept mere agnosticism. Granted that skeptics cannot be proved wrong, our existential interconnectedness and interdependency do not allow us to accept their admonitions to remain silent. Our question, How does it all fit together? is both religious *and* scientific. It emerges in the first moments of reflection: we have a partial grasp of how we fit into time and space, but not a complete grasp. The search for a Unified Field Theory in physics is a contemporary instance of the same urge that drove the first human beings to locate themselves within the boundaries of Nature.³ In our project, we locate many of the sciences and many of the discourses about human being, including religious discourse, rigorously and comprehensively on the basis of size, scope, and meaning. We believe that such an approach can help facilitate a twenty-first century reconciliation between scientific and religious discourses.⁴

³ This question permeates western thought since at least the Greeks of the Classical era. For example, "After Pythagoras' discovery that the harmonious intervals of the musical scale are audible expressions of basic mathematical proportions, it was a bedrock principle of Western thought that music is a pure reflection of cosmic order." "Name That Tuning" December 16, 2001, Late Edition - Final *New York Times*. Byline: By Jamie James. Review of Stuart Isacoff, *Temperament: The Idea That Solved Music's Greatest Riddle* (New York: Alfred A. Knopf, 2001).

⁴ For important criticism of "God of the Gaps" as science and theology, see John Polkinghorne, *Quarks, Christianity, and Chaos*, Crossroad: 2000; John Haught, *Science and Religion*, Paulist Press: 1995; and Ted Peters, ed. *Science and Theology*, Westview Press: 1998, especially essays by Paul Davies and Robert John Russell.

Our practice in the modern university often stands in sharp contrast to the search for unity. Narrowed focus, rigorous exclusion, and relentless self-criticism have produced technical advances not dreamed of by earlier generations. Within information sciences, the pace of advance, miniaturization, and computational power advance inexorably, it seems. But for all the remarkable gains achieved by specialization, there are still far too few chances for discussion among accomplished scholars in the different disciplines. The coming grand synthesis of genomics, protein studies, computer science, and the information sciences is but one example of the beneficial results that collaboration will produce, for health care and medicine, not to mention for philosophy and theology. To address these issues we are undertaking a three-year research project.

Project Outline: The Three-Year Seminar

Year One: Locating Religion and Science: Scales, Hierarchies, Emergence

Year one of the seminar will be a form of fieldwork research. We will review relevant publications, including The CTNS/Vatican Observatory's project, *Scientific Perspectives on Divine Action*,⁵ and engage in mutual education. We will learn about each other's discipline and about its specific objects, tasks, and implications for our mutual inquiry. We intend to not merely survey our colleagues' research, but to understand that research in the context of how each deals with scale, with special concern for the issues associated with reductionism and emergence.

In year one, we will ask each participant to respond to the following questions:

- (1) How do you and your discipline initially conceive the terms "science" and "religion"?
- (2) Where do you locate your research, what are its objects, what objects lie "below" and "above" this level of research?
- (3) What specific problems do you find when you address the issues of below and above? To what degree can you link propositions within your discipline to propositions made above and below yours?
- (4) Do issues of reductionism and emergence appear in these attempts?
- (5) To what degree does literature about Science and Religion, especially papers from the relevant volumes in *Scientific Perspectives on Divine Action*, pertain to your work?
- (6) Having isolated these specific problems, can you compare them to similar problems that emerge in other disciplines?
- (7) Can you generalize any part of these insights to revise your initial conception of religion and science?

⁵ These five volumes of research papers on science and religion provide an ideal starting point for Year One. They set the stage for general issues in quantum physics, chaos theory, evolutionary and molecular biology, the neurosciences, and physics, showing how each pertains to classical issues such as explanation and reductionism. For example, in an important paper, "Quantum Theory and the Macroscopic World," George F. R. Ellis discusses "Micro-to-Macro Relations: Bottom-Up Causality." See: Volume 5, *Quantum Mechanics* (2001), eds. R. J. Russell, P. Clayton, K. Wegter-McNelly, J. Polkinghorne. Notre Dame, IN: Notre Dame University Press, pp. 259-292.

Year Two: Commensurability and Incommensurability: Causality in the Disciplines

Year two of the seminar will build on the shared learning of the first year and move toward more constructive engagement across fields of study. Year one of the seminar is about levels of being; year two is about interactions across levels. In some cases the higher level phenomena can be explained in terms of lower level constituents. Thermodynamics of gases may be the best example. In these cases static structure at the higher level may be dynamic function at the lower level. The apparent success of this reductionistic approach may be deceptive. Important intellectual problems remain. We suggest that there are many examples of explanatory gaps between scientific discourses that pertain to discrete, and apparently impenetrability, levels of being. Examples of this incommensurability and irreducibility include:

- The mass properties of matter that are not explained by subatomic properties.
- The role of reasons in explaining intentional action. The properties of neurons per se cannot distinguish an intentional wink from an unintended blink.
- The role of culture in explaining tools, artifacts, and religion.
- The role of grammar and semantics in explaining language.

In year two we sort out where explanatory gaps are and whether bridging concepts exist or can be formulated. We ask these kinds of questions:

- (1) Given the objects that you study and the scale at which they are located, is morphology of prime importance?
- (2) How do you isolate and identify causal forces that impinge upon these objects?
- (3) Can you isolate causes “from above” as well as “from below”?
- (4) Do problems associated with emergence and reduction in your discipline parallel or diverge from those that we’ve seen in other fields?
- (5) What parallels and dissonances do you observe between your field of study and that of other disciplines, including the study of religion and religious forms (such as myths and rituals)?
- (6) What consequences might these findings have for the task of theology?⁶

Using our heuristic of scale, we can ask if developmental models pertain to *all* the sciences and disciplines.⁷ The concept of morphology (or form) fits well meso-level

⁶ Religion too is both a general phenomenon, typical of most cultures, and a personal, seemingly ineffable (and therefore incommunicable) experience. Using the model of biological adaptation, we can see each religious variation as a response to specific challenges and ecological opportunities. In the study of religion, we confront two tasks: to understand how such adaptations occur and to see how each addresses universal questions about justice and injustice, good and evil, purpose and destiny that emerge in religious traditions. A third task is to relate religious language and experience to the many levels of reality itself—including its moral dimensions.

⁷ Scale and hierarchy are themes; they represent “abstract entities that bring meaning and identity to an experience and its variant manifestations. As such, a theme captures and unifies the nature or basis of the experience into a meaningful whole” (p. 362). DeSantis, L., & Ugarizza, D.N. (2000). The

disciplines, such as botany, clinical psychology, comparative religion and theology, and, by extension, formalist studies in the humanities. Does it also fit nano sciences, on the one hand, and astrophysics, on the other? If the notion of morphology is restricted to only a few of the disciplines, such as comparative botany, what does this imply for theological reasoning? If there are limits to the utility of the concept of morphology, do these predict limits to the utility of related Darwinian concepts, such as adaptation and ecological fit? Even stricter questions arise when we seek to apply mechanical or electrical models of cause to neuroanatomical events.

For example, Jeff Schall, whom we cite below, concludes his review of efforts to map saccadic eye movements in a monkey to specific regions of the monkey's brain by noting how difficult it has proven to understand this seemingly simple event. In a strict model of neural cause and behavioral effect (or event), each neural event produces one, predictable action and each action is produced by that one neural event. Alas, this is not true of the monkey brain: "Several lines of evidence demonstrate that the same saccade can originate from markedly different brain states" (02.20). This is a crucial fact. First, it means that somewhere between the neural origins and the ultimate receptors in the monkey's eye muscles distinctive information was lost. Schall suggests that somewhere in the brain stem differences are resolved into a unified signal that elicits the saccadic movement. Second, it means that the dream of mapping one-to-one cause and effect *cannot* be realized. Since we cannot reduce each saccade to a single, predictable neural cause, we must talk about "intentionality." This is a complex concept that entails equally dense concepts like "reason" and "belief." As Schall notes, this latter concept brings us close to conundrums of psychology and profound questions of what constitutes choice.

Once we have expanded the discussion to talk about intentionality, choice, and reason we are moving even closer to the realm of ethics, law, and, we suggest, theology. Confronting E. O. Wilson's dream of a complete reductionistic triumph, Stephen Jay Gould notes that even if we can map completely an idea onto a fixed neural substrate, we cannot then claim that we can answer all our questions.⁸ Knowing that a particular organization of neurons produced a certain question, such as "What is the nature and destiny of human being?" does not let us answer that question. For this is a religious question; it asks us to locate the future of human being. It talks about the All, and the All has not yet yielded to a fixed attack by any consortium of sciences.

Year Three: Meso-level Analyses: Toward Progress in Religion

Year three of the seminar will begin with a series of papers, findings, workshops, and public events to bring our discussions to much wider audiences. Given the presence of major research centers newly funded at Vanderbilt from which we can draw expertise, and the group of scholars we name below, we believe that these questions can best be addressed here.

concept of theme as used in qualitative nursing research. *Western Journal of Nursing Research*, 22, 351-372.

⁸ (2003). *The Hedgehog, The Fox, and The Magister's Pox: Mending the Gap Between Science and the Humanities*. New York: Harmony, pp.234-235.

Year Three will be centered on the tasks of revising the work of Year Two, preparing publications, and presenting a major conference on Science and Religion. It will be devoted to outcomes from years one and two. The conference theme will emerge from the work of the seminar and it will feature summary papers by seminar participants, reports on seminar findings, and invited presentations by outside experts. A keynote speaker of international stature will anchor the conference.

Given the importance of this discussion and its implications for the university and the larger intellectual community, we will also pursue permanent funding for the seminar on Religion and Science.

On The Importance of Scale to Theology and Science: Neuropsychology, Sociology, Physics

The nature and size of the objects studied by science and religion matter because scientific truths (and discoveries) pertain to the scale of those objects. Attempting to generalize to objects below or above that scale proves challenging, if not impossible. The challenge grows exponentially when theologians or metaphysicians attempt to offer valid descriptions of the “All” because the All must include everything, from the smallest to the largest. We can clarify this by discussing three concrete instances of the problem of scale within neuropsychology, in sociology, and in physics.

Neuropsychology

Within contemporary neuropsychology, numerous scientists have labored to “map” psychological and behavioral events onto a neural substrate: “Cognitive neuroscience is motivated by the precept that a discoverable correspondence exists between mental states and brain states.” (Schall, 2003, p. 02.1)⁹ While some theoreticians may affirm this percept, to bring it into the realm of science one must demonstrate actual instances. To go beyond merely inferring that there is some connection between mental states and brain states, and to discover the precise linkages, neuroscientists must monitor neural events in real time, as they occur during an observed behavior: “A true mapping of neural and mental must be immediate; a mental state can only be supervenient on a neural state in the instant of occurrence” (Schall, 02.3)

This is a demanding requirement. It asks the scientist to specify precisely which neural structure (which neurons or sets of neurons) operates during an observed behavior, such as visual attention. Jeff Schall (Ingram Professor of Neuroscience at Vanderbilt University and a participant in the project) describes lucidly how this strict condition leads him and other neuroscientists to conceive of linking propositions. These are propositions that specify how we link observations of the animal’s psychological behavior (for example, a monkey looks at a stimulus) to observations of specific neural circuits in the monkey’s brain. In their strictest form, linking propositions would state that identical neural states map onto

⁹ Jeffrey D. Schall (2003). “On Building a Bridge Between Brain and Behavior.” *Annual Review of Psychology* 55:23-50.

identical cognitive states (Schall, 0.2.4) On the contrapositive, it must be true that non-identical neural states map onto non-identical cognitive states.

The strictest form of mapping holds that every distinct psychological state corresponds exactly to a distinct neural state. If this were so, we should in principle be able to make valid linking statements between any observed mental event and corresponding neural events. However, before affirming so grand a statement, Schall notes that at its current state of development, cognitive neuroscience struggles with issues of scale and size. “At what behavioral and neural scale must the comparison be judged?” (02.5). It seems very difficult, if not impossible, to specify linking statements at the molecular scale. First, it seems unlikely that the same thought requires us to use the same neuron. Second, given the immense complexity of events at that cellular scale, it would prove difficult to perform the calculations necessary to link events at the level with observed behaviors. It would require us to have a complete map of cellular events that occur in real time. To achieve that remarkable goal we must first create a plausible computational model of cellular events.¹⁰

If we cannot make linking statements at the molecular level, nor, at the level of the single neuron, then we must specify a group of neurons upon which we can map mental states. This group of neurons Schall names the bridge locus, that set or population of neurons that connect with one another in such ways that their outputs give rise to the observed behavior. Drawing upon a multi-year research project, Schall describes efforts by his research group to map neural events in macaque monkey brains that correspond with saccadic eye movements. (These are fast movements of the eye by which we shift gaze from one object to another.) While much is known about the neural circuits that produce these actions, much is also not known. For example, we don’t yet know how the brain terminates saccadic eye movements; theory and evidence tells us that there must be a feedback control circuit but “fundamental questions remain unanswered” (Schall, 02.9). Among the latter are conceptual puzzles as well. For example, how might we map the concepts of “intention” and “deciding” onto neural states? Assuming that we can do so for animals; will this be relevant for humans?¹¹

Sociology

Turning to a very different discipline, Sociology, we find issues of scale dominate attempts to link statements about individuals, small groups, and whole societies. Sociologists have developed two different tendencies: one discourages transitions between levels on methodological grounds and one encourages transitions on theoretical grounds. For over fifty years, a major emphasis in sociology has been to avoid the ecological fallacy (Robinson, 1950). Gary Jensen (Chair of Sociology and a participant in the project) notes that the ecological fallacy is committed when one uses relationships established using aggregate data

¹⁰ Schall cites Masaru Tomita (2001), “Whole-cell simulation: a grand challenge of the 21st century. *Trends in Biotechnology*. 19:205-10. Indeed, so daunting is this challenge the Japanese government in 2002 funded the “E Cell” research project, led by Masaru Tomita with some sixty collaborators. On the “E Cell” project, see Robert Triendle, *Naturejobs* 417, 7 (27 June 2002); doi:10.1038/nj6892-07a; http://www.nature.com/cgi-taf/DynaPage.taf?file=/nature/journal/v417/n6892/full/nj6892-07a_fs.html

¹¹ Jeffrey D. Schall (2001). Neural basis of deciding, choosing and acting. *Nature Reviews: Neuroscience*. Vol. 2: 33-42.

representing societies (or ecological territories) as evidence for theories about the behavior of individuals. One dictionary defines it this way: “The bias that may occur because an association observed between variables at an aggregate level does not necessarily represent an association that exists at an individual level; an error of inference due to failure to distinguish between different levels of organization.”¹²

Wishing to avoid this fallacy, which is making inferences about “levels of organization” above and below that of a social group, some sociologists generalize neither to individuals nor to nation states. In sharp contrast, other sociologists, most notably Talcott Parsons, proffer structural accounts of each of the ontological states. Attempting to fulfill Max Weber’s vision that sociology would offer a complete theory of human development in its most advanced state, western capitalism, Parson’s theory encompasses each level of human experience.¹³

Because our research group confronts different levels of organization, we need instruction from our sociologist colleagues. It seems unlikely that they alone must struggle with this fallacy. We note, for example, that sociobiologists and their progeny make numerous inferences about human behavior based on the behavior of much lower animals, including insects: “Biologists have shown that a number of apparently altruistic types of behavior can be explained in terms of biological success.”¹⁴ This is a strong claim, stuffed with metaphysical assumptions. Before we assent to it we must first dissect out those assumptions and assess how sociobiologists address the ecological fallacy, among other fallacies. Confronting these and related criticisms, some sociobiologists argue that beyond Darwinian evolution there is a second form, the evolution of “memes” or what we might call ideas. Aside from the logical and conceptual puzzles this solution presents, we note that it introduces yet another level of entities into the debate. Where mere instincts were, there memes shall be.

The ecological fallacy has loomed so large to sociologists that few have attempted analysis at different levels. Researchers prefer data collected from individuals because the most common research problem in early sociological research was the use of data from the ecological level to test theories about individual behavior. The fear of committing the ecological fallacy has discouraged scholars from addressing the transitions between macro and micro levels, and the path taken to deal with the fallacy was to shift to the micro-level.

In response, some contemporary sociologists have proposed that there are patterns or principles that apply at different ‘fractal’ scales, a concept borrowed from the physical sciences and mathematics. For example, Jack Goldstone (1991, p. 46) proposes that social structures are near “fractal,” showing similar features on macro-micro scales. Goldstone and

¹² <http://www.dictionarybarn.com/ECOLOGICAL-FALLACY.php>

¹³ “Developments in biological theory and in the social sciences have created firm grounds for accepting the fundamental continuity of society and culture as part of a more general theory of the evolution of living things.” Parsons, Talcott (1966). *Societies: Evolutionary and Comparative*. Englewood Cliffs, N. J.: Prentice-Hall, p. 2.

¹⁴ Sigmund, K., Fehr, E., Nowak, M. A. (2002). “The economics of fair play.” *Scientific American*. Vol. 286, 1: pp. 83-87, p. 87.

Useem (1999) propose that prison riots are ‘micro-revolutions’ and that the theories that explain ‘macro-revolutions’ can be applied to them. Jensen (1997) addresses similar issues that complicate the analysis of relationships over time.¹⁵

While understandable, the retreat from generalizing between macro and micro studies means that questions we have about individuals, using sociologically sophisticated data and analyses, will remain unanswered. For example, in his famous study of the sociology of suicide, Emil Durkheim (1897) seemed to show that suicide rates were higher in Protestant countries of Europe than in Catholic countries.¹⁶ Assuming that this sociological observation is correct, what can we now say about individual Protestant and Catholic persons in these countries? Durkheim’s study spawned many thousands of books and articles attempting to link this sociological fact (again, assuming it merits that title) with theological studies, individual psychology, and epidemiological studies. Each of these must deal with the ecological fallacy and thus each deals with the issue of scale and hierarchy.

Physics

The history of twentieth century physics reflects an enormous effort to find unifying theories that span the entire range of physical phenomena, from subatomic particles to the large-scale structures observed by astrophysicists and the universe itself. These theories reflect the essential tension between two fundamentally distinct approaches to experiments and theory: reductionism and emergence. The reductionist view sees physical reality as an onion, with successive layers to be peeled back until one reaches the ultimate constituents of matter. Emergent thinking, on the other hand, reflects the fact that each length scale seems to be describable by entirely self-contained constructs, as if, for example, the rules for describing molecules were quite indifferent to the rules that govern atomic nuclei.

For three-quarters of a century, we have known that Einstein’s account of cosmic space-time, and the theory of quantum systems developed by Bohr, Heisenberg, and Schrödinger are shaped ineluctably by the scales of time and space. The familiar Newtonian world in which we live constitutes a special case described by both theories at the appropriate scales. No physical theory spans the vast conceptual distance from quarks to the cosmos. In part, there are practical difficulties in developing such a theory because the mathematical framework, the language of each theory, is derived to a significant degree from the constraints

¹⁵ See: Goldstone, Jack A. (1991). *Revolution and Rebellion in the Early Modern World*. Berkeley, California: University of California Press; Goldstone, Jack A. and Bert Useem (1999). “Prison Riots as Micro-revolutions: An Extension of State-centered Theories of Revolution.” *American Journal of Sociology* 104 (January): 985-1029; Jensen, Gary F. (1997). “Time and Social History: Problems of Atemporality in Historical Analyses with Illustrations from Research on Early Modern Witch Hunts.” *Historical Methods*. 30: 46-57; Merton, R. K. (1957). *Social Theory and Social Structure*. New York: Free Press; Robinson, William S. (1950). “Ecological Correlations and the Behavior of Individuals.” *American Sociological Review* 15: 351-357. On chaos theory and social science theories, see Abbott, Andrew (2001). *Chaos of Disciplines*. Chicago: University of Chicago Press.

¹⁶ Durkheim, Émile. (1897). *Le Suicide: étude de sociologie*. Paris: Alcan. Durkheim, Émile. 1951. *Suicide: A Study in Sociology*. Translated by John A. Spaulding and George Simpson. Glencoe, Illinois: The Free Press of Glencoe.

imposed by scale. The difficulties are compounded by the realization that the old Laplacian dream of deducing the dynamics of the entire universe from the motion of its constituent parts is frustrated by the sheer complexity of mesoscale and macroscale assemblies of atoms and molecules that go together to make, for example, the crystalline silicon that is the heart of the modern microcomputer. The reality of each length and time scale seems to emerge without reference to the levels above or below.

In some situations, completely different underlying interactions give rise to similar behavior. It can be difficult, if not impossible, to construct a theory that allows the underlying interaction to manifest itself. One cause of this behavior is described by the *central limit theorem* that leads to the prevalence of measurements with normally-distributed errors. Repeated measurements of properties of systems in which the central limit theorem is applicable have the same description, though the underlying forces and structure may be as different in nature as the quincunx and the motion of molecules in a gas.

A related difficulty arises from the observation that the scale of a problem may not be well-known at the onset of the study. Thus it is not always clear whether a concept derived in one context is applicable to another system or whether a new framework must be developed. An example of this arises in the new field of relativistic heavy ions, the goal of which is to produce in the laboratory a state of matter that existed during the first few microseconds after the beginning of the universe. One of the essential conditions is the existence of a very high temperature, billions of times greater than that of the sun. Temperature is a thermodynamic property that requires a statistical description of the entities that make up the system. If the matter produced in these experiments does not reach equilibrium, such a description is invalid. The use of temperature to characterize the system is misleading and the results of the experiment cannot be described in a way that links old discoveries and new.

The tension between reductionism and emergence can be illustrated in a number of ways. On the complexity frontier, it shows up in the challenge of adapting quantum physics to nanoscale material systems comprising anywhere from a few to a few thousand atoms. In cluster physics, where one deals with a few up to perhaps a hundred atoms, adaptations of atomic physics work reasonably well to describe the properties of the cluster. The reductionist picture that builds upwards from atomic properties can, for example, explain how a cluster of gold atoms two nanometers in diameter can be extremely reactive chemically when bulk gold is a “noble” — that is, unreactive — metal. However, at the scale of a few hundred to a few thousand atoms, the collective properties of the gold, while not yet entirely like bulk gold, seem to follow their own emergent rules that have only a vague resemblance to the prescriptions of atomic physics. The complex exchange interactions that link individual atoms to many other like atoms in their immediate neighborhood call forth quite novel properties that cannot be predicted from knowledge of atomic gold behavior.

While the study of physics crosses many orders of magnitude, scientific activity itself takes place firmly within the mesoworld. As with most human activity, the interactions between physicists with different scientific beliefs are frequently strained. Condensed-matter scientists in physics and chemistry frequently champion the idea of emergence against the reductionist picture of particle and nuclear physicists. The culture of physics is remarkable in

that, despite these strong differences, there is a shared faith in the correctness of the scientific method and the use of the common language of mathematics that permits the subject to span so many orders of magnitude. Although the generally materialist tone of the twentieth century casts a long shadow over attitudes of scientists toward religion, many physical scientists still seem to find some place for religion and religious experience. Here, again, we note the valuable work already done on this question by contributors to the two volumes on quantum physics and religion in the *Scientific Perspectives on Divine Action* series.

The Isolation of the Disciplines and the Estrangement of Theology

These differences matter to the discussion between science and religion for many reasons. First, the life sciences are now among the most dominant in the academy and in the public sphere. Essentially religious questions about the definition of human being, of the individual, of ethical treatment of “proto-human beings,” of cloning, and related dilemmas emerge from the upsurge in the reach of biological discoveries. What the nineteenth century and twentieth century only imagined in science fiction -- the laboratory creation of life -- is now a scientific and ethical reality.

Second, these differences matter because more than ever the modern university is subjected to centrifugal forces that encourage the isolation of the disciplines. That the molecular biologists say little or nothing to the physicists about ‘nano scale’ phenomena is a non-event repeated in most of the sciences and most of the humanities. Given the complexities of scientific research and the depth of humanistic projects, success and promotion within the disciplines accrues to those who hew to a rigorous research agenda, focusing on specific problems that may yield specific results.

Contemporary scholars and scientists suffer no ills by sidestepping issues of incommensurate discourse. We are saved the embarrassment of confronting the diversity of our languages and paradigms by the vastness of the work to be done within each field, a vastness that increases with each new discovery, as whole new disciplines and discourses are opened up. The field of discovery within molecular biology, for example, is immense. Going up and down the scale within the biological sciences invokes vastly different disciplines, each constrained by research languages, measures, units, and incomplete models of its own. Integrating findings within each of these levels is challenging; integrating the findings of adjacent disciplines often seems hopeless.

However, there are at least two causalities; one is the university, the other is theology. The university suffers because as an institution devoted to extending the range of discovery and addition of new truths, it cannot assume that strong disciplines and strong departments enhance the work of the whole. Theology suffers because its practitioners must deal with the “All” or the “Whole” or “Being Itself.” The multiplication of incommensurate discourses has led to the estrangement of theology from its rightful conversational partners.

For theologians and metaphysicians who address their questions to the nature of the “All,” the costs of the isolation of the disciplines is great. The isolation of discourses means that there is no consensus about a shared, master narrative that pertains both to science (in all

its multivariate complexity at all its scales) and to human experience and to God. Addressing themselves to this shared dilemma, theologians as different as David Tracy and Bernard J. F. Lonergan organize their key concepts.¹⁷

As we note below, if one locates human subjectivity at the “meso level” of analysis, then religious experience and religious language are confined to that level. If the isolation of discourses holds for this level, as it seems to hold for the others, then theological reflection that begins with religious experience would be hobbled, if not crippled. For example, if Jewish and Christian theologians ground their accounts upon Biblical narratives and Biblically shaped religious experience – which are mesolevel entities –they will confront barriers to generalizing from these accounts to making larger claims about Nature. Buddhist, Hindu, Muslim, and other theological traditions confront the same dilemma, as did proto-theologians in the Western, Greek tradition, and in the Eastern, Chinese tradition.

For example, Empedocles, a Greek thinker who flourished around 440 BCE, practiced medicine, and wrote at least two books, one titled *On Nature*, a book on science, the other called *Purifications*, which reflected in a “more rhapsodical and religious character” upon human nature (Wheelwright, 1966, p. 122).¹⁸ This union of what we now distinguish, science from religion, and deductive reasoning from poetical singing, seems typical of early Greek thought. It is not surprising that at the dawn of Greek philosophy we should find types of thinking and types of discourse mixed together in the brilliant verses of Empedocles and in the hymns of his great predecessor, Parmenides. His major work is also titled *On Nature* and begins with religious reflection upon “Being itself” (*Esti*).

We see a similar melding of religious, philosophic, and medical thought in the Chinese classic *I Ching*, the Book of Change (collected around the 12th century B.C.E). Paralleling their Greek counterparts, philosopher-theologians like Confucius (551-479 B.C.E.), who commented upon the *I Ching*, sought to draw from it ways to understand nature and human being, especially what we might call character or personality.

With the rise of critical methodologies, differences between discourses and limits to fixed discourses became more obvious. Early in the classical Greek period, for example, we find logicians and philosophers stumbling over the limits of generalized claims. A famous instance of this stumbling is the “Liar’s Paradox” which appears by the 5th century B. C. E. In its usual form, the paradox begins with the Liar’s sentence (1) This sentence is false. Asking about the truth-value of this innocent-looking sentence has consigned numerous students and their teachers to logical nausea. For as Aristotle and others noted, if (1) is true, then what it asserts is the case and what it asserts is that (1) is false. Thus, if the sentence is true it is also false. If, on the other hand, we claim that the sentence is false, then what it asserts is not the case and what it asserts is that it is false. Thus, if the sentence is false then it is also true.

¹⁷ Thus Tracy (1975, *Blessed Rage for Order*, New York: Seabury Press) offers a meta-theology; Lonergan (1970, *Insight: a Study of Human Understanding*, New York: Philosophical Library) offers a meta-psychology of the process of insight as it occurs in both scientific and other-than-scientific rationalities.

¹⁸ Philip Wheelwright (1966) *The Presocratics*. New York: The Odyssey Press.

This generates a paradox and a great deal of anxiety about the limits of logic and the limits of ordinary language.

To address, much less solve the Liar's Paradox, one must plunge into the nature of language, self-reference, logical coherence, the theory of Truth, and limits to discourse. The latter appears in those thinkers who sought to resolve the problem by outlawing it and its numerous cousins.

Indeed, depending upon the density of these problems, attempts to give generalized accounts of the "All" seem doomed. Thus, not just theology, but all efforts to produce metaphysical accounts, including a general philosophy of science, would be reduced to best guesses, or narratives of varying grandeur and rhetorical persuasiveness. In this pessimistic reading of the possibility of theology, one would see little hope of uniting theological discourses with any of the sciences. Creative theologians have long recognized some version of this problem. Thus, Henry Nelson Wieman (1884-1975) argued for a kind of theological empiricism. Granting that the Christian narrative is limited to a certain context and certain group of people, Wieman nevertheless argues that there is a "Something, upon which human life is most dependent for its security, welfare, and increasing abundance."¹⁹

Late in his life Wieman described his core question and core hopes: "How can we interpret what operates in human existence to create, sustain, save and transform toward the greatest good, so that scientific research and scientific technology can be applied to searching out and providing the conditions—physical, biological, psychological and social—which must be present for its most effective operation? This operative presence in human existence can be called God."²⁰

Alongside genuine advances in the basic sciences, we must acknowledge that we cannot claim equivalent advances in the human sciences, nor in politics, nor in religion. To cite Freeman Dyson again, "Science and religion are both still close to their beginnings, with no ends in sight." For against Wieman's optimism are equally trenchant rebuttals by his contemporaries, such as Reinhold Niebuhr. In a scathing review of hyper-rationalists theories, Niebuhr exposed the many ways that social scientists of the 1930's confused advances in the natural sciences with hoped-for advances in the social sciences. Using Niebuhr's terms, natural scientists advanced by excluding human nature and human society as objects of analysis. This let them sidestep fundamental problems of scale and hierarchy between individuals and groups. But, theologians, sociologists, and politicians, to name three groups, must deal constantly with the conundrum that ethical or moral behavior can be ascribed most easily to individuals, not to groups (much less, to nation states): "The relations between groups must therefore always be predominantly political rather than ethical, that is, they will be determined by the proportion of power which each group possesses at least as

¹⁹ Citation from Josh Braley, Ph. D. candidate in Theology, Vanderbilt University, Graduate Department of Religion. The reference is from Henry Nelson Wieman, *Religious Experience and Scientific Method*, (Carbondale, Ill.: Southern Illinois University Press, 1971 [1926]), 9.

²⁰ This passage is from Wieman's Preface to the 1971 reprint of *Religious Experience and Scientific Method* (1926). It appeared in Ralph Burhhoe's piece on Wieman <http://www.harvardsquarelibrary.org/unitarians/wieman.html>

much as by any rational and moral appraisal of the comparative needs and claims of each group.”²¹ One of our essential tasks will be to assess Niebuhr’s pessimistic claim.

We propose to begin our three-year discussion by acknowledging the fact that our discourses may not be fully commensurate and that fundamental questions about science and religion remain unanswered. We hope then to proceed in an interdisciplinary fashion. To organize our conversations, we use the model of scale, or levels of entities.²² We feel that our group is well situated to carry on this discussion because we can draw upon the experience of colleagues across Vanderbilt University who deal with the burden and glory of interdisciplinarity on a daily basis. Among our participants will be colleagues drawn from the following interdisciplinary research groups:

Size, Level	Relevant Sciences/ Disciplines	Vanderbilt Resources (beyond individual departments)
Beginnings	Particle and nuclear physics	International collaborations (BTeV and RHIC)
Nano	Nanoscale Physics	Institute of Nanoscale Science and Engineering
Nano	Molecular biology	Center for Structural Biology
Micro	Genetics	Center for Clinical and Research Ethics
Micro	Cell sciences	Institute of Chemical Biology, Institute for Integrative Bioengineering, Research and Education
Next	Neuroscience	Center for Integrative and Cognitive Neuroscience; Center for Neuroimaging; The Brain Institute
Meso	Psychology Psychiatry	Center for Integrative and Cognitive Neuroscience, Center for Neuroimaging; The Brain Institute
	Anthropology	Center for the Americas
	Arts & Representation	Center for the Study of Religion and Culture Robert Penn Warren Center for the Humanities
	Professions: law, medicine, architecture, etc.	Medicine, Health, Society Research Group
Macro	Sociology, History, Political Science, Ecology, Engineering, Urban Design, Earth Sciences	Vanderbilt Institute for Public Policy Studies Center for the Americas
Super Macro	Astronomy, astrophysics, cosmology	International Collaboration (Hubble Telescope)
	Metaphysics, theology ²³	Vanderbilt University Divinity School Graduate Department of Religion

²¹ (1932) *Moral Man and Immoral Society* (New York: Scribner, p. xxiii).

²² For an example from descriptive mathematics, see Philip and Phylis Morrison and the Office of Charles and Ray Eames, *Powers of Ten* (New York: W. H. Freeman & Co., 1982; revised edition, September 1994). For examples from the philosophy of science, see Nancy Murphy, “Evidence of Design in the Fine-Tuning of the Universe,” in *Quantum Cosmology and the Laws of Nature: Scientific Perspectives on Divine Action*, eds. R. J. Russell, N. Murphy, C. J. Isham. Notre Dame, IN: Notre Dame University Press, 1999, pp. 401-428. See also George F. R. Ellis, pp. 286-287.

²³ At least one of the *objects* of theology, God, is super macro. The methods of theology, one might argue, are inherently meso because they stem from human narratives.

Naturally, within each of these levels are numerous sub-levels, defined in part by the kinds of questions we bring to them and defined in part by current technologies.

Religious Experience and Religious Discourse: Meso-Level Entities

Religious discourse pertains to human cognition and self-awareness; both emerge at meso-levels. Within religious traditions, narrative, metaphor, anthropomorphic, and historical models dominate. Self and group identities, which are essential to survival, depend upon ritual and mythic constraints that emerge at this level. Because core identities emerge along binary lines (Self vs. Other), the mere presence of other faiths can sometimes evoke annihilation anxiety. The latter may contribute to the ubiquity of religiously inspired wars and other atrocities.

Attempts to offer scientific explanations of religious behaviors elicit distress because they seem to invalidate the veracity of religious experience and thus imperil group identity. Since the rise of rationalist systems in Europe in the seventeenth century, it has proved impossible to affirm both naïve religious claims and scientific method. Essential to the advance of Western science are insights like those of Descartes who found ways to unify fields of mathematics that up to his time had remained separated.²⁴ But a corresponding unification or harmonization among religious ideas or between religious and naturalistic ideas has proved elusive. Descartes's own division between the realms of spirit and extension is emblematic of the problem. While we harbor no ambition to homogenize the diverse realms of experience, we do wish to help those traditions, religious and non-religious, communicate with one another. We believe that such communication will be beneficial not only in terms of mutual understanding but also in terms of the self-understanding of all who are able to take part, whether directly and face to face or through the records that we make of the problems and the progress of our explorations.

Some educated persons have found ways to affirm what Paul Ricoeur called "second naiveté," a refined, critical form of religious thought that remains aligned with the natural sciences. Evidence in favor of a "second naiveté" is the common insight that religious language itself points to its own limitations. Religion itself is often and articulately aware of limits of our human, meso-level discourses. As the great poet-theologian John Donne put it, "Our God is a metaphorical God." Echoing precisely this insight, twentieth-century critics of religion, including formalists like Claude Lévi-Strauss, championed the validity of mythic constructs as a kind of concrete logic that enables the working out of logical conundrums using names and concepts drawn from everyday life.

For all the brilliance shown by scholars of the meso-level, none has created a singular, unquestioned solution to meso-analytic puzzles. In contrast to the unity of the sciences, at

²⁴ Descartes "makes the first step towards a theory of invariants, which at later stages derelativises the system of reference and removes arbitrariness." J. J. O'Connor and E. F. Robertson. <http://www-gap.dcs.st-and.ac.uk/~history/Mathematicians/Descartes.html>

least in terms of values, methods, and ideals, meso-level analyses are rife with fundamental problems:

- Metaphorical models tend to dominate.
- Inward-looking “schools” and groups may control the agenda.
- Group identities are linked to fixed teachings, in which heritage needs or political agendas trump intellectual values.²⁵
- Brilliance does not always build upon previous insights.
- Core discoveries sometimes devolve into gnomic or paradoxical utterances: wisdom.²⁶
- There is no shared consensus on what counts as progress, especially in religion.
- The concepts of “proof” and “falsifiability” have little common meaning.

Within the university, notionally at least, we defer to the claims of reason and in it seek an eventual unity or community. Such a vision of knowledge animated the Dutch Jewish philosopher, Benedictus de Spinoza (1632-1677). He argued that at its most refined, reason is the ability to “perceive things under a certain form of eternity (*sub quadam aeternitatis specie*).”²⁷ Is the capacity to observe all sentient beings from a distance, with equanimity and justice, clarity and composure, essential to reasoning about human being? Does this equanimity, in turn, depend upon the capacity to imagine a benign entity, God, observing us with the same form of concern?²⁸

Our Strategy: Size Matters

People sympathetic to religion, whether or not they are traditional believers, frequently regard the capacity for religious forms, especially religious symbols, to encompass or restructure new experiences as one of their cardinal values. Thus, Paul Ricoeur says "modern hermeneutics brings to light the dimension of the symbol, as a primordial sign of the sacred.... it is one of the ways of rejuvenating philosophy.... Every symbol is finally a hierophany, a

²⁵ This is especially true of Romantic artists and critics who believed that creativity and the artistic experience itself could provide revolutionary insights into the gloom of ordinary existence. See G. Bays's discussion of Arthur Rimbaud's aesthetic doctrine in *The Orphic Vision: Seer Poets from Novalis to Rimbaud* (Lincoln: University of Nebraska Press, 1964).

²⁶ For another point of view, see Jurgen Moltmann, *Science and Wisdom*, Fortress Press, 2003.

²⁷ “Proof--It is in the nature of reason to regard things, not as contingent, but as necessary (II. xlv.). Reason perceives this necessity of things (II. xli.) truly--that is (I. Ax. vi.), as it is in itself. But (I. xvi.) this necessity of things is the very necessity of the eternal nature of God; therefore, it is in the nature of reason to regard things under this form of eternity. We may add that the bases of reason are the notions (II. xxxviii.), which answer to things common to all, and which (II. xxxvii.) do not answer to the essence of any particular thing: which must therefore be conceived without any relation to time, under a certain form of eternity.”

²⁸ For example, see Wolfhart Pannenberg who concludes his study of Jesus: “. . . the predestination of all things toward Jesus, their eschatological summation through Jesus, is identical with their creation through Jesus. Every creature receives through him as the eschatological judge its ultimate illumination, its ultimate place, its ultimate definition in the context of the whole creation. The essence of all events and figures is to be ultimately defined in the light of him because their essence is decided on the basis of their orientation to him” (*Jesus, God and Man*, trans. L. L. Wilkins and D. A. Priebe [Philadelphia: Westminster Press, 1968], p. 391).

manifestation of the bond between man and the sacred."²⁹ By locating Ricoeur's statement within meso-level analyses, we can ask him to explain how he conceives of entities "below" and "above" religious language. If symbolic processing is a neural event mediated by brain structures, how does neuroscience discourse (with its vast descriptive power) impinge upon Ricoeur's notion of symbolism and the sacred? Going in the other direction, "up," to macro-level entities, such as groups and organized cultures, we can ask what discoveries about group behavior and adaptive advantages would cause us to re-evaluate Ricoeur's notion of the sacred as hierophany.

By providing a seating chart for scholars spread throughout the university, we bring together colleagues who would not otherwise interact with one another. From this interaction and the mutual learning that will take place, we hope to help advance the conversation on religion and science.

²⁹ *The Symbolism of Evil*. Boston: Beacon Press, 1969, pp. 353, 356.