INTRODUCTION

This part of the volume consists of “case studies” that explore the complex interface between theological developments in the sciences and critical religious reflection (especially Western theological traditions). A summary for the nonspecialist of significant contemporary developments in a given field is always included in the first essay of each case study, and a constructive philosophical or theological argument is always advanced in the second.

Beyond this basic similarity, there is wide variation in approach among the case studies. The interaction involved in a case study may be one-way or two-way. The scientific material may be illustrative of a theological theme, it may furnish a key analogy for systematic reflection, or it may be evidential support for a theological belief. The critical-religious reflection may be broadly relevant to religious traditions, or it may be focused on a single tradition (usually Christian theology). The authors may claim that the science has implications that call for large-scale theological revision in theology, or they may issue a critique of reductionism in science where it is believed to foster inadequate interpretations. Finally, in some cases the authors worked together, and in other cases one author responded to the other.

A fuller description of each case study is provided below. However, before plunging into details, a few remarks on noteworthy features of these case studies as a group are in order.

First, these case studies show diversity in the ways that current theology interacts with science and the wider intellectual culture, reflecting the pluri-form nature of theology today. Some of these essays are more historical, others more phenomenological, and still others more representational in their emphases. Even so, it is clear that six case studies could not possibly exhaust all of the constructive possibilities.

Second, by appropriating current scientific understanding of the natural world, the theological essays represent something new in theology today. Major change in our understanding of self and world puts revisionary pressure on theology no less than on other areas of intellectual culture, and the pace of change in the twentieth century has been staggering. These theological essays are usually new, sometimes tentative, attempts to articulate classical religious beliefs (especially but not exclusively of the...
Christian tradition) in the contemporary setting, and in relation to developments in some of the sciences.

Third, these essays in varying degrees are sensitive to the philosophical and methodological issues discussed in Part II. Consequently, they exemplify a new openness in the relationship between contemporary science and theology that is far more conducive to constructive dialogue than could have been expected during the first half of this century. Behind this shift toward greater amicability lies a more unified understanding of the relationship between empirical evidence about the physical universe and theological belief. In theological terms, these essays express a tendency to collapse the "two-books" model of theological knowing (that is, the biblical book of special revelation and the universal book of nature) into a single authoritative tradition with many strands of input. Emphasis is placed on achieving intelligibility in the relations between theology and knowledge from all domains of human experience.

Finally, the case studies have been conducted according to a wide range of methodologies. In the first, second, and fifth case studies, the science essay was written first, after which a philosopher or theologian responded with a constructive contribution, interacting with the specific arguments of the scientific essay to greater or lesser degrees. In the first case study, two scientist-theologians with a long history of interaction with each other's thought produced the essays, whereas the second and fifth case studies bring together thinkers with no prior history of interaction. The third case study has three essays rather than two, each of which deals with the complex issue of quantum complementarity, one primarily from the point of view of a philosopher of science, another from the perspective of a scientist-theologian writing team, and a third from the position of a theologian-philosopher. Each of the contributors was already familiar with the previous work of the others, but the papers were written in the order reproduced here. In the fourth case study, two scientist-philosopher-theologians already familiar with each other's thought advance competing theological interpretations of Jesus Christ. In this case, a draft of the second essay was made available to the first contributor so that he could direct the case study in the direction of a debate. The sixth case study was based on an unusual model of cooperation and interaction, with both essays emerging during an extended period of discussion and mutual criticism, as the postscript to the case study indicates. This range of methods is interesting in itself, not least because it offers the attentive reader an opportunity partially to evaluate the value of the methodological positions delineated in Part II of this volume.

CASE STUDY I: COSMOLOGY AND CREATION

William R. Stoeger, SJ opens this study with an introduction to some of the profound changes in scientific cosmology in the last century. Stoeger notes that our most recent scientific pictures of the early universe (variations on the Big Bang model) give
meaning to the idea of a “totality”: everything in the physical universe derives from a common evolution from simple materials and laws.

One of the chief foci of his essay is the Hartle-Hawking quantum cosmology theory that the universe is finite but has no beginning. This initially very puzzling idea plays a central role in Robert John Russell’s theological essay on creation.

Russell has two basic intentions in his essay. The first is to show how a theology of creation can find a path between independence from, and over-identification with, science. To achieve this, he tries to identify what “theological data” might be, and discusses the relation of such data to theological core hypotheses by means of a network of interacting beliefs. This understanding of theological reflection clarifies the function of scientific information in the theological context. Moreover, it gives theology a way to discriminate in more rational, less arbitrary, fashion among competing theological views.

Second, Russell illustrates the above by showing how one might relate the theological notion of creation as “ontological origination” to the Hartle-Hawking conception of “a finite universe with no beginning.” In a discussion of fundamental features of both the theology of creation and scientific cosmology, Russell shows how one of theology’s central concepts (namely, finitude) is informed and constrained by the Hartle-Hawking model. Russell is careful to point out that this process of informing and constraining of theology by science does not impugn the integrity of theology; its subject matter and tasks are distinctive and mark out theology as a discipline with independent standing among the various types of intellectual activity.

CASE STUDY II: CHAOS THEORY AND DIVINE ACTION

Karl Young introduces chaos theory, tracing the history of its development. According to Young, chaotic systems, based in classical mechanics, have two principal features: they are deterministic (the system functions according to rigid, deterministic laws, so that any state of the system is traceable to precise initial conditions), and they are nonlinear (the sum of two states of the system at times 1 and 2 is not generally the state of the system at time 1 + 2). Since chaotic systems are deterministic and explicable without any reference to a designer, Young doubts the weighty theological significance that some have placed on them. However, he does ask whether there might be a modest epistemological insight for theologians: Does the intrinsic unknowability of outcomes in chaotic processes indicate a potentially uncrassible line between human knowledge and (divine) omniscience? Young closes with a brief discussion of recent attempts to integrate quantum mechanics and chaos theory.

In his theological response, John Polkinghorne offers a bold interpretation of divine action in light of chaos theory. He brings to the theological task a distinguished background as a particle physicist, and a more recently developed interest in chaos. Leaning on the realist’s dictum that “what we can or cannot know is a reliable guide to
what is actually the case," Polkinghorne asserts that limits on human knowledge in the spheres of quantum mechanics and chaotic systems are evidence for genuine openness in nature. As a way of accounting for and responding to this openness, Polkinghorne defends a metaphysics guided by Christian faith but true to scientific insights about the world. In this respect, Polkinghorne turns the position of Young on its head, denying the assertion that chaos in nature presupposes metaphysical determinism, and making this the critical point for his theology.

The most controversial element of Polkinghorne’s theological proposal is that God acts in particular, law-conforming ways in the natural world by means of the input of active information. Such information cannot in principle show up in experimentation, though it may be grasped by faith, and may count in one’s interpretation of natural events and processes. Note that he does not say that the epistemic openness of chaotic systems proves that God has a place within creation to act in conformity with natural laws, and that God does in fact do so; rather, Polkinghorne’s claim is that nature is such that it is intelligible to believe God acts within it to effect particular outcomes, and he then goes on to confess that he personally believes this is the case.

Polkinghorne’s attempt to demystify the “causal joint” (the elusive nexus of divine interaction with the world) has captured the attention—both supportive and critical—of a number of theologians. Those who support his view appreciate two of its consequences: illumination of law-conforming divine action, and insight into the basis in nature of human freedom. Those who are most sharply critical interpret the move from epistemic limits on human knowledge to affirmation of openness in nature as a dramatic mistake, holding instead that chaos in nature supports (without finally proving) the thesis of metaphysical determinism, rather than that of metaphysical openness.

CASE STUDY III: QUANTUM COMPLEMENTARITY AND CHRISTOLOGY

Whereas the first two case studies dealt with the somewhat general Western religious themes of divine creation and divine action, the third focuses on a specific doctrine of Christian theology, namely, that Jesus Christ is truly human and truly divine. This doctrine, called the incarnation, is widely believed among Christians, though Christian theologians debate whether incarnation is intelligible and, if so, whether the person and work of Jesus Christ is unique in such a way as to signify absolute ontological status. While the unique applicability of incarnation to Jesus Christ is not debated in this case study, the question of the intelligibility of the Christological concept of being "truly divine and truly human" is treated in great detail.

Ever since quantum complementarity was discovered, advocates of the incarnation have tried to exploit wave-particle duality as an analogy for divine-human "duality." At the level of linguistic trope, likening the incarnation to quantum complementarity illuminates neither; the analogy has no obvious metaphysical implications, and is merely suggestive in a vague way. Unfortunately, appeals to complementarity as a way to
understand incarnation are often nothing more than uninteresting restatements of this analogy. This case study is set apart from these superficial attempts to connect quantum complementarity and incarnation by its attempt to discern a common metaphysical thread in both, one intimately linked with paradox. At this level of discussion, arguments for the intelligibility of the incarnation by means of an appeal to quantum complementarity and paradox in nature are serious, if difficult, instances of the interaction between theology and the natural sciences.

Edward MacKinnon begins the case study by exploring philosophical implications of Niels Bohr's interpretation of quantum mechanics. He places Bohr's concept of complementarity within the larger history of apparent contradictions in philosophy, drawing attention to the fact that reality cannot be conceived within the limits of our ordinary language and its network of concepts and meanings. The epistemic structure of complementarity in quantum physics—the application of concepts from mutually exclusive frameworks in order to understand different aspects of one reality—is one more instance of our inability to describe realities that are unique or otherwise outside the range of the conventional applications of our concepts. The typical example in quantum physics is wave-particle duality: genuinely contradictory assertions cannot simultaneously be true (that would be irrationalism), but the assertions that "electron is a particle" and "electron is a wave" are not contradictions but contraries, and jointly offer important insights into a reality too complex for the categories of ordinary language.

MacKinnon's thesis that ordinary language plays an indispensable role in our descriptions of reality is crucial. He argues that the language of classical physics is a specialized form of ordinary language which must be employed in understanding the quantum domain. For it to be used coherently toward this end, one must "develop incompatible extensions that play a complementary role in describing reality." MacKinnon's interpretation of complementarity is that it expresses epistemic limits, but in a helpfully precise, and not an irrational, way.

This raises the question of whether there is insight to be gained from juxtaposing Bohr's complementarity with the sometimes paradoxical formulations of religious reflection. James E. Loder and the late W. Jim Neidhardt coauthored an essay on this topic, with an eye especially toward the famous paradox of classical Christian theology that Jesus Christ is truly divine and truly human. Their task is a bold one, first, because the material is intrinsically complex (Christology, quantum physics, and dialectical logic applied to our thought about them); and, second, because the spotty history of attempts to theologize about complementarity does not immediately warm the informed reader to their project.

Without loss of clarity, however, the Loder-Neidhardt essay sets exacting standards for making epistemic comparisons between physics and theology, and is able, because of this focus, to throw light on the material: the relation between Christian faith and understanding, and its object. The nature of Christ, they claim, is beyond the reach of human reason and experience, so the theologian is led into conceptual paradox in
describing him. However, the paradox embedded in the classical formulation of "truly divine, truly human" does not indicate irrationality; instead, much like the way complementarity functions in physics, it points to a higher order, unified reality.

Thus, the dialectical logic needed to explain classical formulations of Jesus Christ's form of being is far from being an oddity called for by an obscure theological formula. Rather, it is present in many different thinkers and fields: it appears not only in Bohr's thought, but also in the thought of theologian Karl Barth, as well as in the writings of philosopher-theologian Søren Kierkegaard, who inspired both Bohr and Barth. The breadth of presence of this kind of thinking suggests both that reality really does require dialectical descriptions of this kind, and that theology and metaphysics may have much to offer the theoretical imagination of scientists.

Christopher B. Kaiser is a pioneer in constructive efforts to integrate insights from physics and theology in this area. Kaiser crisply states the fundamental issues covered in the two preceding essays, showing points of agreement and disagreement between them, and revealing an alliance with the Loder-Neidhardt perspective where it differs from MacKinnon's view. In the last section of his paper, Kaiser focuses on four issues that he thinks require further attention: (1) expanding on the thesis of theological impact on the scientific quest for explanation; (2) determining more exactly the conditions in human experience under which dialectical or bipolar reasoning arises; (3) reflecting on theological implications of the relation in science between measuring instruments and quantum objects; and (4) exploring the meaning of "asymmetry" in bipolar epistemic structures, as described in the Loder-Neidhardt essay.

CASE STUDY IV: INFORMATION THEORY AND REVELATION

The fourth case study continues the focus of the third case study on the specifically Christian doctrines of Jesus Christ (Christology). Whereas the focus in the last essay was on the intelligibility of the concept of incarnation as "truly divine and truly human," the focus here is on revelation in Jesus Christ; the sense in which God can be thought to be present in, and to communicate through, the human person Jesus. The issue of how information is processed in biological systems is directly relevant to such questions, and this relevance is exploited in a number of recent works in Christian theology, including especially the writings of Arthur Peacocke and John Polkinghorne.

Though not in itself properly described as a science, information theory is a widely used mathematical-philosophical tool in many sciences today. Thus, this case study represents a three-way dialogue among religious reflection (on revelation and Christology), a natural science (biology), and a tool proving itself useful in many sciences, including biology (information theory). Scientists sometimes voice the objection that information theory ought not be applied beyond its original domain of applicability (primarily the biological sciences). Yet there seems to be nothing in prin-
ciple blocking the attempt to use information theory to ensure that discussions about such topics as revelation are intelligible and plausible. That is the way information theory is used in the essays of this case study.

John C. Puddefoot presents an overview of the salient features of information theory. Information is divisible into three kinds, according to this theory: counting information, meaning information, and shaping information. Roughly speaking, the theory is about the ways in which the input of data into a natural system can affect the organization and behavior of that system by virtue of patterns of significance the receiving system finds in the data.

Puddefoot draws attention to the kinship between information theory and systems theory, as they are both based on the principle that “nothing is self-interpreting because meaning is distributed over systems.” Information theory brings a nonreductive accent to disciplines such as biology by its insistence that the functions of genes and cells can be understood only in relation to each other.

Information theory, states Puddefoot, also sheds light on nature’s dynamism, openness, and plasticity: a system must be flexible if it is to embody new information, and adapt to data that has not yet become intelligible or usable to it. He also discusses what is called the “K” factor, which is employed in formalizing the relationship between new information important for a system’s organization, and entropy.

On the basis of his introduction to information theory, Puddefoot briefly gives an account of Jesus as fully human and as “Word” of God. This sets up a stimulating interaction with the next essay, by Arthur Peacocke, who closely follows Puddefoot’s perspective on information theory but offers a different interpretation of its significance for christology. Peacocke sees revelation as divine “informing” of the natural world, and asserts that this happens most fully in Jesus Christ. He finds this outlook intelligible within the present scientific worldview. What and how God reveals in Christ is continuous with what we find in the world in general; yet it also is an emergent new expression of divine being and becoming.

Peacocke feels compelled to revise those aspects of classical christology which stress Christ’s preexistence, his “two natures,” or any articulation of the self-communication of God in Christ which interprets it as an event different in kind from what God is doing generally in the world (and herein lies Puddefoot’s opposition). He prefers, instead, to think of Jesus as the fullest expression of a human potential that we share. Jesus Christ is not represented in the gospels as “a unique invasion of the personhood of an individual human being by an utterly transcendent God; but rather as the distinctive manifestation of a possibility always inherently there for human beings.”

One important question to be asked in the wake of this debate is whether one of these christological interpretations is more consonant with the insights of information theory. Put differently, and more sharply: Is information theory sufficiently specific to select between competing theological visions of Jesus Christ, or must such decisions be settled on other grounds?
CASE STUDY V: MOLECULAR BIOLOGY AND HUMAN FREEDOM

With Case Studies Five and Six, the themes being treated are once again more generally relevant to Western religious traditions, though the Christian context is at times still used for the sake of concreteness. The fifth case study is concerned with the relation between molecular biology, with its vague suggestions of determinism, and religious reflection, which finds the notion of human freedom indispensable.

Individually and in their interaction, the two essayists urge that the human experience of freedom can neither be understood in isolation from molecular biology, nor adequately explained solely at the level of molecular biology. As in other case studies, we see here the importance of respecting the integrity and independence of the various natural sciences in their diverse relations to one another: we may readily acknowledge the validity of causal reductionism (for instance, neurophysiology is the causal basis for mental activity) without slipping into the much more aggressive position of ontological reductionism (for instance, explaining mental activity demands no new ontological categories beyond those already explicit in neurophysiology).

R. David Cole introduces three general features of the biology of the human organism: cell adaptation, cellular structures and functions, and plasticity in neurobiology. The common characteristic in each of these areas is that genetic information predetermines a range of possibilities, but actual expressions in each case are dependent on a plurality of factors within and external to the organism. Cole then reflects on the possible significance of this for our understanding of human freedom. He concludes that there is legitimacy to the idea of human free will, but that we must more clearly understand it within the limits of the human genetic constitution.

W. Mark Richardson attempts to show that the implications of scientific data of the kind Cole introduces can be made intelligible in the context of a theological understanding of “free will” only after it is interpreted within a mediating philosophical-theoretical framework. Richardson attempts to show the congeniality between what he calls theology’s commitment to “commonsense psychology” and an emergent theory of mind-brain, on the one hand, and between emergence and Cole’s account of neurobiology, on the other. In this way, biological insights can be employed both to sharpen our concept of free will, and to specify the nature of the limits on finite human freedom. Richardson also asserts that some current alternatives to emergent theories of mind, in particular eliminative materialism, cannot simultaneously satisfy the conditions set by the theology of free will and by neurobiology. He concludes with illustrations of ways that an emergent theory of mind informed by contemporary neuroscience might illuminate certain aspects of theological anthropology.

CASE STUDY VI: SOCIAL GENETICS AND RELIGIOUS ETHICS

The final case study is the only one of the six to draw the social sciences into dialogue
with critical religious reflection. Sociobiology and evolutionary science together form the basis for a powerful explanation of the emergence of religious and ethical structures within societies, one that appears to offer an alternative to traditional religious self-understandings. Making a positive religious assessment of religion and ethics cannot casually ignore the existence of such a powerful explanation, but must take full account of it. This case study, the unusual cooperative procedure for which is described in its conclusion, presents both a sociobiological explanation of the origin and continuance of religious and ethical social structures, and a bold attempt to achieve a synthesis between this explanation and a positive religious assessment of those structures.

William Irons applies an evolutionary model to the understanding of human morality, based on the premise that human beings are “bundles of inclusive fitness maximizing mechanisms shaped by a history of natural selection.” This sociobiological anthropology has advanced in recent years with the aid of game theory. Irons views his proposal as superior to E.O. Wilson’s theory, as it explains cooperative behavior among individuals in non-kin situations, invoking sociocultural and not just individual survival criteria to do so. Nevertheless, the theory still shows the utility of certain social, non-kin cooperative behaviors according to the criterion of the survivability of individual genes. In this respect it does indeed build upon earlier sociobiological theory.

In an interpretive move strongly reminiscent of Durkheim’s theory of religion, Irons holds that religion, in evolutionary-based morality, stabilizes and deepens, through symbol and ritual, the biological, cultural, and environmental forces that shape group behavior. Irons finds this basis for morality and religion preferable to a traditional theological basis in one crucial respect: the account of sociobiological anthropology can be evaluated on evidence, whereas traditional theological construals of morality and religion rest on incontestable “truth” claims which are immune from correction and verification.

Philip Hefner offers an intriguing theological response which he believes can take seriously the sociobiological model of Irons, yet go beyond it as an explanation of morality. One of the most important of Hefner’s arguments involves a rejection of Irons’s claim about the difference between religious and evolutionary bases of morality. Hefner insists that an understanding of the human person based on the evolutionary principle of natural selection is a regulative principle, in something like the Kantian sense, and thus has a theoretical function equivalent to the function of “God” in theological systems. Each operates as an axiomatic core for the building of theory and testing of data. Thus, Hefner believes that Iron’s reasons for preferring an anthropological over a theological foundation for morality and religion are based on an unarticulated prejudice. Each is grounded in a metaphysical vision of the world and of human beings within it.

Hefner concludes that the Christian theological model is a more inclusive one for explaining cooperative and self-giving behaviors, for it is based on the largest possible construal of what nature is. However, utilizing a hierarchical perspective of scientific
disciplines created by E.O. Wilson, Hefner argues that the Christian theological basis for morality does not cancel, but builds upon, the insights of evolutionary theory, allowing the latter to constrain the theological model, even though, ultimately, more can be explained on the theological basis. Hefner reinforces this last claim by citing the kinds of human behavior for which he believes his theory can account, but that Iron's theory cannot. At the conclusion of this case study, we have included a short paper, jointly written by Irons and Hefner, reflecting on the process they developed for interacting on this case study. We believe their work bears out the fruitfulness of process and we hope the readers will also find it useful.