

Belief in God in an Age of Science

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Introduction

I wave my hand. Can my mind move matter, or am I merely atoms in motion? I clench my fist. Am I a free agent, who could have done otherwise, or do I merely transmit the push of the past? I prick my finger. Are my subjective experiences real, or are the *painfulness* of pain and the *redness* of red merely characters in stories I tell myself about myself? I lie awake in the dark. Why should there be something rather than nothing? Not simply the empty vacuum of space, but not even space, and no vacuum?

The monotheistic worldviews of the Abrahamic religions (Judaism, Christianity, Islam) respond positively to such metaphysical questions, affirming agency, subjectivity, and purpose for finite minds whose nature reflects the infinite mind of God, the creator of the universe. Their emphasis on the rationality and contingency of the world nurtured the birth of modern science. Yet, today, they are challenged by the belief that science is the *only* legitimate way to understand the world.

In this seminar, we will explore a relationship between science and religion that goes beyond conflict to dialogue, interaction, and consonance, in [the work](#) of such scientists and theologians as Ian Barbour, Arthur Peacocke, John Polkinghorne, Bob Russell, John Haught, and Keith Ward, for whom belief in God is a rational option that complements rather than opposes the scientific quest to understand the world.

We will be especially interested in the implications for the nature of reality, including: Is consciousness an epiphenomenon of brains, like foam on a wave, or is it a defining feature of the world? Are the laws of physics a closed causal web, or is there sufficient freedom to allow agency, both human and divine? Is an evolving, law-abiding universe God's way of creating life and mind, including subjective agents of otherwise unobtainable value?

Outline

An ordinary place in the universe is the near vacuum of interstellar space, one atom per cubic meter, three degrees above absolute zero. But you and I are extraordinary places. In us, the universe becomes conscious, self-reflects, and comes to know itself in uniquely human terms.

In that spirit, we will examine scientific and religious efforts to understand the nature of reality. We will be especially interested in attempts by [some scientists and theologians](#) to create a unified worldview incorporating both science and theism, two enormously influential strands of Western civilization.

Prologue: Science & Religion

Does science demand atheism, or does physics *underdetermine* metaphysics? Is nature enough, or is any nonpoetic account of reality incomplete? Must science and religion necessarily conflict? Can they be independent? Or is dialogue or even integration possible? Can theism withstand the challenges of materialism, reductionism, and scientism? Or does engaging in science already entail a muted but still present theistic worldview? Indeed, can theism confirm science?

1. Cosmology: Was the Universe Created?

Why is there something rather than nothing? What came before the Big Bang? Is the universe finely tuned or self-selected from a multiverse? Did God breathe fire into the equations of physics? Either nothing exists, or everything exists, or what decides what exists and what does not? And anyway, isn't it overwhelmingly likely that our universe is a [Matrix](#)-like virtual reality?

2. Complexity: Did Life & Mind Evolve?

Does God create things that create themselves? Are we created co-creators? Is evolution the way God does it? Is the design in the laws, not the products? Does God withdraw kenotically to admit novelty?

into the universe? If mind saw through complexity to underlying simplicity, would mind be impossible?

3. Subjectivity: Can Physics Generate Experience?

Is consciousness an epiphenomenon of brains, like foam on a wave? Or is it a defining feature of the universe? Does mind reflect Mind? Is physics information "from the outside" and qualia (subjective experience) information "from the inside"? Are generalized persons (AI and ETI) possible? If they practiced anything like religion, would we want to abandon ours for theirs?

4. Agency: Does God Violate the Laws of Physics?

Do we consciously cause our actions, or do they just happen to us? Are the laws of physics a closed causal web, or is there sufficient freedom to allow agency, both human and divine? Are layered explanations sufficient or is downward causation necessary? Does God violate the laws of physics or work seamlessly within nature (via the indeterminacies of quantum physics or the extreme sensitivity of chaos)? Does a law-like universe reflect the faithfulness of God?

5: Teleology: Does the Universe Have a Purpose?

Are we merely flotsam and jetsam? Or, in some sense, are life and mind what the universe is about? Does moral agency require a history of free choices? For soul-making and science, must the world be as if God does not exist? Is God necessarily at an epistemic distance?

Blog

2007 August 22 (Wednesday) 7:30 PM

At our introductory meeting tonight, I distributed math placement and writing tutorial information. The numbers in red ink are your online registration times for Friday. Everyone signed-up for a half-hour advising slot Friday. I then emailed everyone the list as a reminder and posted it outside my

door. In addition to the placement exams Thursday, I encourage everyone to attend one or more of the Departmental Information sessions between 4 and 5:30 PM. I briefly introduced our primary, secondary, and tertiary texts:

1. John F. Haught, *Science & Religion: From Conflict to Conversation* (Paulist Press, 1995).
2. Ian G. Barbour, *When Science Meets Religion: Enemies, Strangers, or Partners?* (Harper San Francisco, 2000).
3. John Polkinghorne, *Science & Theology: An Introduction* (Fortress Press, 1998).

These should be available in the bookstore or you can purchase them online at the usual places. Tomorrow we will meet, off the record and just for fun, to discuss *The Riverkeepers*.

2007 August 28 (Tuesday) 9:30 AM

Our First-Year Seminar is about **science** and **religion** and the **nature of reality**. In our preliminary discussion this morning, we characterized science with words like dispassionate facts, proven hypotheses, measurements, and by scientists like Bacon, Newton, Darwin, Einstein, and Compton. We characterized religion by words like faith, community, tradition, good will, helping people. Science was precise where religion was imprecise. Science was impersonal and public where religion was personal and private. But both science and religion search for higher truths, and both have creation stories.

We next discussed faith, which is sometimes opposed to reason. We characterized faith variously as believing without having complete evidence, of trusting when you don't know for sure, as a leap in the dark, as analogous to commitment in marital love. We noted that while the religious may have faith in God, scientists have faith in the laws of physics and in electrons and quarks, which cannot be directly observed.

We discussed possible pitfalls of faith. Few people are willing to have faith in ideas that are demonstrably wrong, inconsistent, or incoherent. We considered how people with faith can fly planes into tall buildings, as in physicist **Steven Weinberg's** observation that "Good people will do good and bad people will do bad, with or without God. But for good people to do evil, that requires religion." We recognized that the human response to God may be fallible. We also discussed physicist **Richard Feynman's** remark, "I'd rather live without knowing than have answers that might be wrong", and we noted that individuals need to make their own decisions about whether or not to continue searching for answers that might prove elusive. However, we argued that testing or questioning one's faith can be healthy and can deepen it rather than destroy it.

After the break, we reviewed the course syllabus, which is this web site. We then discussed a surprising limit to reason. Twentieth century mathematician **Kurt Gödel** proved that all sufficiently complex logical systems contain statements they can neither prove or disprove. There exist **logically undecidable** propositions. Gödel's paradox stems from curious statements involving self reference, like the **Epimenides paradox**, "This statement is false", which is false if it's true, and vice versa.

We discussed a parable, from Paul Davies' *The Mind of God*, about a kingdom that built a fantastic machine, called Tom, designed to correctly answer any yes-no question. So confident was the kingdom that the king offered a great prize for anyone who could stump Tom. One day, a traveler from a distant land arrived with an envelope, and she asked Tom if the statement it contained was true. Tom promptly and spectacularly malfunctioned. The Epimenides-like sentence inside, "Tom cannot prove this statement true", was indeed true, but Tom could not consistently claim that it was true!

According to some commentators, Gödel's theorem demonstrates that reason alone will never be able to answer certain seemingly profound boundary

questions like "Why should there be something rather than nothing?" And this may open the door for some kind of religious commitment to one answer or another.

2007 August 30 (Thursday) 9:30 AM

We began by contrasting Western and Eastern religious traditions. In the monotheism of the **Abrahamic religions**, ultimate reality is personal, and these God-religions offer the possibility of an **I-thou** relationship with the universe. However, many Eastern religions are non-theistic and offer impersonal views of ultimate reality. In **Buddhism**, the self is said to be an illusion to be extinguished in the ultimate enlightenment of **nirvana**, the freedom from all worldly concerns that breaks the otherwise endless cycle of reincarnation.

Which is more scientific? On the one hand, some spiritually-inclined scientists are drawn to the non-theistic Eastern religions because they find the idea of a personal God **incredible** (not believable). Furthermore, the Buddhist idea that the self is an illusion is consistent with the **reductionist** picture of persons being merely atoms in motion. On the other hand, modern science emerged in the context of the theistic idea that reality was a **rational but contingent** creation of God. According to [CTNS](#) director **Bob Russell**, Buddhists sometimes tell him "Even when we talk just about the Big Bang as Buddhists, we are already engaging with a Judeo-Christian conception of the world."

So is ultimate reality personal or non-personal? Physicist **Niels Bohr**, one of the founders of **quantum mechanics**, maintained that while the opposite of a simple truth is a falsehood, the opposite of a profound truth is another profound truth. Bohr was thinking of his **principle of complementarity**, wherein waves and particles were complementary descriptions of elementary particles. If an electron can exhibit, in different contexts, both wave properties and particle properties, perhaps ultimate

reality can be understood differently as both personal and non-personal.

We noted a spate of recent best-selling anti-religion books and considered Steven Weinberg's remark that the world must awake from "the long nightmare of religion". Vocal atheism is reacting in part to religious fundamentalism, from suicide bombers to young-Earth creationists. Defenders of religion respond that many of the greatest atrocities of the twentieth century were **secular** genocides. Extreme views on either side are a challenge for those interested in dialogue between science and religion.

We observed that theologians attempt a middle ground between saying nothing about ultimate issues, on the one hand, and being over-specific (and probably wrong), on the other hand. The famous phrase from the Christian New Testament, "For now we see through a glass, darkly" (1 Cor 13:12 KJV), describes our imperfect perception of reality.

We began discussing John Haught's *Science & Religion*. In Chapter 1, **Is religion opposed to science?**, Haught proposes four different ways to relate science and religion: **conflict**, **contrast**, **contact**, and **confirmation**. Under **conflict**, some skeptical scientists reject religion because its teachings, such as the existence of God, are **unfalsifiable**, and hence unscientific. Some religious fundamentalists reject science, in areas of creation, evolution, and miracles, because it conflicts with a literal reading of the **Torah** or **Bible** or **Qur'an**.

Under **contrast**, science and religion are independent, autonomous ways of knowing. They are as incomparable as a chess move is to a baseball play. In his confrontation with the Roman Catholic Church, the great Italian scientist **Galileo Galilei** expressed the contrast approach as, "The Bible tells us how to go to heaven, not how heaven goes" (where the latter phrase alludes to his astronomical discoveries involving Sun, Earth, satellites, and planets). Similarly, paleontologist **Stephen Jay Gould** described the domains of science and religion as non-overlapping magisteria.

2007 September 4 (Tuesday) 9:30 AM

We continued discussing Haught's four-fold typology of ways to relate science and religion. The contrasters carefully distinguish between **science**, a powerful but neutral way of knowing, and **scientism**, the belief that science is the **only** reliable guide to truth. They warn of **conflating** (or blending) science with Biblical literalism (to form "creation science"), on the one hand, and with scientism, on the other hand.

Under **contact**, the goal is dialogue without conflation or segregation. The contacters note that religion and science have both influenced each other. For example, the Abrahamic religions' emphasis on the rationality and contingency of the world provided a fertile environment for the birth of modern science in the sixteenth and seventeenth centuries, on the one hand, while the discovery by science in the twentieth century of the immense age and size of the universe has caused many contemporary theologians to reimagine God, on the other hand.

The contacters interpret science and religion through the lens of **critical realism**, in which there are no "raw" uninterpreted facts, as some social construction of ideas is always necessary, but nevertheless both approximate something real. Physicists don't directly experience electrons, and theologians don't directly perceive God, but both uncover elements of a partially hidden but nevertheless objective reality.

Under **confirmation**, religion actually nurtures the scientific quest. Science tacitly assumes that the real world is rational, coherent, and intelligible. We don't seem to inhabit a capricious or magical universe where nature is unreliable and unfathomable. Religion confirms this fundamental trust, as the regularity of nature reflects the faithfulness of God.

We next began discussing Haught's Chapter 2, **Does science rule out a personal God?** The scientific skeptics present the **conflict** approach, alluding to Steven Weinberg's (in)famous statement,

"The more the universe seems comprehensible, the more it also seems pointless." As science chips away at the unknown, there is less and less mystery for God to explain. In the end, the universe does not need to be grounded in an interested, personal God for life and mind to arise.

The conflictors also discuss physicist **Albert Einstein**, who wrote "Science without religion is lame; religion without science is blind." They note that while Einstein was committed to ethical values and had an "unbounded admiration for the structure of the world", he did not believe in a personal God. Rather, he was inclined to equate God with the laws of physics.

The **contrasters** object that physics does **not** put us in touch with fundamental reality. They note that since physics methodologically excludes the personal, it is not surprising that it does not find evidence of a personal God. The equations of physics are not suitable for expressing love.

The contrasters further object to **scientific materialism** or **reductionism**, the idea that **all** of reality is reducible to lifeless matter. While scientists should seek natural explanations for natural phenomena, this **methodological** naturalism should not become the **metaphysical** naturalism of scientism, in which nature is all there is. The absence of evidence (of God in science) is not the evidence of absence.

The contrasters bemoan the historical deprecation of "secondary" qualities with respect to "primary" qualities. The latter are public, measurable, objective, and include the mathematical abstractions of physics. They contain no trace of God. The former are private, unmeasurable, subjective. They make the world "colorful" and personal. With physicist **John Barrow**, the contrasters maintain that "No non-poetic account of reality can be complete."

2007 September 6 (Thursday) 9:30 AM

We continued discussing Haught's Chapter 2. The contrasters complete their argument by noting that

most encounters with God are not through scientific observation or mathematical proof but are in the context of a community of faith and the wisdom of a tradition. Such encounters are responses to God's self-revelation. Their subjective nature may infuriate scientific skeptics, but the claims of scientism themselves are untestable. Demanding proof of God is like asking your spouse to scientifically demonstrate his or her love for you.

The **contactors** argue that theology must take into account important scientific discoveries of the universe, because physics places constraints on what may be plausibly said about God. Theology risks irrelevancy unless God-talk is intelligible to contemporary audiences who have heard of the Big Bang, evolution, relativity, quantum mechanics, and chaos theory. Can we continue to get by with an **anthropomorphic** one-planet deity overseeing a three-tiered cosmos with Earth sandwiched between heaven and hell?

This prompted a discussion of the possibility of life and mind arising on other planets about other stars. We might not be the only flower in God's garden. Instead, somewhere a Michelangelo of a species of intelligent dinosaurs may represent God in a ceiling fresco as a T-rex rather than as a man with a white beard.

In addition, the contactors argue that modern science is more conducive to the idea of an interested, personal God than the classical physics of a clockwork solar system. Astronomy's **Big Bang** seems, at least superficially, like a creation event. Both relativity and quantum mechanics appear to elevate the importance of observers. Quantum probabilities and indeterminacies may allow room for agency, both human and divine. And even evolution, the bane of biblical literalists, may provide an elegant mode for God's continual creation.

Finally, the **confirmers** affirm again that religion can justify science's basic trust in the rationality and intelligibility of the world. What science assumes without proof, the faithfulness of God guarantees.

Following the break, I presented a brief biographical sketch of **Ian Barbour**. After obtaining a Ph.D. in physics from the University of Chicago, Barbour obtained a B.D. from the Yale Divinity School. He then taught physics and religion for many years at Carleton college. He has given the prestigious [Gifford Lectures](#) in Natural Theology and is the winner of the 1999 [Templeton prize](#). He is one of the most influential figures in science and religion today.

We next began discussing Barbour's *When Science Meets Religion*. In the preface, Barbour notes that science raises questions it cannot answer but which religion might clarify. He asks why did the Big Bang occur? How does quantum mechanics challenge our assumptions of reality? Is evolution God's way of creating? Can a person be simultaneously a biological organism and a responsible self? Can God act in a law-abiding world? These questions will resonate all through the book and throughout our seminar.

With respect to God's actions in nature's world, we briefly touched on the question of miracles. Is narrowly escaping death in an auto accident a miracle or luck? Can chance be interpreted positively as part of the openness with which God has gifted the universe? We will return to such questions.

Barbour's introduction notes that while belief in God among U.S. scientists has remained steady in the twentieth century, Americans are far more likely to reject evolution than Britons. This may reflect the fact that the U.S. is a younger country with puritanical roots. As we shall see, Barbour is a U.S. scientist who believes in God **and** evolution.

2007 September 11 (Tuesday) 9:30 AM

I briefed everyone on the [first writing assignment](#), which is due next Tuesday. After a short presentation from a representative of the [Writing Center](#), we continued discussing the introduction of Barbour.

Barbour's famous four-fold typology of relating science and religion includes **conflict**, **independence**, **dialogue**, and **integration**. The first two categories are individually similar to Haught's **conflict** and **contrast**, while the second two collectively include Haught's **contact** and **confirmation**. Such categories can be of organizational help, but not all approaches to science and religion will fit neatly into them.

Barbour focusses primarily on the Christian tradition, where reflection on science has been more extensive, both today and historically. However, his approach can be extended to other major world religions. In this regard, I referred to chapter 7 of John Polkinghorne's *Science & Theology*, which observes that religions encounter the sacred in dramatically different ways. Polkinghorne suggests that science can be a meeting point for dialogue among them. How, for example, do Buddhism, Hinduism, Christianity, and Islam react to the Big Bang?

We next began discussing Barbour's Chapter 1, **Four views of science and religion**. Barbour argues that two (in)famous historical cases of the "warfare" between science and religion are more complex than usually reported.

In the early 1600s, **Galileo Galilei** championed a sun-centered or heliocentric model of the solar system. This earned him the condemnation of the Catholic Church, which forced Galileo to recant and placed him under house arrest for the rest of his life. (In the mid 1700s, the Church formally rehabilitated Galileo, and in 1992 Pope John Paul II expressed regret at how his case was handled.)

However, it is important to note that Galileo himself was a very religious but argumentative man. On the one hand, he believed that the Book of Nature and the Book of Scripture both come from God and could not conflict. On the other hand, he overstated the scientific certainty he could provide for the Earth's motion about Sun. (In particular, he could not explain the lack of stellar aberration, and he was wrong that tides were sloshing due to

Earth's motion and not stretch due to lunar gravity.)

In 1859, **Charles Darwin** published *On the Origin of Species*, wherein he proposed that all species of life evolved from one or a few common ancestors through a process of random variation and **natural selection** over a very long period of time. For some conservative Christians, this was a disturbing challenge to biblical literalism, human dignity, and the argument for God's existence from design. For some atheists, it provided materialism with a welcome all-embracing explanation for life and mind.

However, then and now, the responses have been more diverse than these. In fact, some theologians welcome evolution as "the way God does it". For them, the idea that God designs the evolutionary process — but not the details of the individual organisms — is a more subtle and satisfying interpretation of creation. The design is in the laws not the products. God makes things make themselves.

Under **conflict**, Barbour argues that the popular image of warfare between science and religion is perpetuated by the media because it is more dramatic than other approaches. He highlights the writing of several outspoken naturalistic scientists, including Pulitzer-prize winning astronomer **Carl Sagan**.

We discussed Sagan's novel *Contact*, in which astronomers make contact with an advanced extraterrestrial species. When asked if they have *anything like* religious experiences, the extraterrestrials reply that they have discovered messages embedded deep in the infinite sequence of digits of the transcendental number π . Such messages could only have been placed there by the Creator of the universe, perhaps as a kind of Artist's Signature.

Elsewhere in the novel, characters argue that God could have planted messages in the Bible, such as the number of atoms in a grain of sand, that would only have been verified by future generations. Or God could place a giant neon sign in orbit about Earth proclaiming "I am God." While such evidence

might convince a scientific skeptic like Sagan, forcing belief would undermine the faith that is an essential ingredient of many religious traditions.

Barbour's response to the scientific skeptics is that they fail to distinguish between scientific and philosophical questions. Science is selective in what it studies, and so its picture of reality is incomplete. To illustrate, I told a parable due to astronomer **Arthur Eddington**. Imagine fishing using a net with 3-inch holes and, after many catches, concluding that there are no fish smaller than 3 inches. Our method of fishing determines what we catch!

2007 September 13 (Thursday) 9:30 AM

We began by discussing biblical literalism, which Barbour also classifies under conflict. Fundamentalists maintain that scripture is **inerrant** (incapable of error). We discussed several possible reasons to relax this view: written texts are fallible human responses to divine inspiration; they frequently use metaphors because of God's transcendence; along with much good, they often also contain ethically embarrassing passages. A more realistic position might be to take scripture seriously but not literally.

Creationists maintain that Earth was created suddenly just a few thousand years ago. Yet, **multiple** lines of scientific evidence, from physics, astronomy, biology, geology, and paleontology suggest that Earth and the visible universe have a long evolutionary history of at least several billion years. Could the universe be young and created with signs of great age? Yes, but the light from distant stars would have had to been created in flight. Indeed, the universe might even have been created yesterday, and you and I created with memories of our previous lives! This is not a fruitful hypothesis.

While some religious conservatives consider evolution to be an affront to human dignity, others find the scientific claim that humans and chimpanzees share a **common ancestor** about 6 million years ago

to be very implausible. By contrast, I related how impressed I was by the humanness of the pygmy chimps at the San Diego zoo. My brother and I look similar, but we are only one year apart; if we were six million years apart, we might look **very** different. Among dogs, Chihuahuas and Great Danes do look very different, and yet they diverged from a common wolf-like ancestor in just the few thousand years of recorded history.

Barbour's response to the biblical literalists is that they err in assuming that evolution and theism are incompatible. He believes that creation science is a threat to both science and religion. He contends that contemporary religious fundamentalism is fueled by a search for certainty in a time of rapid cultural change.

Barbour discusses diverse ways of relating science and religion under **independence**. Protestant **neo-orthodoxy** maintains that religious faith depends entirely on divine initiative and not on human discovery of the kind occurring in science. **Instrumentalism** claims that science and religion are human constructs, pragmatic, useful fictions, neither of which represent reality. On the contrary, Barbour is a **critical realist** who believes that both science and religion reflect ultimate reality, but indirectly. He argues that they cannot be totally unrelated, as they refer to the same world.

Dialogue emphasizes similarities where independence emphasizes differences. Barbour argues that the biblical doctrine of Creation set the stage for modern science. Both the ancient Greeks and the Bible asserted that world is orderly and intelligible. But the Greeks thought the order was necessary and so could be deduced from first principles. Only biblical thought held that Creation was rational but contingent, and so its details must be discovered by observation. Furthermore, in the biblical worldview, Creation is good but not divine, so that it is permissible to experiment with it.

Barbour also argues that science is not as objective nor religion as subjective as is generally assumed. Scientific data are **theory-laden**, and the theories

themselves arise from creative imagination using analogies and models. Religious data includes experience, rituals, and scriptures, while religious languages uses metaphors and models.

Under **integration**, Barbour discusses **William Paley's** 1802 *Natural Theology*, which attempts to infer the existence of God from evidence of design in nature. Paley argued that just as finding a watch, with its intricate and interdependent mechanisms, implies the existence of a watchmaker, so too the many intricacies of nature, such as the fit of a bee to a flower it pollinates, suggest the existence of a Creator. Paley's argument was undermined by Darwin's theory of evolution, as vigorously described by **Richard Dawkins'** 1986 *The Blind Watchmaker*.

Recently, the argument from design has made something of a comeback in the form of the **Anthropic Principle**, which suggests to some that the laws of physics are finely tuned for the evolution of life and mind. Physicist **Freeman Dyson** has famously remarked, "I do not feel like an alien in this universe". However, rather than natural theology, many contemporary theologians focus instead on developing a **theology of nature**, which attempts to interpret science in light of a religious tradition, such as understanding evolution as God's continual creation.

We considered whether the patriarchal features of the **Abrahamic religions** can be rejected without rejecting the traditions entirely. Theists wish to maintain that God is at least personal, and so are reluctant to refer to God as "It", but the traditional "He" seems inappropriate to some modern ears.

2007 September 18 (Tuesday) 9:30 AM

Before beginning our discussion of **astronomy and religion**, we reviewed the state of the universe as revealed by astronomy and summarized in my lecture notes on the [Big Bang](#) and the [Creation](#). Our goal here is to understand the mainstream

scientific thought on these issues, which we will take seriously but need not accept unconditionally.

According to contemporary astronomy, the universe is **large and old**. On a clear night from a dark spot, you can see thousands of stars with your eyes. You can see millions of stars with even a small telescope. Stars are suns but far away; the sun is a star but close up. How distant then must be the stars?

Astronomer **Fred Hoyle** coined the term **Big Bang** and meant it derisively. Hoyle opposed the theory on atheistic grounds, because it could be too easily interpreted as evidence for God. The name stuck, and today there is a scientific consensus on the Big Bang scenario, in which the visible universe began very hot and dense billions of years ago and has expanded and cooled ever since.

In retrospect, the necessity of something like the Big Bang was already apparent to nineteenth century science. Thermodynamicists noted that while energy is conserved in any process, the quality or usefulness of energy decreases, and thus the universe is in a one-way slide to thermal equilibrium, the so-called **heat death**. However, the universe running down suggests that it was once wound up. Meanwhile, astronomer **Heinrich Olbers** noted that if the universe were infinite in space and time, every line of sight should intersect a star, and so the night sky should be everywhere as bright as the sun. In the Big Bang model, the visible universe is only about 13.7 billion years old, and there simply has not been time for the light from most stars to reach us.

There are multiple and independent lines of evidence for the Big Bang. In the 1920s, **Edwin Hubble** noted that the specific colors radiated by atoms in stars from distant galaxies were **red-shifted**, or stretched toward longer-wavelengths, which he interpreted as resulting from the expansion of the universe. He was able to extrapolate the expansion backwards to infer that everything must have been together billions of years ago, in rough agreement with the ages of the oldest stars. In its first three

minutes, the universe was so hot and dense that it must have acted like a **nuclear reactor**, fusing primordial hydrogen into helium and trace amounts of heavier elements, in agreement with current observations of the relative abundances of these elements. The expansion of the universe stretched the relic radiation from the primeval fireball from visible light into microwaves, and this **cosmic microwave background** was first observed by Arno Penzias and Robert Wilson in the 1960s using a small horn antenna.

The Big Bang was not an explosion of matter into pre-existing space; rather it was the expansion of space itself. Today, it is the space between galaxies that expands, not the galaxies or solar systems themselves, which are held together by their own gravity. (Planets and people are held together electromagnetically.) Astronomers use Albert Einstein's theory of general relativity, in which mass, energy, and pressure determine the geometry and dynamics of **spacetime**, to mathematically describe the Big Bang. Thus, along with matter, time as well as space was created in the Big Bang, so that before there was no "before". Early Christian theologian **Augustine** arrived at a similar conclusion, about 1600 years ago, when contemplating what God was doing before Creation.

Astronomers speculatively extrapolate the Big Bang into the distant future. If the expansion continues, eventually the last stars will exhaust their hydrogen fuel and the universe will go dark. Stellar corpses of degenerate matter will disintegrate slowly by proton decay, and black holes will even more slowly evaporate via **Hawking radiation**, leaving a diffuse sea of light elementary particles at a temperature near absolute zero. Can life and mind survive indefinitely in such a universe? Or will a **Copernican principle** for time ensure that new phenomena of longer time scales continue to emerge?

Finally, we discussed attempts by physicists to construct speculative models of the creation of the universe from nothing. It is hard to understand

how something could come from nothing or how the Creation event could be preceded by a cause. However, if the positive energy stored in mass balances the negative energy stored in the gravitational binding of stars and planets, the total energy of the universe might be zero. Furthermore, physicists are accustomed to events without causes in radioactive decay and other **quantum phenomena**. Perhaps the universe is an inflated vacuum fluctuation.

However, not only do such scenarios assume the laws of physics (and the quantum vacuum), but what implements those laws? What instantiates a universe? In **Stephen Hawking's** famous phrase, what breathes fire into the equations? We can accept the universe as a **brute fact**, which is no explanation at all. We can speculate that the universe is **logically necessary**, but this runs afoul of the Gödelian limits to rational thought. Or we can reason that since everything in the universe is non-self-explanatory, the explanation for the universe resides in a self-explanatory being, **God**.

2007 September 20 (Thursday) 9:30 AM

We began discussing Barbour's Chapter 2, **Astronomy and Creation**. In the twentieth century, with the **Big Bang** model, astronomers plausibly reconstructed cosmic history, revealing a universe of immense size and age. Some scientists and theologians welcomed the Big Bang scenario as support for the biblical idea of creation. However, because scientific knowledge is always tentative and subject to revision, Barbour cautions against identifying a theological doctrine with a particular scientific theory.

Under **conflict**, Barbour discusses the scientific skeptics' view that the universe is created by chance. While the Big Bang may look like a unique creation event, contemporary physics suggests many ways by which the visible universe might be one among many universes in a **multiverse**, a new kind of **Steady State** alternative to the Big Bang.

These mechanisms include successive cycles of Big Bangs and Big Crunches; multiple isolated domains in truly infinite space; many worlds quantum theory; and infinitely many inflated quantum vacuum fluctuations. Nevertheless, a cosmic process producing intelligent persons is what we would expect if God is intelligent and personal.

Under **independence**, Barbour considers **Genesis**, the first book in the **Torah** and the **Bible**. If Genesis is not history or science, then what is it? Barbour suggests that Genesis tells a symbolic and poetic story, set in the prescientific cosmology of its day, that timelessly affirms the goodness and purposefulness of creation, its dependence on God, and God's transcendence. In addition, early Christian theology formulated the idea of creation from nothing, *creatio ex nihilo*, against various heresies, but also emphasized God's continuing creation, *creatio continua*, in preserving and grounding the world.

Across cultures, creation stories help people locate their lives in a cosmic order. In the **Abrahamic religions**, the idea of creation characteristically includes wonder and gratitude for life as a gift. I personally have never lost the wonder and excitement of being surprised, now and then amidst everyday activities, by a sudden awareness of my conscious self. Historically, though, many human lives have not been as easy or as rich as mine. I told an old tale of a group of men discussing the pains and joys of life. They ultimately agreed that, on balance, it would have been better if they had not been born. But when they informed the local rabbi, he responded, "You should be so lucky!"

Under **dialogue**, Barbour discusses the **contingency** and the **intelligibility** of the cosmos. The universe is contingent in its existence, laws, boundary conditions, and even its events. It is a unique and irreversible history in which genuine novelty can arise. Belief in the rational intelligibility of the universe motivates physicists in their search for a **grand unified theory** of everything. But atheism alone does not justify or support such a belief. Einstein remarked, "The most incompre-

hensible thing about the world is that it is comprehensible."

We debated whether God's design was in the laws or products. Physicist **James Trefil** is more comfortable with a God clever enough to devise laws of physics that make our universe inevitable rather than with a traditional God who makes it piece-by-piece. I suggested that our minds reflect God's mind; **mind reflects Mind**.

This prompted a wide-ranging discussion on God, spirituality, and religion. Guiding a child's spiritual development is one thing; force-feeding it a religion is another. In this regard, we discussed the controversial but Academy-award nominated film [Jesus Camp](#). Many people raised in the religion of their parents experience a period of questioning, where they may internalize and strengthen their childhood beliefs, transform them, or reject them.

2007 September 25 (Tuesday) 9:30 AM

I returned the first draft of the [first writing assignment](#) with comments. The second and final draft will be due next Tuesday. We continued discussing Barbour's Chapter 2.

Under **integration**, Barbour examines evidence for design in astronomy. Small changes in physical constants would render our universe uninhabitable. For example, if the strong nuclear force were slightly weaker, no hydrogen would fuse to helium; if it were slightly stronger, *all* hydrogen would immediately fuse to helium. Either way, there would be no long-lived stars. For every billion antiprotons in the early universe, there were a billion and one protons, which annihilated in pairs to form the photons of the **Cosmic Microwave Background**, leaving just one proton in a billion to form matter as we know it.

Barbour comments that such fine-tuning is what would be expected from a God interested in conscious life. In this context, **Freeman Dyson** remarked, "The universe must have known we were

coming." However, self-selection from some kind of multiverse is an alternate explanation, so the universe remains open to atheism.

Barbour next discusses **model making** in science and religion. Physicists use complementary wave and particle models to describe electrons, while Western and Eastern religions use personal and impersonal models for God. The Bible describes God as Designer, Artisan, Potter, Architect, Gardener, Sovereign, and Parent (mainly Father but sometimes also Mother), among other metaphors.

Has modern astronomy demoted humanity? We should not be surprised by the vastness of space and time, as billions of years are required for stars to cook the elements of life, and so the expanding universe **must** be billions of light-years across. We may seem insignificant, but in some ways we are extraordinary, as complexity and consciousness are more important than size and duration.

The greatest complexity is not in atoms or galaxies, but in human minds. There are more neurons in our brains than there are stars in the Milky Way galaxy, and the number of ways to interconnect them is larger than the number of atoms in the visible universe. A greater richness of experience occurs in us than in a thousand lifeless galaxies. Similarly, **Emily Dickinson's** poem, [The Brain is Wider than the Sky](#), which I read, affirms that we are greater than the stars, because we know them and ourselves, and they know nothing at all.

Yet, we are intimately connected with the universe, what Carl Sagan calls **animated star-stuff**. The chemical elements in our hands were forged in the furnace of stars. The iron in the hemoglobin carrying oxygen in our veins was created in the deaths of stars. The cosmos is all of a piece.

After the break, we began discussing Haught's Chapter 5, **Was the Universe Created?** The idea that the universe is a gift freely created by a loving, personal God is central to the **Abrahamic religions**. It suggests that the universe has deep significance, even if we do not completely understand it.

It would be momentous if science either supported or undermined this vision.

Under **conflict**, the scientific skeptics argue that quantum physics may have allowed the universe to burst into existence spontaneously and uncaused. They resist equating Big Bang physics with the actions of a Creator God. They are not happy when scientists use God-language in cosmology.

The **contrasters** are adamant that, unlike religion, science does **not** deal with ultimate questions. Independence works both ways: the Big Bang tells us nothing about the religious depth of Creation, and Genesis has nothing to teach science about cosmic beginnings. Religious Creation is not about chronological beginnings, but about **ontological dependency** on God. It is not the first moment, but the shear **being** of things that evokes religious wonder. Even an eternally existing world would be continuously **grounded** in the graciousness of God.

Recently, in a revival of **natural theology**, some scientists have attempted to derive God from their studies of nature. In *The Physics of Immortality*, physicist **Frank Tipler** argues that the consistency of the laws of physics themselves requires life and mind to emerge, gain control of the evolution of the universe, and ultimately resurrect each one of us as **emulations** in the limitless computers at the end of time. Tipler identifies such an **Omega Point** as God, although not everyone agrees that that would be the personal God of **Abraham** and **Jesus** and **Muhammad**.

The **contacters** are excited by the new cosmology, which presents us with a world still in the making, an unfinished product, an ongoing creation. The Big Bang is not over, it is still happening! Even among scientific skeptics contemplating the universe, they detect strains of **ontological shock**, irrepressible awe at the **thatness** of the universe. The scientific sense of wonder about cosmic origins is already incipiently religious. Meanwhile, theism provides the most straightforward and uncomplicated answer to why the universe exists.

2007 September 27 (Thursday) 9:30 AM

I briefed everyone on the [second writing assignment](#), which is due next Thursday. We then completed our discussion of Haught's Chapter 5, where the **confirmers** again argue that science might never have arisen outside a cultural and historical context imbued with the idea that the world is a contingent creation of God.

We then began discussing Haught's Chapter 6, **Do We Belong Here?** In the preamble, Haught considers the relation of mind to matter. Is mind a spiritual reality descended into the material world? Is it a freak accident of atoms in the void? Is it an adaptive characteristic bestowing survival value? Is it a natural development latent in matter? Is it intrinsic to the cosmos? Might mind be what the universe is really about?

In classical theology, it is natural to find finite minds in a universe that is an expression of an infinite Mind. In classical science, mind is unexpected among a universe of atoms in motion. However, in modern physics, the observer is more central, and mind no longer appears like an alien interloper. In **relativistic physics**, the lengths and times we observe depend on our motion. In **quantum physics**, an atomic history depends in part on the observations we choose to make.

According to the **Anthropic Principle** (AP), mind matters. The uncontroversial **Weak Anthropic Principle** (WAP) states that physical phenomena are constrained by the fact that we exist. We can only understand a universe that can produce minds capable of understanding it. The controversial **Strong Anthropic Principle** (SAP) states that the universe **must** be such as to allow mind to develop. Proponents claim that SAP is the most direct and economical way to explain the universe's fine-tuning. Just as an acorn is such that it may grow to an oak tree, physics is such that the universe may generate life and mind. We do indeed belong here.

Under **conflict**, the scientific skeptics vigorously object to the SAP because it has no predictive power and is not subject to experimental falsification. Furthermore, it is unscientific as it is **teleological**. (It explains by purposes rather than causes.) The universe is either necessarily the way it is, or it could have been different, in which case there are infinitely many other universe, and we necessarily find ourselves in a **mind-bearing** one. The skeptics contend that universe would still be wonderful even if mind were not essential to it.

The **contrasters** are also not enthusiastic about the SAP, as it recalls failed design arguments from natural theology. Faith loses its intensity and depth as soon as it relies on rationality or science. They are wary of binding theology too tightly to SAP or any scientifically derived theory. Anyway, questions about meaning and purpose reside in theology and religion, not in science. The deepest essence of the universe is displayed more fully in a single act of human kindness than in all the elaborate formulas of physics.

The contrasters are additionally skeptical of the many-worlds or **multiverse** hypothesis, as there is no evidence for it, and it is not testable. Furthermore, the material cannot beget the mental, no matter how many universes exist. Anthropic self-selection from a multiverse is a **desperate hypothesis** by materialists to counter a non-materialist, religious interpretation of the universe. If our present universe is all there is, materialist and reductionist explanations are in serious trouble.

However, the **contacters** believe that SAP is of considerable theological interest. They criticize the scientific skeptics for their reductionist belief that mind is fully explainable by lower and earlier levels of reality. They criticize the contrasters for their **mind-body** dualism, including the fear that if we insert humanity too deeply into nature, we might forget that humanity also transcends nature. Instead, they argue that SAP clearly puts mind back in the physical universe. Matter is hospitable rather

than hostile to mind.

The contacters argue that science should explore natural explanations for natural phenomena; supernatural explanations are not within its scope. While the teleological nature of SAP prevents it from being a scientific explanation, it can be a non-scientific explanation, so long as **scientism** is avoided.

As usual, the **confirmers** seek ways in which religion can support the scientific adventure. For them, the multiverse hypothesis is theologically plausible because a plurality of worlds is consistent with the extravagant graciousness of an infinite God of love. Could God possibly keep track of so many worlds? To illustrate the **power of infinity**, I told the story of the Infinite Hotel.

The **Infinite Hotel** has infinitely many rooms, and on this night, all of them are occupied. A traveler pleads for a room, and the manager accommodates her by moving the person in room 1 to room 2, the person in room 2 to room 3, and so on, thereby vacating room 1. Next, a group of travelers pleads for 5 rooms. The manager accommodates the group by moving room 1 to room 6, room 2 to room 7, and so on, thereby vacating rooms 1 through 5. Finally, a second, rival infinite hotel across the street burns down. Its guests evacuate safely and plead with the first hotel's manager for infinitely many rooms. The manager accommodates even them by moving 1 to 2, 2 to 4, 3 to 6, and so on, thereby vacating the infinitely many odd numbered rooms 1, 3, 5, and so on.

2007 October 2 (Tuesday) 9:30 AM

I collected the final drafts of the [first writing assignment](#), which was due today. Before beginning our discussion of **biology and religion**, we reviewed molecular and evolutionary biology as summarized in my lecture notes on [life](#) and [evolution](#). As with astronomy, our goal is to understand the mainstream scientific thought on these issues,

which we will take seriously but need not accept unconditionally.

To begin, we considered four philosophical perspectives on life. Both panpsychism and reductionism claim there is **no** distinction between matter and life. In **panpsychism**, God is in everything, and animate and inanimate differ by degree rather than kind. Even stones have an inner being. In **reductionism**, the distinction between animate and inanimate is an illusion, and life is nothing but atoms in the void. Mind, spirit, and God are simply products of neuronal complexity.

Both dualism and emergentism claim there **is** a distinction between matter and life. In **dualism**, matter and life are like two different essences, one describable by science, the other not. In **emergentism**, animate differs from inanimate not because it possesses an extra nonphysical ingredient, but because of the way it is **organized**. Life emerges from matter when its complexity exceeds a critical threshold.

Life is sometimes defined as self-replicating information or, more specifically, replication by nucleic acids. The **universe within** is marvelous: Every cell continuously performs a fantastically complex ballet of chemical reactions. The score for the ballet is written in long threadlike molecules of deoxyribonucleic acid, **DNA**. The base pairs A-T and C-G spell, in three-letter words, instructions for assembling all the enzymes and proteins the cell needs for metabolism and reproduction.

But which came first, the DNA or the proteins, the chicken or the egg? How did the genetic code arise, and is it unique? We considered the 1953 **Miller-Urey** experiment that exposed an abiotic mix of gases to lightning-like electrical discharges and produced amino acids, the building blocks of proteins. Since then, almost all the chemical components of life have been created abiotically and also discovered spectroscopically in interstellar space. The stuff of life is common. Today, biologists can synthesize viruses, and soon they expect to synthesize entire cells.

After the break, we reviewed the theory of evolution. **Neo-Darwinism** refers to the fusion of DNA-based molecular genetics with Darwin's original idea of differential reproduction arising from random variations and natural selection. Evolution is biology's grand unified theory. Without it, biology doesn't make sense. Evolution elucidates and substantiates taxonomy, the fossil record, the molecular clock (that dates species' divergences based on DNA differences), and both graceful and awkward adaptations. Evolution typically requires many generations, and so is easiest to observe in microscopic organisms with short life spans, as in the emergence of **antibiotic-resistant bacteria**. Evolution of large organisms often requires the **deep time** of geology and astronomy.

We discussed two simple examples of evolution in action. In the first, black **bears in Alaska** stand out against the white snow and have difficulty surprising prey. Their survival and reproductive rates are less than those of white bears, beginning with the occasional albino mutation, which predominate in just a few generations. In the second, industrial pollution in 1800s England blackened trees with soot, making the light-colored **peppered moths** stand out and die off due to predation, while the dark-colored peppered moths flourished thanks to their then excellent camouflage.

After surveying biology's panorama of the evolution of life on Earth, we asked the question: **Is God a creationist?** While some theologians maintain that God created the universe all at once just a few thousand years ago, others argue that perhaps God used evolution to bring forth life and mind gradually over deep time. Maybe God's design is in the laws rather than the products.

We examined a couple disturbingly or awkwardly designed natural products. The female **ichneumon wasp** lays eggs inside hosts, such as caterpillars. The larvae eat the hosts' bodies from the inside out killing them. Darwin could not believe that God would **specifically** design such a relationship. However, the caterpillar's diminutive or absent

consciousness renders this a less disturbing example of the food chain. The **panda's thumb** is an apparently opposable digit, which the panda uses to grasp and eat bamboo, its only food. However, the thumb is not a finger but a bone spur, an elongated wrist bone. Many biologists contend that such odd solutions are witness to evolution.

In this regard, we considered some engineering defects in the otherwise amazing human body. The appendix is a **vestigial** organ. The retina is wired backward so that nerves must exit to the brain through a retinal hole known as **the blind spot**. The tubes carrying food to the stomach and air to the lungs fuse in a single tube to the mouth. Cats and dogs have two types of color-sensing retinal cone cells, while humans have three, but birds have four!

2007 October 4 (Thursday) 9:30 AM

Today, I returned the graded [first writing assignment](#), and collected the first draft of the [second writing assignment](#). We then completed our overview of the science of evolution.

During successive epochs, life remains dominated by simple microbes, but the tail of its distribution increases toward complexity. Does this reflect a trend toward complexity or a random diffusion away from a wall of simplicity? **Stephen Jay Gould** and **Richard Dawkins** argue that evolution is not progressive. There is no "ladder of progress" or direction to evolution. Life does not "advance". **Christian de Duve** and **Paul Davies** argue for a general trend from simple to complex, from microbes to minds, inherent in the cosmos. Matter self-organizes complexity, and life and mind are inevitable.

In the face of seemingly overwhelming evidence for evolution, atheists argue that evolution and theism are incompatible, and therefore theism is wrong. Meanwhile, some theists are creating **theologies of evolution**. [CTNS](#) director **Bob Russell** believes that evolution is how God is creating life,

and he has issued a call-to-action: theists must reclaim evolution from atheists. They must "take back" evolution. Science need not and must not be warped to include **agency** in its explanation of the universe, but theists can and must see evolution as the **handiwork of God**. Russell accepts evolution (as he accepts gravity), but he doesn't accept that evolution implies atheism (any more than he accepts that Newtonian mechanics implies atheism).

We next began discussing Barbour's Chapter 4, **Evolution and Continuing Creation**. In the preface, Barbour succinctly summarizes evolution by saying species evolve by (1) variation and (2) selection over (3) long times. In the modern synthesis, variations arise from mutations or copying errors in **DNA**. The fact that all known organisms use the same genetic code to translate DNA to amino acids, the building blocks of proteins, suggests a common origin for all life on Earth.

Under **conflict**, Barbour considers two diametrically opposed ways of believing one can not be both a theist and an evolutionist. Richard Dawkins and Daniel Dennett represent **evolutionary materialism**, while Philip Johnson and Michael Behe represent **theistic critics of evolution**.

Richard Dawkins is an evolutionary biologist who, in books like *The Blind Watchmaker*, asserts that science is the only acceptable form of explanation and that matter is fundamental reality. He argues that the eye evolved gradually multiple times via many small improvements, but no sensible designer would wire the human eye backward. For him, widespread suffering, pain, and fear in nature reveal a universe without design. However, Dawkins may be unfairly projecting human emotions on nature that, although **red in tooth and claw**, is not as self-aware as humans are; most of nature does not know happy and sad the way we do.

Daniel Dennett is a philosopher of science who, in books like *Darwin's Dangerous Idea*, insists that evolution is a mindless, purposeless process. He even rejects Darwin's idea that the laws of evolution rather than individual species are the product

of design. He is adamant that acceptance of evolution requires rejection of theism.

Philip Johnson is a law professor who accepts **microevolution** but not **macroevolution**. He notes that animal breeders have produced great diversity but no new species, and while the beaks of the famous Galápagos finches vary from island to island, the finches are not distinct species. (He does acknowledge that artificial selection of fruit flies has produced forms that do not breed with their ancestors.) He argues that there is a scarcity of transitional fossils, with a few exceptions, like the archaeopteryx, a primitive bird-like creature with reptilian features. He suggests that the **Cambrian explosion** of life forms about 570 million years ago represents God's introduction of new genetic information into nature. Johnson's scientific critics claim he exaggerates the deficiencies of evolutionary theory and offers no empirically testable alternative theory. Johnson's theological critics note that he assumes that theism requires a **God-of-the-gaps** (in our scientific knowledge).

Michael Behe is a biochemist who believes that the **irreducible complexity** of biochemical systems, such as the human immune system and bacterial flagellum, can not be produced by gradual evolution. He offers the analogy of a **mousetrap** that will not work at all if it is missing any of its five parts. He does believe in some evolution in deep time, but he also believes that God occasionally injects additional information into evolution. Behe's scientific critics argue that many evolutionary changes are improvisations that co-opt already existing components for new functions under different conditions. Behe's theological critics are troubled by the notion of a God-of-the-gaps intervening only discontinuously in nature.

Under **independence**, Barbour describes a 1984 **National Academy of Sciences** pamphlet that, in an attempt to protect high school science teachers and defuse conflict over biology courses in public schools, insists that science and religion have **nothing whatsoever** to do with each other. We found

that your recent high school experiences ranged from evolution without intelligent design in a Catholic school to biology without evolution in a conservative school.

Stephen Jay Gould was a paleontologist who, in his book *Rock of Ages*, argued that science and religion are independent realms or **non-overlapping magisteria** (NOMA). Although Gould claimed to be agnostic, in his final chapter and other writings, he goes beyond NOMA by referring to our "cosmic insignificance" and the "sublime indifference of nature".

We ended our discussion by considering protestant **neo-orthodoxy**, which does not have a problem with evolution, because in its view God acts in **human history** and not in nature. The doctrine of creation is not about the beginning or subsequent natural processes but an affirmation of our dependence on God and the goodness of creation. However, Barbour believes that neo-orthodoxy's dichotomy between humanity and nature is as dubious as that between body and soul. **Steven Weinberg** is harsher, in a different direction, when he remarks that while religious conservatives are wrong, religious liberals are **not even** wrong!

2007 October 9 (Tuesday) 9:30 AM

I returned the first draft of the [second writing assignment](#) with comments. The second and final draft will be due one week from Thursday. We completed our discussion of Barbour's Chapter 4.

Under **independence**, some theologians distinguish primary and secondary causality. They argue that God, as **primary cause**, works through the **secondary causes** that science investigates. For example, why is a fire burning? A secondary cause might be that oxygen is combining with carbon to form carbon dioxide. A primary cause might be that I lit a match, or even that I wanted to roast marshmallows. In this way, God acts **through** the laws of nature rather than against them.

This approach emphasizes the **integrity** (or coherence or unity) of nature and science. God created nature without leaving any gaps to be plugged or deficiencies to be remedied. But the absence of gaps does not imply that the world is closed to divine action, as the laws of physics are regularities that do not imply strict **determinism**. God should not be invoked in scientific accounts, but a religious perspective can discern purposeful patterns in nature. What is chance to one person may be a miracle to another.

Under **dialogue**, Barbour examines several ideas from science that are conducive to theological reflection, including the **self-organization** of complexity. Normally, if a physical system like a fluid is disturbed, it returns to its most probable, disordered state of equilibrium. However, as **Ilya Prigogine** has championed, some systems driven far from equilibrium self-organize a stable, collective order, like vortices in a turbulent fluid flow, or convection cells in fluid heated from below. God may have designed a world that encourages the growth of complexity, including ultimately life and mind.

The concept of **information** may be important both scientifically and theologically. DNA records information about the environment, of proven survival value, including the remarkable, instinctive behavior patterns of social insects like ants and bees. Human culture, especially language and writing, encodes symbolic information passed between generations, enabling multigenerational project like science. **John Polkinghorne** suggests that God influences evolutionary history, without violating the laws of physics, by communicating information, either at the level of quantum indeterminacies, or via the extreme sensitivity of chaos, or by direct revelations to persons.

In practice, science recognizes a **hierarchy of levels**, such as physics, chemistry, biochemistry, physiology, psychology, sociology, and ethics, along with three kinds of **reductionism**. The research strategy of **methodological reduction**,

which involves studying lower levels to understand higher levels, has been spectacularly successful. However, the philosophy of **epistemological reduction**, wherein lower level laws explain higher level laws, may be flawed. For example, Barbour argues that physics and chemistry cannot completely define biology. Similarly, the metaphysics of **ontological reduction**, which asserts that ultimate reality is matter and only physical forces are causally effective, may be incorrect. Instead, Barbour defends an **ontological pluralism**, a multi-leveled view of reality, where evolution generates new levels that are distinctive from but consistent with the lowest-level laws of physics.

As a slogan, **reductionism** insists that the whole is **equal** to the sum of its parts. In contrast, **holism** asserts that the whole is **greater** than the sum of its parts.

Scientists are used to thinking in terms of **bottom-up causation**, where lower levels control upper levels. However, **top-down causation** may be important also, as higher levels may impose boundary conditions on lower levels. For example, the rules of chess severely constrain the possible moves, but they leave sufficient freedom for players to develop distinctive styles of play. Similarly, the laws of chemistry limit how atoms combine in DNA, but they leave room for environmental selection to encode information in a sequence of base pairs. Top-down causation may be a model for divine (and human) agency in the world. From a higher level, God may act as a top-down cause without violating lower-level laws.

Under **integration**, Barbour asks if evolution is a directional process. He notes that the **panda's thumb** developed from a wrist bone, which is a far from perfect design. Some species seem to progress, but others seem to retrogress and, according to the fossil record, most have become extinct. Nevertheless, in Barbour's view, evolutionary history shows an overall trend toward greater complexity, from matter to mind. There is little doubt

that a human being represents an astonishing advance over a bacterium.

Some have argued that the assembly of a protein by evolution from hundreds or thousands of amino acids is as inconceivably improbable as the fabrication of an airplane by a cyclone stirring up a heap of metal in a junkyard. However, not all combinations of amino acids are equally likely, and evolution is a subtle interplay between **chance and necessity**, so calculating the probabilities is not so easy. The theist can maintain that, perhaps at the indeterminate quantum level, God controls biological events that appear to us to be random. However, is God then responsible for every specific mutation, good and bad? Does evolution exhibit too many blind alleys, extinct species, suffering, and waste to attribute **every** event to God's specific action?

Perhaps God's plan for Creation includes chance as freedom in the design. God respects the integrity of the world and **lets it be itself**. God is patient and endows matter with the potential to evolve life and mind. This provides a partial answer to **death and suffering**, each of which are intrinsic to the evolutionary process.

Finally, we discussed theologian **Arthur Peacocke**, who created many models of God in an evolutionary world. These include striking metaphors like God as choreographer of an ongoing dance; God as composer of an unfinished symphony, improvising themes and variations. Chance as God's radar beam sweeping through diverse potentialities. Peacocke argued that God has endowed the world with creative possibilities that are **successively** disclosed, and that continued creation is an open-ended process. He spoke of the self-limitation of a God who suffers with the world. He suggested that God acts in the world via top-down or **whole-part causation**. God is the world's mind, and cosmic history can be viewed (with faith) as the action of an agent expressing intentions.

2007 October 11 (Thursday) 9:15 AM

In order to better understand science and scientists, we watched the DVD version of the award-winning 1987 movie [Life Story](#) (or **The Race for the Double Helix**), which dramatizes one of the greatest scientific discoveries of the twentieth century, the gene-encoding, self-replicating structure of DNA. The movie was written by [William Nicholson](#) and produced and directed by [Mick Jackson](#).

[Life Story](#) is set in early 1950s England. It follows two groups of scientists as they attempt to decipher the structure of DNA and the secret of genes. **Jim Watson** and **Francis Crick** are at the Cavendish laboratory in Cambridge. **Maurice Wilkins** and **Rosalind Franklin** are at King's College in London. Watson and Crick are brash and enthusiastic and form a close team, while Wilkins and Franklin are restrained and methodical but at odds with one another.

[Life Story](#) presents diverse perspectives on the scientific enterprise. Crick asks, "What's the point of science if it isn't fun?" He later says, "That's what science is like. It's not all cold reason. There has to be excitement. It's like love." When Crick mentions a rival theory for DNA, Watson replies, "Ugly. It doesn't deserve to be true. Truth is pretty." Watson plugs the value of intuition by telling his sister, "Blessed are they who believed before there was any evidence."

Wilkins seems painfully shy, admitting that he can see practically nothing without his eyeglasses — but that it's sometimes better that way — and then repeatedly removing them in emotionally charged situations. He seems baffled and befuddled by Crick and Watson's enthusiasm and competitiveness. Of the search for the structure of DNA, Crick says, "Maurice doesn't see it as a race, more a brotherhood of science." Indeed, Wilkins says, "Science is a communal activity."

Franklin steadfastly resists the intuitive leaps of Crick and Watson, whom she refers to as "children". At one point, she angrily tells Watson, "This isn't a game. Little boys — you're all just little

boys!" She tells her research student, **Raymond Gosling**, what she likes about their kind of work, "You can be happy or unhappy. It makes no difference. It doesn't matter if you like what you find or hate it." When asked if she would like to be married, she replies that she would rather do one thing well than two things badly.

Sir W. L. Bragg, the head of the Cavendish laboratory, says "Science is like a sport ... you have to play by the rules of the game." **Sir J. T. Randall**, the head of the King's College biophysics unit, says "Nonscientists think of science as universal, as celestial even. Science is terrestrial, territorial, political."

Upon viewing Crick and Watson's now-famous double-helix model of DNA, Wilkins says, "It's very beautiful, Francis. Very ... simple. Very true." When separately viewing the model, Franklin says that it doesn't matter who first discovered it. All that matters is the elegant structure itself, encoding and reproducing all life. **It's so beautiful, it has been true.**

The 1953 April 25 issue of the science journal **Nature** announced the structure of DNA in three consecutive articles: the first, a theoretical paper by Crick and Watson; the second, an experimental paper by Wilkins *et al.*; and the third, an experimental paper by Franklin and Gosling.

A postscript at the end of the movie informs us that just five years later, Franklin died of cancer. A second postscript reports that four years after Franklin's death, the **Nobel Prize** was awarded jointly to Crick, Watson, and Wilkins. The final postscript reveals that the rules of the Nobel foundation forbid posthumous awarding of the prize.

Earlier this year, scientists presented Watson, who is now 79, with a pair of DVDs containing his own **genome**, one of the first individual genomes to be sequenced. However, at Watson's request, the sequence deliberately omits the status of a gene linked to **Alzheimer's disease**.

2007 October 18 (Thursday) 9:30 AM

I collected the final drafts of the [second writing assignment](#), which were due today. We discussed our reactions to the movie [Life Story](#). Especially interesting were Rosalind Franklin's experiences as a woman scientist in the mid twentieth century.

We then began discussing Haught's Chapter 3, **Does Evolution Rule Out God's Existence?** Given that experts today consider Darwin's 1859 *On the Origin of the Species* to be generally accurate, can there be a fruitful encounter between religion and evolutionary thought? Of course, scientific skeptics say no. **Steven Weinberg** asserts that evolution refutes the idea of an "interested" God much more decisively than physics.

Haught summarizes evolution in three parts: chance, struggle, and natural selection. Pessimistically, **chance** refers to random, accidental, or even irrational variations; **struggle** refers to survival of the fittest and the cruelty of the universe, especially toward the weakest; **natural selection** is blind and indifferent to life and humanity. However, Darwin himself apparently never completely lost the religious faith of his youth, during which he considered becoming an Anglican parson. Toward the end of his life, he might have been best described as a reluctant **agnostic**.

The **conflictors** argue that evolution and religion are incompatible. Creationists reject evolution and scientific skeptics reject theism. Creationists recognize that literal interpretations of the biblical creation stories are incompatible with evolutionary biology. In fact, many believe that evolution is fundamentally incompatible with **any** religious vision. **Don Davis's** fantastic [cover painting](#) for **Carl Sagan's** *The Dragons of Eden* suggests (perhaps) some of this tension. For the skeptics, **Richard Dawkins** writes, "Darwin made it possible to be an intellectually fulfilled atheist." They believe that evolution is a challenge to religion that religion cannot meet.

The **contrasters** argue that evolution and religion are **not** incompatible. They consider science and religion to be completely different ways of viewing the world, and they criticize two kinds of conflation: **scientific creationism**, which conflates science and the Bible, on the one hand, and **scientific materialism**, which conflates science and materialism, on the other hand. Such **(con)fusion** of science with other things results in inevitable conflict.

Scientific creationism assumes the Bible provides scientifically accurate information. However, the scientific case for evolution is substantial, including multiple independent but converging lines of evidence. Gaps in our knowledge do not mean that evolution does not happen; they simply mean scientists have more work to do. Furthermore, scientific creationism is theologically **embarrassing**, as it imposes scientific expectations on a sacred text. Reading the Bible to learn about science misses its real message. Nevertheless, the contrasters recognize that, for many people, "evolution" stands for all the shortcomings of modern secular society.

Scientific materialism presents evolution as inherently anti-theistic. **Stephen Jay Gould** writes, "Matter is the ground of all existence; mind, spirit and God as well, are just words that express the wondrous results of neuronal complexity." No wonder the religious do not rush to embrace evolution!

Responding to evolutionary pessimism, the contrasters note that **chance** may be an illusion: what seems like chance from a human's finite perspective might be rational and coherent from God's infinite perspective. Responding to the **struggle**, suffering, waste, and cruelty in evolution, they note that the problem of evil is not new to religion. The Bible knows about **Job** and the crucifixion of **Jesus**, yet still paradoxically proclaims faith and hope in a God of love. Blind **natural selection** is no more problematic than gravity, which pulls equally on the weak and strong, but is not an argument against the existence of God.

Ultimately, the contrasters believe that our evolutionary history is not important, because with our species, evolution leapt to a new plane, realizing freedom and value, goodness and love, and the core of humanity now lies beyond scientific illumination. Nature provides evidence neither for nor against God, and so they are neither heartened nor troubled by evolution.

The **contacters** argue that theology must do more than show that evolution does not contradict theism. While some theologians seem not to acknowledge that we live in a post-Darwin world, others do. For example, **Hans Kung** argues that evolution makes possible a deeper understanding of God (not above or outside but in the midst of the world), of creation (not contrary to but enabling evolution), and of humans (not distinct from but organically related to nature).

The contacters defend a positive role for chance in evolution. **Indeterminacy** in nature is expected from a loving God, because love persuades rather than coerces. God allows the universe to be itself. If God were a **magician**, we might expect the universe to be finished all at once and remain eternally unchanged. However, God is a **Creator** more interested in promoting freedom and the adventure of evolution than preserving the status quo. Evolution is life unfolding.

Evolution does not demand we give up the idea of God, but it does ask that we think of God in a fresh way. A theology that seriously encounters evolution cannot remain completely unchanged.

2007 October 23 (Tuesday) 9:30 AM

First-years will register for spring semester classes on November 14 or 15. So, I asked everyone to schedule an advising meeting with me during the next three weeks. I also returned the graded [second writing assignments](#).

We began by viewing a projected image of the haunting **Don Davis** painting [The Dragons of](#)

Eden along with the biblical quotation, "I am brother to dragons, and a companion to owls" (Job 30:29 KJV). The painting suggests Adam and Eve in Paradise, but the former are nonhuman hominids and the latter includes dinosaurs!

We then completed our discussion of evolution and Haught's Chapter 3. The **confirmers** argue that just as the Abrahamic religions provided the context from which modern science arose, so too they provided fertile soil in which Darwinian ideas have taken root. Unlike many Eastern religions, which imagine time as cyclic, biblical time is directional and irreversible, because God is both **Creator** and **Redeemer**. Especially in **Christianity**, God promises a new Creation at the end of time, a radically different future for all persons, which is consonant with the scientific idea of a universe evolving complexity from simplicity.

Furthermore, the confirmers argue that a finite universe cannot accept the infinite gift of God all at once. In order to adapt to the **divine infinity**, the finite universe must **gradually** absorb it. This recalls the evolutionary theology of twentieth century paleontologist and Jesuit priest **Pierre Teilhard** de Chardin. Teilhard imagined the universe growing spiritually until a maximum level of complexity and consciousness emerged in what he called the **Omega Point**. Teilhard argued that the Omega Point would be both personal and transcendent, and he identified it with God.

In summary, theism is not simply **compatible** with evolution, as the contrasters argue. It is not merely **consonant** with evolution, as the contacters contend. It actually **anticipates** evolution, as the confirmers claim.

As a transition to our discussion of the **science of the mind and religion**, we began discussing Haught's Chapter 4, **Is Life Reducible to Chemistry?** In the preamble, Haught notes that, after cracking the mystery of genes, **Francis Crick** turned his attention to the study of the mind. Crick's **astonishing hypothesis** is that "'You', your joys and your sorrows, your memories and your

ambitions, your sense of identity and free will are in fact no more than the behavior of a vast assembly of nerve cells" In Crick's view, this is an alien idea to most people, whose thinking is dominated by pre-scientific illusions of religion, but one that is widely held among **neuroscientists**.

Physicist **Stephen Wolfram** goes further. His **Principle of Computational Equivalence** suggests that the thermal motion of a stone may be every bit as complex as human thinking. The only difference is that human thinking has behind it a rich history of biology, civilization, and technology.

Traditional religion grades the universe into levels of relative importance to God. In modern language, this implies a hierarchy of **emergent phenomena**. From bottom to top, this includes matter, plants, animals (life), humans (soul, mind), God (divinity, Mind). **Ontological discontinuities** separate one level from the next. Higher levels can understand lower levels, but not vice versa. Human science can understand matter but not God — or even mind and soul. The most "real" stuff is at the top, rather than at the bottom.

In discussing this hierarchy, Haught distinguishes methodological reduction from metaphysical reductionism. **Methodological reduction** is an illuminating scientific method of breaking phenomena into simpler, more easily understandable parts. It does not claim that physics is closer to reality than (say) ethics. However, **metaphysical reductionism** is the idea that scientific analysis into parts is the **only** way to grasp what things really are. It maintains that purely physical explanations are sufficient. It is allied with **scientism** and **scientific materialism**.

To the metaphysical reductionist, the apparently "higher" levels of emergent phenomena, like life, mind, and God, can be fully explained by the apparently "lower" levels of chemistry and physics. In particular, mind is merely an **epiphenomenon**, a byproduct or derivative of a purely material substrate, without **causal efficacy**. The "real" stuff is at the bottom.

Under **conflict**, the scientific skeptics endorse the reduction of all things to physics and the **demystification** of the world. They argue that reductionism is responsible for the fantastic success of science. They reaffirm that science must attempt to explain things naturalistically and are confident that science can provide purely materialistic explanations for life, mind, ethics, and religion.

Reductionism has a long history since the ancient Greek philosopher **Democritus** declared that reality consists of **atoms and the void**. It is powerfully explanatory and, some would say, irresistibly simple and elegant. Although, the skeptics do admit that with **quantum physics**, matter is far more subtle than ancient atomism supposed.

In the sixteenth century, the clockwork solar system of **Newtonian mechanics** initiated a push toward reductionism. In the nineteenth century, life was understood as an expression (not a violation) of the second law of **thermodynamics**, as for every increase in order by life, there was a correspondingly larger decrease in order by radiation from the sun. Meanwhile, **evolution** demonstrated that living and thinking beings lie in an unbroken continuum with inanimate reality, and the universe can evolve life and consciousness from mindless matter, **mind from mud**. In the nineteenth century, biology reduced to chemistry with the discovery of the structure of **DNA** and the **genetic code**. Life requires no **elán vital** or "vital impulse".

In the twenty-first century, will science succeed in explaining human consciousness, the most subtle of natural phenomena? The skeptics think so. The mind is the expression of the brain, and the brain is a piece of meat, as even simple chemicals (including drugs) can alter the way we think and feel. **Daniel Dennett**, in his modestly titled *Consciousness Explained*, agrees: there is ultimately only one sort of stuff, the stuff of physics.

Sociobiologist **E. O. Wilson** further believes that culture and religion can be explained materialistically. Religion exists not because there exists a **divine reality**, but because religious tendencies have

proven survival value. Ethics is an illusion fobbed off on us by our genes to get us to cooperate so that those genes will survive.

With only one level of reality, no evidence for an overarching, transcendent meaning, and no non-material causality, the skeptics conclude that **theology** is superfluous. In fact, it should not be part of the intellectual life of any modern college or university.

I ended the discussion on a different note. The skeptics briefly (and dismissively) reference the great seventeenth century philosopher **Immanuel Kant**. On Kant's tombstone is inscribed his most famous quotation, "Two things fill the mind with ever new and increasing wonder and awe ... the starry heavens above me and the moral law within me." From these two different kinds of **infinities**, Kant fused a theology of hope in which God must exist to provide an afterlife to ensure the triumph of good over evil. The Creator is the Redeemer.

2007 October 25 (Thursday) 9:30 AM

I collected the first draft of the [third writing assignment](#). We then completed our discussion of Haught's Chapter 4. The **contrasters** note that the clarity and economy of the reductionist explanation appeals to our impulse to find the simplest explanations for complex phenomena. However, despite the success of methodological reduction, metaphysical reductionism is mistaken.

Metaphysical reductionism is a belief system (con)fused with science and sold to the public as though it were pure science. It is a modern ideology currently dominant in academia, a corollary to the assumption that science is the privileged way to truth, a partner to the materialist conviction that matter alone is real, an unfalsifiable belief rather than verifiable knowledge, a leap of faith beyond neutral **methodological reduction**.

The contrasters are critical of an unwarranted shift from methodological reduction to metaphysical

reductionism, which consigns the **noblest thoughts** of all previous generations to **superstition**. They speculate that reductionism gives its devotees an exhilarating sense of power over nature and the illusion of absolute intellectual rule.

Meanwhile, the contrasters defend the traditional hierarchical vision of the world. Each higher level has properties incapable of being grasped at the lower levels. At the highest level, if there exists an all-encompassing divine mystery, it would comprehend us without our being able to comprehend it. If science could grasp it, it would no longer be the infinite God but something trivially finite, subject to the **poverty** of our finite imagination. At the lowest level is the domain of science, but the mystical never shows up here, so no wonder science does not find it.

It is even impossible for one level to completely understand itself. The mind will never fully be able to understand the mind (let alone Mind). As **Lyall Watson** has written, "If the brain were so simple, we could understand it, we would be so simple we could not."

The contrasters also defend the refined sensibility of religious experience. Religious faith is capable of attuning our minds to a reality deeper than science. The divine mystery is both the **ground** and the encompassing **horizon** of nature, not something that falls within it. We become sensitive to divine reality not by mastering it, but by surrendering ourselves to it in religious worship.

Ultimately, the contrasters argue that the world of reductionism, where our feeble minds are made the upper limit to everything, is too small, too suffocating. Reality is not a closed box. There is an unlimited horizon, an intrinsic openness to infinity. God is an endless mystery. Science can accomplish only so much. To understand reality, we need other ways of knowing. Of these, religion is the most important.

The **contacters** follow the conflictors and the contrasters with an appeal for less polemics and more

dialogue. They agree with the contrasters that metaphysical reductionism is a belief system that is not a necessary accompaniment to science. However, they also believe that science can profit from deeper contact with new developments in **molecular biology** and **neuroscience**.

They are wary of the traditional hierarchy of being, because hierarchical thinking stems from **patriarchal** societies in which men have oppressed women. Yet, life is more valuable than matter, human consciousness is more important than animal sentience, and God is the most significant reality of all. They offer instead an image of **concentric circles**.

The contacters discuss the writing of twentieth century social scientist **Michael Polanyi**, who argued that metaphysical reductionism is both culturally and ethically debilitating **and** logically mistaken. The full reality of life must be apprehended **holistically** rather than **reductively**. For example, the sequence of bases in DNA transcends pure chemistry. It is the information about the history of the species in its environment that organizes its chemical components. In this sense, biology is not reducible to chemistry.

The strict, deterministic rules of **chess** confine the moves within the boundary that defines the game, yet do not themselves determine every game and move. All chess games are not the same. Players can develop unique strategies and styles within the space left undetermined by the rules. Just as we cannot reduce a particular game or a player's style to the rules of chess, so too we cannot reduce life and mind to chemistry and physics. Indeed, in both chess and life, our personal interest is in the possibilities **left over** after applying the **rules of the game** or the **laws of science**.

The contrasters suggest three things theology can learn from the close connection between chemistry, life, and mind. Firstly, the chemical bases of life and mind offers a new lesson in humility. Humans are embodied beings not disembodied spirits, and we depend on nature.

Secondly, the close connection suggests a fresh way of formulating God's relation to the universe. In traditional theology, God is both **transcendent** (beyond and above) and **immanent** (within). Perhaps God is in the world in the same gentle and unobtrusive way in which life embeds itself in matter. Life does not violate the laws of chemistry and physics. It does not interrupt nature and break its laws. Rather, like a master player creatively exploiting the rules of chess, life expressively exploits the laws of nature, insinuating itself into matter in a quiet but effective ordering of **information**. As life unobtrusively informs biochemistry, so too God gently informs the cosmos. God is as intimately related to the world as life is related to matter, without ever being noticed by science.

Thirdly, the close connection between **mud and mind** suggests a model for life after death. **John Polkinghorne** notes that information transcends the matter that encodes it. Furthermore, although most of the atoms in our bodies are naturally replaced every few years, the pattern remains the same (or changes only slowly). Our **psychosomatic unity** is dissolved at death, but our information-bearing pattern, which some identify with the **soul**, can be reconstituted elsewhere and elsewhere as a **resurrected body**. This suggests the simple prayer, "God, remember me!"

For the **confirmers**, the reductionist quest for simplicity corresponds to the religious quest for an ultimate foundational **unity** to all things. They note that the monotheism of the Abrahamic religions is a **simplification** of much earlier polytheism. Indeed, they only fault the reductionists for settling for shallow and simplistic **atomism** as the ultimate ground of simplicity and unity.

2007 October 30 (Tuesday) 9:30 AM

I returned the first draft of the [third writing assignment](#) with comments. The second and final draft will be due next Tuesday. We then began discussing the theologically important idea of **person-**

hood, which most people associate with the **mind**, which in turn is clearly related to the **brain**.

We first distinguished three distinct but related terms: conscience, conscious, consciousness. **Conscience** is an inner guide to the rightness or wrongness of behavior. **Conscious** typically refers to awareness or wakefulness. **Consciousness** is notoriously difficult to define and will be the subject of much of our discussion over the next couple of weeks. Consciousness connotes things like our **subjective perceptions** and our **free will**. Philosopher **David Armstrong** has called consciousness "the cream on the cake of mentality".

We then broke into small groups for twenty minutes to discuss a series of case histories designed by philosopher **David Holley** to explore the nature of [personal identity](#). In each case, a person changes, sometimes radically. In which cases are the original persons eliminated or new persons created?

A woman suffers irreversible brain damage and will never recover consciousness, but her body is kept alive artificially. What is the difference between brain death and heart death? We recalled the long and very public death of **Terry Schiavo**. We discussed death and dying with dignity.

A man develops an inoperable brain tumor that produces major personality changes. To what extent are our mind and spirit dependent upon our embodiment? We reviewed the famous case history of **Phineas Gage**, an 1848 rail worker who survived an iron rod blown through his skull, but whose behavior was permanently and profoundly altered. Was Gage still Gage?

Do people diagnosed with **Multiple Personality Disorder** represent two souls in one body? Can such personalities be verified by brain scanning technology? What are the **invariants of consciousness** that remain the same as we age and change, perhaps even undergo radical religious conversion?

What is it like to be a person incapable of forming new long-term memories, like the lead character in the 2000 movie [Memento](#)? To what extent are we our memories? Do **split-brain** patients have separate minds? How do infant half-brain patients adapt as they grow?

Would you be you if we transplanted your brain into another body? Are we **minds-in-bodies-in-society**? What would it be like to wake up in a new body every day? What if your brain's contents were transferred to another brain's contents? What if they were recorded to computer memory first? Would your recording need to be played to be you? When and where does a symphony exist: in the written score or in the performance?

Would you hesitate to use the **Star Trek** transporter, which de-materializes you in one location and re-materializes a copy of you in another? (When asked how exactly does the transporter work, a Star Trek technical advisor famously replied, "Very well, thank you!" However, even today, physicists can teleport simple quantum states.) Which is more important, your physical continuity or the pattern instantiated by your brain and body? If a transporter accident produced two copies of you instead of one, which would be the **real** you?

2007 November 1 (Thursday) 9:30 AM

We watched the Emmy-nominated 1989 episode [The Measure of a Man](#) from **Star Trek: The Next Generation**, which examines the definition of **person-hood**. The episode was written by [Melinda Snodgrass](#) and directed by [Robert Scheerer](#).

In the twenty-fourth century, the starship *Enterprise* explores strange new worlds and seeks out new life and new civilizations. Its commander is **Jean-Luc Picard**, and its first and second officers are **William Riker** and the android **Data**. The *Enterprise* crew considers Data to be an invaluable colleague and a trusted friend. Starfleet cyberneticist **Bruce Maddox** considers Data an extraordinary piece of engineering, but ultimately a **non-**

sentient machine. Maddox refers to Data as "it" and wants to disassemble him and reverse engineer many more similar androids.

Data and Picard object, and this forces a courtroom confrontation at the newly built **Starbase 173**. Due to lack of staff, Picard must defend and Riker must prosecute. With a sense of duty but a heavy heart, Riker convincingly demonstrates that Data is a machine. After taking the wise counsel of **Guinan**, the mysterious *Enterprise* bartender, Picard argues that declaring Data property would doom all future androids to **slavery**. He notes that we, too, are a kind of machine, made from our parents' DNA, but not their property.

Finally, **Phillipa Louvois**, the Judge Advocate General (and Picard's old nemesis and flame), rules in favor of Data. She admits that the case deals with **metaphysics** and with questions best left to **saints** and **philosophers**. However, she rules for the future: Data is a machine, but he is not the property of Starfleet. "Does Data have a **soul**? I don't know that he has. I don't know that I have! But I have got to give him the freedom to explore that question himself."

Afterwards, we discussed the possibility, within our lifetimes, of life-like computers and machines. When the **IBM** computer **Deep Blue** defeated world chess champion **Gary Kasparov** in 1997, Kasparov remarked that he sometimes saw deep intelligence and creativity in the machine's moves. It is likely that Artificial Intelligence or **AI** will increasingly affect our lives. However, will we sufficiently generalize our notion of persons to include advanced robots and computers? Will we pray for them and they for us?

I also noted two biblical but contrasting notions of person-hood: the **dualistic** idea of an immortal soul somehow temporarily attached to a mortal body, and the **emergentist** idea of a perishable psychosomatic unity followed by a later resurrection of the body. We will soon return to these distinct paradigms.

2007 November 6 (Tuesday) 9:30 AM

I collected the final draft of the [third writing assignment](#). We then reviewed scientific thinking about the brain and the mind in my lecture notes [Mind from Matter?](#)

The human brain is a **three pound universe**. Its **microstructure** features a collection of a hundred billion specialized cells, electrically nonlinear neurons, coupled into highly interconnected neural networks. Its **macrostructure** features an ancient reptilian complex, which we share with reptiles, surrounded by a more modern limbic system, which we share with mammals, wrapped in a modern neocortex. During embryonic development, our brains crudely repeat the sequence our ancestors evolved: **ontogeny recapitulates phylogeny**.

The two halves of the human brain are functionally asymmetric or **lateralized**. For example, in a right-handed male, the left brain controls the right side of the body and is said to be verbal, intellectual, and analytic. The right brain controls the left side of the body and is said to be spatial, intuitive, and holistic. In the 1960s, to control **epileptic seizures**, the main connection between the two hemispheres of some patients' brains was surgically severed. Such **split-brain patients** quickly compensated for loss of coordination, but careful experiments, by **Roger Sperry** and others, revealed two brains in one body.

In the 1950s, also when treating epileptic patients, **Wilder Penfield** was able to elicit specific memories by electrically stimulating their exposed brains. However, memories do not appear to be **localized** in single places in the brain. Rats that learn a maze can not simply be excised of that memory by surgical removal of specific brain tissue. Neuropsychologist **A. R. Luria**, in his book *The Mind of Mnemonist*, described **S. V. Shereshevskii**, a journalist with a seemingly unlimited memory, due in part to his fivefold **synesthesia**, an hallucinatory

conflation of the senses (so that a sound elicits a color, a touch elicits a taste, and so on).

Historically, we have learned about the functions of different brain regions by studying the effects of brain injuries due to stroke or trauma, like that caused by the iron rod blown through the skull of **Phineas Gage**. Today, because firing neurons require more nutrients, we can monitor brain activity nondestructively using **Positron Emission Tomography** and **Magnetic Resonance Imaging**, with increasing spatial and temporal resolution.

Still, the **mind-body problem** remains one of the deepest philosophical conundrums. It seems as if my brain, a physical system, will do what it will do, whether or not "I" drive it. Can mental states have their own dynamics above and beyond the dynamics they inherit from the physics of the corresponding brain states? How can mind influence matter without violating the laws of physics? But, if minds are only atoms in motion, then what loves chocolate and dreams of being an astronaut?

A popular answer is **Cartesian Duality**. Seventeenth century philosopher **René Descartes** postulated two kinds of stuff: matter and mind/soul. By analogy, "a driver" is to "a car" as "a mind" is to "a brain". However, this answer has been severely criticized. Twentieth century philosopher **Gilbert Ryle** referred to it derisively as **the ghost in the machine**. How exactly does mind move matter? Where precisely is in the mind? (Descartes suggested that the mind interacts with the brain at the **pineal gland**, which is located on the brain's centerline. Today, we know that the pineal gland secretes **melatonin**, a hormone that may help modulate sleep-wake patterns.)

An alternate answer is to deny the problem. **Idealism** denies the physical world, while **behaviorism** denies mental states. For the latter, **Daniel Dennett** has a clever analogy: "romantic love" is to "marital love" as "consciousness needs explanation" is to "consciousness doesn't need explanation".

Epiphenomenalism holds that mind is like froth on the surface of a wave. Mind parallels brain, but if your mind shuts off, it would not matter at all. **Functionalism** holds that mind **emerges** from the the functional organization of the brain above a certain threshold of complexity. Other examples of **emergent phenomena** include wetness and avalanches. (Wetness is not inherent in a single water molecule but emerges in a sufficiently large collection of water molecules; a single sand grain can not experience an avalanche, but many grains in a sufficiently large pile can.)

From a **theological perspective**, Cartesian Dualism is consonant with the traditional idea of an **immortal soul** briefly attached to a mortal body. However, this still raises many questions, some with significant societal implications. For example, when is the soul first attached to the body: at conception, or at birth, or at some other time? On the other hand, functionalism and emergentism are consonant with the alternate biblical idea of **resurrection of the body**.

From an **evolutionary perspective**, why did minds evolve? Obvious survival value accompanies the ability to **simulate** future histories, but why does self-awareness accompany this ability? Why are we not merely **automatons**? Perhaps the **novelty** of our subjectivity has survival value. To help make life worth living, natural selection may have favored the evolution of a subjectivity that is as astonishing as it is ineffable.

2007 November 8 (Thursday) 9:30 AM

I reminded everyone to schedule an advising meeting with me prior to registration next week. We then reviewed key ideas in the **philosophy of mind** in my lecture notes on [the hard problem](#) of consciousness.

I first asked, What is conscious? Today, **neuroscience** cannot predict what type of system has conscious experience. We need a theory that can predict, based on physical measurements, which of the

following is conscious: a **fruit fly**, a **dog**, a **chimpanzee**, a **human fetus** five months after conception, an unresponsive **Alzheimer's patient**, the **World Wide Web**. (Some of us were skeptical that the World Wide Web could ever be conscious, but some computer scientists are concerned that we may inadvertently create a conscious computer before we can recognize it — and it might be in pain! Today's science fiction is tomorrow's science fact.)

To be conscious is to be aware, and it may come in degrees. But I then asked, What is consciousness? Philosopher **David Chalmers** divides consciousness research into the easy and hard problems. The **easy problems** are how we discriminate stimuli, (verbally) report information, monitor internal states, control behavior, and so on. Actually, these problems are not so easy, but neuroscientists are making steady progress on them.

The **hard problem** of consciousness is **subjective experience**, also known as **phenomenal states** or **qualia**. When we think and perceive, there is a whirl of information processing, but there is also a **subjective** aspect. **There is something it is like** to be conscious, see a vivid green, feel a sharp pain, visualize the Eiffel tower, feel a deep regret, think that one is late, and so on. It is widely believed that experience arises from a physical basis, but why and how?

You are looking at **blue sky**. Physicists can tell you about the wavelength of the electromagnetic radiation. Biologists can tell you about the rods and cones in the retinas of your eyes. Neuroscientists can tell you about electrochemical synaptic encoding of visual stimuli. But why do you experience the **blueness** of blue? You have a **stomach ache**. Physicians can tell you about the acidity of your stomach. Biologists can tell you about the evolution of pain receptors. But why do you experience the **painfulness** of pain? Why don't these processes take place **in the dark**, without any accompanying experiences?

Against **materialism**, Chalmers suggests that physical accounts explain at most structure and function, but structure and function are insufficient to explain experience. Chalmers also ponders the existence of **zombies**, beings functionally identical to us but entirely lacking consciousness. **There is nothing it is like** to be a zombie. If zombies were possible, then consciousness must be a further, nonphysical component of the universe. After creating the physics of our universe, God must have had more work to do to include consciousness.

Philosopher **Frank Jackson** argues that there are facts about consciousness that are not deducible from physical facts. In a famous thought experiment, he asks us to imagine a neuroscientist named **Mary** who knows everything there is to know about the physical processes of color vision. However, Mary has been raised in a black-and-white room. Despite all her knowledge, it seems that there is something important about color that Mary does not know: she does not know **what it is like** to see red (as we ourselves will never know **what it is like** to echo-locate like a bat). A scientific theory of a tornado does not itself produce a tornado.

Daniel Dennett considers Mary's story to be a deceptive **intuition pump**, and he finishes it differently. You play a trick on Mary: To her black-and-white room you bring a banana painted red. To your surprise, she exclaims, "That banana should be yellow not red." With her **perfect** knowledge of the structure and function of color vision, Mary knew **exactly** what dispositions red and yellow would invoke in her. (Actually, because she was developmentally deprived of color sensations, her brain might not be able to interpret this extra information at all, just as cats initially raised in rooms without vertical lines will repeatedly bump into table and chair legs.)

Dennett argues that subjective experiences seem to exist, but do not. **Qualia** are merely characters in stories we tell ourselves about our selves. That's why the **redness** of red and the **painfulness** of pain are so **ineffable** and **incommunicable**. They are

merely dispositions for us to act in different ways. In a phrase with echoes of **Buddhism**, cognitive scientist **Douglas Hofstadter** writes, "I am an hallucination hallucinating an hallucination."

Dualistic alternatives to materialism include **epi-phenomenalism** and **interactionism**. In the former, physical states cause phenomenal states but not vice versa. In the latter, causation goes both ways. Interactionism is bolstered by some interpretations of quantum physics, where **observations** determine, in part, the history of physical systems.

According to the principle of **organizational invariance**, all systems with the same functional organization will have qualitatively identical conscious experiences. A silicon **isomorph** of your brain will have the same experiences you have. It may seem counterintuitive that generations of monks inscribing large books to compute neuronal inputs and outputs might give rise to conscious experience, but it seems equally counterintuitive that one hundred billion appropriately organized neurons should give rise to consciousness!

We considered a thought experiment in which your neurons are replaced one-by-one with **functionally equivalent** silicon computer chips. Would you ever notice a subjective change? Due to the functional equivalence, would you be able to report such a change even if you noticed it?

Finally, we considered a **monistic** alternative to dualism. Qualia may be ineffable, but physics is silent about the intrinsic nature of an electron (or superstring). Building on the work of philosopher **Bertrand Russell**, Chalmers suggests that **information** underlies and unifies both physics and experience. In a rainbow, both the physics and the experience of the colors code information. Physics is concerned with the relationship among these information states, while experience is concerned with their intrinsic natures.

Like two sides of the same coin, perhaps **physics is information from the outside, experience is information from the inside**. If so, as the intrinsic

aspect of the physical, experience would be causally relevant, even if physics is causally closed. Furthermore, such a deep intertwining of consciousness and physics would imply that **there is something it is like** to be an electron. Such **panpsychism** or **panexperientialism** has echoes in religious traditions that invest a little bit of mind or soul in everything.

2007 November 13 (Tuesday) 9:30 AM

I reminded everyone that first-years register for classes this week. Everyone needs to schedule an advising meeting with me before registering.

We then began discussing Barbour's Chapter 5, **Genetics, Neuroscience, and Human Nature**. In the preamble, Barbour outlines the scientific story, which he accepts, of human physiology and behavior evolving from nonhuman forms. Humans are social beings. We construct our sense of self from interacting with others. Feral children, like **The Wild Boy of Aveyron**, who have grown up without people, have difficulty acquiring language or fully socializing. (Deafblind **Helen Keller** vividly described how she was transformed when she acquired language via **tactile signing**.) Barbour notes that many animals also live in societies, including social insects like ants and bees and primates like chimpanzees. The former's behavior is largely encoded in its **DNA**, but the latter exhibits considerable cultural learning.

I described a colony of **macaques** studied by **primatologists** on a small Japanese island. The scientists fed the macaques by dumping sweet potatoes and wheat on a sandy beach. In 1952, a macaque named **Imo**, rinsed the sand off the potato by dunking it in a nearby brook. By 1957, all the macaques had acquired this skill. (In 1956, Imo took a handful of mixed wheat and sand to the brook and dropped it on the water, where the sand sunk and the wheat floated. Imo then skimmed the now clean wheat off the surface. Imo was the **Archimedes of macaques!**)

Chimpanzees have some grasp of language. Although their lack of a **larynx** inhibits speech, their dexterity enables them to use symbolic keyboards or sign language. The chimpanzee **Washoe**, who recently died at age 42, was raised by humans and taught **American Sign Language**, which she herself taught to her children. Washoe had a vocabulary of about 250 words. The first time she saw a goose, she reportedly signed "water" + "bird", which, supporters say, was like receiving a message from outer space. Although chimpanzee language ability stalls at the level of a two-year old child, it does suggest that language could have evolved gradually.

Most animals don't "get" mirrors. For example, birds will attack their reflections in glass. Only a few species exhibit **mirror self-awareness**: if you discretely apply paint to the back of an animal, does it rub itself when it notices the spot in a mirror? Chimpanzees, orangutans, and dolphins can pass this test. They have at least a rudimentary grasp of self-awareness. However, only humans are (poignantly) aware of their inevitable deaths, and only they construct complex symbolic worlds, such as novels and movies, via language and the arts.

Because recent research reveals both similarities and differences between humans and (other?) animals, evolutionary descent from a **common ancestor** is no longer such a threat to human uniqueness. The evolutionary changes have been gradual and continual, but they add up to dramatic differences. We are indeed set apart from nature, but not in the absolute way of traditional religious thought.

Under **conflict**, Barbour first considers **reductive materialism**, which, as we have seen, argues that all human behavior follows from the laws governing the behavior of matter. **Francis Crick** declaims, "You're nothing but a pack of neurons." He equates dualism with religion, unaware that many contemporary theologians, like Barbour, have rejected dualism. Crick's colleagues seek the **neural correlates of consciousness** by, for example, monitoring brain activity during **binocular rivalry** experi-

ments. He suggests that the subjective character of consciousness cannot be studied by science.

Daniel Dennett claims that consciousness is the last bastion of the **occult** (or the **supernatural**), which he is determined to breach. Dennett argues that the unity and continuity of consciousness are illusions, and the **self** is a useful fiction we create to order our lives. He echoes Crick by declaring, "You are made of robots" (trillions of macro-molecular machines).

Barbour next considers **sociobiology**, which claims that human morality developed from behavior that enhanced the survival of our ancestors' genes. If evolution is about the **survival of the fittest**, how can it explain **altruism**? Sociobiologist **E. O. Wilson** notes that social insects will sacrifice themselves to protect the colony. Although this limits the number of their own descendants, it enhances the survival of their close relatives, who carry many of the same genes. Wilson believes that evolutionary biology will eventually account for all aspects of human behavior, including **ethics** and **religion**.

Philosopher **Michael Ruse** argues, "Morality is a collective illusion foisted upon us by our genes." Values are **subjective** human constructs we project on the world, but in order to take them seriously, we have to believe they are **objective**. Barbour notes that Ruse's position appears to be self-defeating!

Alternatively, philosopher **Holmes Rolston** notes that **cultural evolution** differs significantly from **biological evolution**: rather than being transmitted via **selfish genes**, it's transmitted via language, education, and tradition (including religion), and hence is both faster and cumulative. He objects to using terms like "selfish" and "altruistic" for lower life forms because, at those levels, there are no **free moral agents**. The **capacity** for moral judgments may result from natural selection, but not **particular** moral judgments.

Rolston believes that sociobiologists themselves subscribe to values that cannot be justified by their

own theories. For example, it is implausible that Wilson's deep concern for endangered species is merely an unconscious and indirect way of maximizing his own genetic fitness.

Finally, Barbour considers **genetic determinism**, the thesis that we are controlled by our genes, and human freedom is illusory. I recalled a T-shirt I saw at Scot Spirt Day that read, "Whether it's nature or nurture, my parents are to blame." Studies of **identical twins** separated at birth suggest that genetic factors for traits like **homosexuality** and **criminality** account for (only?) about half of the variation. A recent book titled **Identical Strangers** records the story of identical twin sisters separated at birth but united in adulthood to discover many shared traits.

Barbour concludes that genetic and cultural factors cannot be separated in any simple way. **Nature and nurture** pose significant constraints, but human freedom is self-determination at the level of the **person**. We can't choose the cards we're dealt, but we can choose how we play them.

2007 November 15 (Thursday) 9:30 AM

We finished discussing Barbour's Chapter 5. One way to maintain the **independence** of the science of the mind and religion is to adopt a **body-soul dualism** and argue that science studies the body while religion caters to the soul. However, Barbour extensively critiques this strategy.

The notion of an **immortal soul** entering the body at conception or birth and leaving it at death is foreign to the biblical view of a person as an **undivided whole**. Instead, body-soul dualism developed in the early Christian church due to the influence of Greek philosophy. Four hundred years before **Jesus**, **Plato** held that a pre-existent immortal soul enters a body and survives its death. In the century after Jesus, **gnosticism** maintained that matter is evil and death liberates the soul from the imprisonment of the body. The early Christian church rejected gnosticism as a heresy, but accepted a **neoplatonic** dualism of **body versus soul**

and, to a lesser extent, **good versus evil** and **God versus Devil**. (Note the similar spelling.)

In medieval theology, the immortal soul established an absolute line separating humans and animals and encouraged a human-centered worldview. The matter-mind dualism of **René Descartes** departed even further from the biblical view. Mind became a nonmaterial, nonspatial thinking substance characterized by reason and not emotion. Matter was spatial and controlled by physical forces. How could such dissimilar substances possibly interact? In addition, Descartes considered animals to be soulless automata and practiced **vivisection**.

Today, **Catholicism** affirms evolution but also the presence of a soul in humans from conception, with major implications for **reproductive ethics**. Despite the continuing influence of dualism in Western culture, most scientists and many contemporary theologians reject both body-soul and matter-mind dualism.

A second way to maintain the independence of science and religion is to argue that body and soul are **complementary perspectives**. Theologian **Keith Ward** contends that rather than being distinct entities, body and soul are different forms of **discourse** about human beings. Actions can be described in terms of physiological mechanisms or moral choices. A third-person story of **neural** events and a first-person story of **mental** events are complementary rather than competitive. Brain and mind are two ways of talking about the same thing.

Ultimately, Barbour himself rejects both body-soul dualism and body and soul as complementary languages. Instead, he defends an integral (undivided) view of a person as a **psychosomatic unity**. According to biblical scholar **Robert Gundry**, we are animated bodies rather than incarnated souls. This perspective is both closer to the biblical view and more consistent with the scientific evidence.

Under **dialogue**, Barbour notes that both **neuroscience** and theology recognize the importance of the

embodied self. Unlike the rational mind of Descartes, the human self is a unified activity of reason **and** emotions. Neuroscience records experiments with a patient devastated by a prefrontal tumor who could no longer feel emotions. The Christian New Testament records Jesus saying, "Thou shalt love the Lord thy God with all thy heart, and with all thy soul, and with all thy mind" (Matt. 22:37 KJV).

Both **anthropology** and theology recognize that we are inherently social beings. Our personal identities are established by the stories we tell ourselves about ourselves, in which we are both agents and subjects. In the biblical tradition, God's **covenant** is with a people, not a succession of individuals. Individuals are always **persons-in-community**.

Many **computer scientists** view the brain as an information processing system like a computer. **Strong AI** maintains that thinking is computation, the substrate is immaterial, and "mind" is to "brain" as "software programs" are to "computer hardware". On the contrary, Barbour surveys a number of computer scientists who believe that computers will need to be embodied like us before they become truly **sentient**. We wondered what it would be like to grow up with a teddy bear that could pass the **Turing Test** and impersonate a human using only natural language.

Under **integration**, theologian **Philip Hefner** asserts that we are both biological organisms and responsible selves. Evolution is God's way of creating free creatures, and we are **created co-creators**, helping open up further creative possibilities. In us, nature is stretched and enabled as it gives rise to new zones of freedom. Our **eschatological** hope is that God will one day perfect and fulfill creation.

Finally, Barbour reviews **David Chalmers'** theory of mind and brain: two aspects of one process. As we have discussed, Chalmers rejects **materialism** and holds that consciousness is **irreducible**. **Information states** are the fundamental constituents of reality, and they are always realized both subjectively and physically. Internal aspects are subjective

tive and external aspects are physical. Simple information states are realized in simple physical structures and simple subjective experiences. Only a very restricted group of (sufficiently complex) subjects of experience would qualify as **agents** or **persons**.

2007 November 20 (Tuesday) 9:30 AM

Today, I returned the graded [third writing assignment](#), and collected the first draft of the [fourth writing assignment](#). To complete our analysis of the science of the mind and religion, we then discussed the 1969 short story [Super-Toys Last All Summer Long](#) by British author [Brian Aldiss](#).

One of challenges and pleasures of reading science fiction is to deduce the alternate world of the writing from clues placed by the author. Here, we first meet **Monica Swinton** and her son **David**. Monica's garden is always summer, and we soon understand that this is not a metaphor, but an illusion created by advanced technology. The Swintons live in a near future that is overcrowded with people and crammed with gadgets. Mother and son seem poignantly estranged. Monica fears that David is more interested in playing with **Teddy**, one of his voice-activated toys, an electromechanical teddy bear. However, David confides to Teddy that he loves Mummy, only he can't find the words to express himself.

Meanwhile, husband and father **Henry Swinton** is the director of **Synthank**, a manufacturer of synthetic life-forms, including very successful **miniature dinosaurs**. In a company speech, he announces its latest breakthrough product, a full-sized synthetic serving man.

The two strands of the story intertwine when Henry comes home (with one of the new serving men). Monica greets him breathlessly to announce that they have won the **parenthood lottery** and can conceive a child at once! After a brief celebration, they pause and consider David and Teddy. Henry asks, "Is David malfunctioning?" — and we are

surprised to learn that David himself is a robot.

We are surprised because, while the author emphasizes in numerous ways that Teddy is a **non-sentient** automaton, he puts us inside David's head, so we know for sure that David is **sentient**, even though his parents do not (and cannot?) know this!

Since this short story is the basis of the 2001 film *A.I. Artificial Intelligence* by **Steven Spielberg**, we watched two teaser trailers for the movie. The first trailer introduces the tag line, "His love is real, but he is not". However, according to physicist **Frank Tipler**, if David's love is real, David is real, regardless of his embodiment. The second trailer provides a stylized version of how David bonds to Monica, a kind of **imprinting** famously studied in the 1930s by ethologist [Konrad Lorenz](#), whose **goslings** spent their first few hours of life with him and then constantly followed him around. This trailer also offers a brief glimpse of Teddy.

Back to reality, I just received the latest 2007 **Sharper Image** gift catalog. Prominently featured on the cover is the newest in home robotics: **Pleo**, a robotic **baby dinosaur**. Pleo has organic skin, multiple vocalizations, numerous sensors, hundreds of smooth, realistic movements, and the ability to learn from its environment and develop a unique personality. This **Jurassic pet** is available immediately for \$349.99, and it would make the fictional Synthank proud. What, we wondered, will the 2017 or 2020 Sharper Image catalogue feature?

2007 November 27 (Tuesday) 9:30 AM

We began our discussion of **human** and **divine action** by reviewing my lecture notes on [quantum physics](#), in which a series of thought experiments introduce some key ideas. The **macroscopic** world of our classical intuition emerges from the **microscopic** world of quantum physics. Billiard balls are made of atoms, not the other way around.

At normal to high intensity, light behaves like a classical (electromagnetic) wave. At low intensity, the **graininess** of light becomes apparent and **photo-multiplier tubes** register individual particles of light called **photons**. This fundamental **wave-particle duality** was first discovered about a century ago through the work of **Albert Einstein** and **Arthur Compton** and others.

If high intensity light strikes a beam splitter, perhaps a half-silvered mirror, half is transmitted and half is reflected. If low intensity light strikes the beam splitter, photons are transmitted or reflected with **probability** one half. Wave-particle duality, and the implicit need for **classical correspondence**, forces probabilities into fundamental physics. In the conventional interpretation, these probabilities are **ontological** rather than merely **epistemological**. To Einstein's consternation, God apparently does **play dice** with the universe.

Recombining the light from the first beam splitter with additional mirrors and a second beam splitter creates an **interferometer**. Single photons in an interferometer can be used to perform **null measurements**, as in the **Elitzur-Vaidman** bomb testing problem, where the outcomes are determined by **counter-factuals**, things that might have happened but did not. Such classically bizarre behaviors are, to invert **Shakespeare**, the dreams that stuff is made of.

Following the break, I presented a brief biographical sketch of **John Polkinghorne**. For 25 years, beginning in the 1950s, Polkinghorne was a prominent theoretical particle physicist involved in the discovery of **quarks**. In 1982, he "turned the collar around" and became an Anglican priest. Today he is a Christian theologian with a special interest in science and religion. Polkinghorne has delivered the prestigious [Gifford Lectures](#) in Natural Theology and is the winner of the 2002 [Templeton prize](#). He is one of the most important figures in science and religion today.

Although more theologically conservative than **Barbour**, Polkinghorne is a **critical realist**, who

believes that science and religion address different aspects of the same reality. Rejecting **dualism**, he is also a **dual aspect monist**, who affirms that the world consists of one kind of stuff, which can occur in two contrasting states, the mental and physical. **Active information**, mediated by **higher-level causation**, selects which of multiple energetically possible states occur, thus enabling human and divine **agency**. Controlled physics experiments are highly atypical natural processes and, due to quantum physics, reality is more **cloud-like** than **clock-like**.

We next began discussing Polkinghorne's Chapter 5, **Divine Action**. In the preamble, Polkinghorne notes that limited considerations yield limited insight, and so **natural theology**, which attempts to reason from nature to God, can at most yield a **de-istic** God, absent from creation. Nevertheless, natural theology is consistent with a **theistic** God, active in creation. Deism and theism agree that God sustains the laws of nature, but theism maintains that God is present in both natural regularity (necessity) and historical contingency (chance).

Polkinghorne asks to what extent can we suppose **with integrity** that God acts in the universe science describes? Is the net of physical causality drawn too tight to allow divine or human actions?

Divine action has been the focus of much recent research in science and religion. Polkinghorne identifies three major approaches. **General providence** asserts that God breathes fire into the equations of physics, and the laws of nature are expressions of God's faithfulness. It is consistent with deism or theism. **Special providence** allows particular divine actions **within the grain** of physics that are not immediately or unambiguously distinguishable. They are discernible by faith, but not demonstrable to skeptics. **Miracles** are radically unnatural events **across the grain** of physics.

Within these general approaches to divine action, there are many specific proposals. **Single action** is a minimalist account which provides only for general providence. God is the **ground of being** and performs a single timeless act of sustaining cosmic

history. God is overall necessity, but chance is random. One motivation for this approach is the fear that any other approach would breach the integrity of modern science. A second motivation is **theodicy**, the defense of God's goodness in a world suffused with suffering and evil. A God of a single act does nothing in particular and hence cannot be held responsible for anything in particular.

Polkinghorne notes that the stronger one's account of divine action, the more difficult is theodicy. Can **any** theological arguments defending God be convincing to the parents of burning children? That's a harsh image, but the problem of suffering should not be minimized.

2007 November 29 (Thursday) 9:30 AM

We continued discussing Polkinghorne's Chapter 5. **Primary causality** is an approach to divine action that is metaphysically opposite but practically equivalent to the **single action** approach. It proposes that God acts via a divine primary causality within a network of natural secondary causality that is the subject of science. Divine agency is thus ineffably present in all that happens, and theology is rendered invulnerable to science. However, it is not clear if postulating **multiple causes** (or becauses?) for individual events is a coherent idea, despite a long tradition in philosophy. Furthermore, it complicates theodicy, as God would be directly responsible for all events, good and bad.

Process thought is a metaphysics introduced by **Alfred North Whitehead**, which proposes that the basic elements of reality are not **entities** (like atoms) but **events**, and each event is influenced by the **lure** of divine persuasion. God persuades rather than coerces. Process thought's **Pleading Participant** replaces classical theology's **Cosmic Tyrant**. However, Polkinghorne is skeptical that this approach is adequate to the religious experience of prayer or can guarantee the eventual triumph of good over bad.

Analogies with human agency may help explain divine action. However, because we do not understand the nature of the **causal joint** that allows human agency, these are appeals from the **unknown** to the **Unknown**. Although some philosophers argue that free will is compatible with determinism (compatibilism), most theologians affirm that we don't merely transmit the push of our past (necessity), nor do we simply disconnect from the past (chance), and yet by what **transcendental magic** do our actions escape both chance and necessity?

Nevertheless, one such approach to divine action is **embodiment**, which imagines that God acting in the world is analogous to us acting in our bodies. When we move our bodies, it certainly seems as if our minds are moving matter. Similarly, God is embodied in the universe as the **Mind** of the world. Although Polkinghorne is skeptical of the analogy, because the universe does not resemble an organism, this approach is compatible with either **pantheism** or **panentheism**.

In traditional physics, parts influence wholes in **bottom-up causality**. Conversely, wholes may influence parts in **top-down causality**, which we seem to experience when our minds appear to move the atoms of our bodies. By analogy, perhaps God acts similarly. **Arthur Peacocke** envisions God as the **boundary condition** of the universe, where cosmic influences trickle down to produce localized effects. As with primary causality, Polkinghorne's concern is that the nexus of bottom-up causality may be drawn tight enough to exclude the effects of the whole on the parts.

An **open universe** may enable both human and divine agency. Possible sources of openness in physics include **quantum** and **chaos** phenomena. As we have discussed, quantum theory predicts probabilities rather than certainties for microscopic events, include the genetic mutations that underlie biological evolution and the neuronal couplings that underlie thinking. Theologians, like **Bob Russell**, propose that God acts via the indeterminacies

of quantum physics. Polkinghorne worries that such divine influence would be episodic rather than continuous.

Chaos theory describes many **nonlinear** systems that exhibit **extreme sensitivity to initial conditions**. We were mesmerized by a toy chaotic pendulum, which I placed in the middle of the seminar table. The weather is another chaotic system, and **Edward Lorenz** famously suggested that a butterfly flapping its wings in Brazil could spawn a tornado in Texas. Although the unpredictabilities of chaos are conventionally interpreted **epistemologically**, Polkinghorne interprets them **ontologically** and proposes that God acts through them.

Both open universe approaches locate the causal joint within the unpredictability of physical processes. Hence, for any event, it is impossible to disentangle the **causal web** and distribute the responsibility among God, people, and nature. Faith can discern but science cannot demonstrate such divine action.

Related to divine action is **divine temporality**. How does God relate to time? Does God perceive the whole cosmic history all at once in a timeless act of knowing? Or does God experience time the way we do, the future becoming the past via a moving present? Is the future up ahead, waiting our arrival, or do we make it as we go along? Some theologians defend a **dipolar God**, who somehow experiences time both ways.

The mathematics of **relativity** theory describes a **spacetime** where the future exists equally with the present and the past. If the future already exists, is free agency possible? However, physicist **David Mermin** cautions against **reifying** spacetime, which may be better understood as an abstract organizational tool.

2007 December 4 (Tuesday) 9:30 AM

I returned the first draft of the [fourth writing assignment](#) with comments. The second and final

draft will be due this Friday by 5 PM. We then completed our discussion of Polkinghorne's Chapter 5 and had a lively discussion of prayer.

Polkinghorne does not have a **scientific** problem with **miracles**, because miracles are unique, nonrecurrent events that science cannot exclude. They are outside of normal scientific enquiry. Furthermore, as **Bob Russell** has argued, any miracle could be interpreted as a first instantiation of a new law of nature.

However, Polkinghorne considers miracles to be **bad theology**. A quarter century as a working physicist has convinced him of the beauty and consistency of nature, which he interprets theologically as reflecting the faithfulness of God. How can such wholly exceptional events be reconciled with divine consistency? It is **incredible** (not believable) that God is a **celestial conjurer**.

However, God's self-consistency is that of a person, not that of a machine. In unprecedented circumstances, God may act in unprecedented ways. Polkinghorne offers an analogy with the **phase transitions** of physics: ice is solid water, water is liquid ice. Melting and freezing would be astonishing if they weren't so common, but deep continuities underlie the superficial discontinuities. Similarly, the quiet steadfastness of God may underlie the exceptional natures of miracles.

But if God does act in the world, why are such actions not more extensive and effective? In returning to **theodicy**, Polkinghorne distinguishes moral evil (or suffering), which seems primarily a human responsibility, from physical evil, which seems primarily a divine responsibility. He considers several response strategies. One is to deny or diminish the reality of evil: just as darkness is the absence of light, evil is the absence of good. However, this defense rings hollow as it fails to acknowledge the terrible intensity of suffering.

A second theodicean strategy is to argue that bad things happen as the necessary cost of other very good things. Polkinghorne deploys a free will de-

fense against moral evil and a free process defense against physical evil. The **free will defense** affirms that it is better for creation to contain freely choosing persons, however disastrous their choices. **Character** cannot be ready made but must be formed through a history of moral choices. Moral evil is a necessary cost of the existence of the greater good of human freedom and moral responsibility. The **free process defense** affirms that reliable physical laws provide an essential **stage** for moral development. However, in such a world, gravity pulls on the weak and strong, and cells that mutate to form new life can also mutate to cause cancer.

If God is all-good and almighty, why is there so much suffering? Polkinghorne nuances his understanding of "almighty". Our world is not God's puppet theater. God let's go and leaves room for the created other, allowing us both free will and free process.

Ultimately, though, there is no complete explanation for the **profound mystery** of suffering. A totally risk-free world might be too bland to stimulate human spiritual and artistic development. (Can there be art without suffering?) Yet the weight of suffering seems often to exceed what can be borne. Some rise above evil in inspiring ways, but others seem destroyed by it. A specifically **Christian** response to suffering is the idea of God suffering with us, especially through the life and death of **Jesus**.

After the break, we discussed **prayer**, which is an important feature of the **Abrahamic religions**. I imagined a scientific study of the efficacy of prayer for the sick. If prayer increased survival and recovery rates, not only would prayer become (nearly) universally accepted and practiced, but scientists would attempt to optimize it by testing different combinations of prayer groups from different religions, and so on. This seems far fetched. We have repeatedly discussed the idea that God's actions may be subtle and intentionally under science's radar. In fact, I revealed that studies of the efficacy

of prayer have indeed recently been performed, and no significant correlation between prayer and health has been found.

In the wide ranging discussion that followed, we touched on many issues related to prayer, and many opinions were offered. Praying for an "A" on a test is different from praying for focus while studying for the test. Prayer need not be **petitionary**: It can be meditating, listening for or to God, talking or even arguing with God. Prayer is not about what I want; prayer is unselfish. Prayer need not be institutionalized or ritualized; you don't have to go to **synagogue** or **church** or **mosque** to have a relationship with God. Nevertheless, many of us, including our authors, value the long and deep wisdom of our traditions.

2007 December 6 (Thursday) 9:30 AM

I briefed everyone on the [fifth writing assignment](#), which is due next Tuesday at the end of our final exam slot. We then completed our discussion of prayer.

Contemporary physicists have discovered that reality is far more subtle than classical physicists imagined. God's action in the world may be similarly more subtle. In that spirit, writer **C. S. Lewis** has suggested an interesting literary metaphor for divine action, prayer, and the vexing theological problem of how God experiences time. Lewis imagines that God first creates a **rough draft** of history, then listens to (the prayers of) all finite persons in that history. Based on their feedback, God **revises history** and iterates this process until history converges to what we experience. Thus, history is a combination of God's initial rough draft, which may simply be the laws of nature, plus God's revisions based on our feedback. God and finite persons together create reality.

Finally, we discussed the preamble to Barbour's Chapter 6, **God and Nature**. In previous chapters, Barbour focusses on religion and particular sciences. In this final chapter, he takes a broader view:

How does God act in a world of lawful natural processes? Like Polkinghorne, Barbour's detailed knowledge of science engenders a deep respect for the profound and elegant laws of nature.

In attempting to model God's action in the natural world, Barbour notes that the Bible itself contains many different theological models of God, including Designer, Potter, Architect, Communicator, Sovereign, Shepherd, Parent, and Redeemer. The **medieval Christian model**, which remains so relevant to Western thought and literature, is the **mon-archial model** of God as omnipotent and omniscient ruler, for whom every event is foreknown and predetermined. God affects the world but not vice versa, as God is eternal and unchanging (which, by the way, seems dramatically different from the passionate and dynamic God of Israel).

Barbour argues that that medieval model needs **revision**. The model includes, for example, a pre-ordained hierarchy of God, man, woman, animal, plant. Medieval theologians knew that men had souls, as they themselves were men, but they debated whether or not women had souls. Barbour and contemporary theologians reject this hierarchy. Instead, they attempt to adapt the **wisdom** of their **traditions** to the best of contemporary knowledge, including modern **science**.

I invite you to do the same.

scientia
et
religio
ex
uno
fonte