INTEGRATING FAITH AND LEARNING IN THE TEACHING OF PHYSICS

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The physics professor often has difficulty in finding ways of integrating faith into the teaching of his subject matter, but possibilities are available. The ideas in this paper draw from presentations at past *Faith and Learning Seminars* (Woolford; Rogers; Pilli) and add to them.

CHRISTIANITY AND THE ASSUMPTIONS OF PHYSICS

A Christian's belief about God results in certain assumptions about the natural world. Historians of science have suggested that the Judeo-Christian environment of western Europe and the belief in a monotheistic God were responsible for the development of modern science in that culture. Today students can still see that Christianity and physics are compatible and that similar assumptions underlie both.

The Judeo-Christian God is a <u>law giver</u>. His creation would then be lawful, understandable, repeatable, and amenable to study with rational inquiry. In contrast, the polytheistic warring factions and arbitrary gods of other cultures would give a world where rational inquiry would be useless. These puny gods might be envious if man came to understand nature.

The <u>personal</u> God of Christianity is separate from nature, making abstract laws for nature reasonable. Nature can be studied objectively—all observers will record the same natural phenomena given the same conditions. In contrast, a belief in impersonal nature gods makes abstract natural laws unrealistic and experimentation on nature a fearful and forbidden endeavor.

Genesis depicts God <u>freely creating a good world</u>—a freely created world that must be experimented on to understand and a good world worthy of man's experimentation. Manual labor in the study of nature is not degrading. For the Christian, especially in the Puritan work ethic, science was an attractive vocation. The Royal Society in England was largely begun by Puritans, and their goal was to give glory to God. One learns about nature from nature itself, not from the authorities. In contrast, philosophy was held in high regard in Greek culture, where manual labor was for the slaves. The determination of the one and only way in which nature could operate was a philosophical problem, so experimentation was unnecessary. The real world was imperfect anyway and would quite likely give erroneous results; only the ideas were perfect.

The creation of <u>man was in God's image</u>, with rationality and the ability to understand the world. He was made a steward of the world and given dominion, and thus a need to learn how to control it.

Unfortunately, these intellectual developments gradually led to a mechanistic worldview based on naturalism, rationalism, determinism, and reductionism, and seemingly without need for the supernatural. However, more recent developments in science, particularly physics, have suggested that this mechanistic worldview is not totally satisfactory—objectivity and determinism are incomplete, reductionism and logic are insufficient, and the universe had a beginning and is designed. This too is understandable in terms of the Judeo-Christian God who only is all powerful, all wise, and eternal.

The next section mentions several physicists who have done their science within the Judeo-Christian worldview. The third section uses a brief history of physics developments in this century to outline limitations of any scientific endeavor. The fourth section describes some relations between physics principles and theological concepts, with emphasis on how the "new physics" displays the insufficiency of a totally naturalistic worldview.

EXAMPLES OF CHRISTIAN PHYSICISTS

Nicolas Copernicus (1473-1543) was an astronomer and canon (staff clergyman) in Poland, though he never went on to become a priest. His research he regarded as "a loving duty to seek the truth in all things, in so far as God has granted".

Johannes Kepler (1571-1630), who described the motion of the earth and other planets around the sun in his *Mysterium Cosmographicum* (Mystery of the Universe), states that his ideas came from the concept of the Trinity. In the preface he says:

> There were three things, especially, whose causes, why they are the way they are, and not differently, I incessantly researched, the *number*, *magnitude*, and *movement* of the orbits. I was led to dare this by those beautiful harmonies of things at rest; that is, the Sun, the fixed stars, and the intervening space, with God the Father, the Son, and the Holy Spirit. . . .

Sir Isaac Newton (1642-1727) developed theories of light and of universal gravitation and shares with Leibniz the honor of inventing calculus. Newton's science was closely related to his theology. In the General Scholium of his Principia, he states that its purpose was to establish the existence of God; it was to combat atheism, challenge the mechanical explanation, and point to the need for a wise and benevolent deity and an intelligent Creator. John Locke said that Newton had few equals in Bible knowledge. Newton wanted certainty in his beliefs and to use the Bible as a clear rule, so he had a well defined set of rules for interpreting the Bible. He believed that the ancient texts provided science information, including a description of a recent creation and catastrophic destructions. Later in life he wrote on prophecy and the chronology of ancient kingdoms. He believed that he was part of a remnant, chosen by God to restore the interpretation of the Bible. (Westfall)

Michael Faraday (1791-1867), arguably the leading scientist of his generation, is known for his pioneering work in electricity and magnetism and is honored by having the unit of capacitance named after him—the farad. He was also a fully committed Christian who belonged to a very small sect known as Sandemanians. This group kept itself distinct from all other religious groups in the belief that they alone were accurately following the directions given in the Bible. For his admission to the church, Faraday demonstrated before the congregation his faith in the saving grace of God and his commitment to live in imitation of Jesus Christ. He met with fellow believers every Sunday morning and Wednesday evening. As a church elder, he participated in the Sabbath services, including the exhortations, and performed numerous pastoral duties among the London brethren, such as visiting those in need and tending to them materially and spiritually. Faraday had a strong need to order his environment, a theme that pervaded both his science and his religion. He was cautious about the speculative interpretation of experimental facts—a caution that parallelled the Sandemanians' adherence to the literal word of the Bible without interpretation. (Cantor)

Joseph Henry (1797-1878), the leading American physicist in the mid-nineteenth century, was a professor at Princeton from 1832 to 1846. His studies in electromagnetism led to the discovery of self-inductance, with the physical unit of inductance—the henry—being named after him. Henry is also remembered as the first director of the Smithsonian Institution. He believed that scientific knowledge resulted in moral betterment because it led to the contemplation of God's creation, and science study required moral discipline, imparting to scientists the virtues of truthfulness, respect for others, care and diligence.

James Joule (1818-1889), a committed Christian, demonstrated the relation between mechanical, electrical, and chemical effects, thus discovering the principle of energy conservation, also called the first law of thermodynamics.

Sir George Stokes (1819-1903), a professor at Cambridge and president of the Royal Society, was a contributor to the theory of light and sounds waves. His Christian beliefs are amply displayed in his book, *Natural Theology*. (Heeren)

Lord Kelvin's [William Thomson] (1824-1907) second law of thermodynamics, that the dissipation of energy is a universal feature, was directly related to his theology. Here he unified two of his deepest commitments: universal natural law is created and governed by divine power, and the world is progressively developing toward an inevitable end. He summarized his belief by quoting Psalm 102:26, "all of them shall wax old like a garment". He believed that God alone could restore the original distribution or arrangement of energy in the created universe.

Related to this, Kelvin objected to evolution by blind chance. He believed that life proceeds only from life, that it is a mystery and a miracle, and was designed and guided by a Creator. (Smith and Wise)

James Clerk Maxwell's (1831-1879) abstract equations of the electro-magnetic field were comparable to his religious beliefs conceived in symbolic, almost abstract terms. He proceeded from the contemplation of material relationships to spiritual truth, as he did from the model of the electro-magnetic field to the equations. Maxwell was aware of the limitations of a rigidly deterministic outlook and replaced mechanical causation by a statistical approach. This was a decisive step towards quantum physics and the principle of indeterminism. He ridiculed the shallow materialism of the Philistines:

> In the very beginning of science, the parsons, who managed things then,
> Being handy with hammer and chisel, made gods in the likeness of men;
> Till Commerce arose, and at length some men of exceptional power
> Supplanted both demons and gods by the atoms, which last to this hour.
> From nothing comes nothing, they told us, nought happens by chance but by fate;
> There is nothing but atoms and void, all else is mere whims out of date!
> Then why should a man curry favour with beings who cannot exist,
> To compass some petty promotion in nebulous kingdoms of mist? ...

Maxwell made a deep seated and permanent faith commitment at age 22. He came away from his upbringing in the Church of Scotland and the Church of England in his very personal religious quest. After his religious conversion, he was sure that the basis of religion did not lie in rationalist elaborations. Maxwell freely acknowledged that science should never be considered a guide to religious truth. "The rate of change of scientific hypothesis is naturally much more rapid than that of Biblical interpretations." Movements from science to theology may be more than illegitimate, they may be dangerous for believers. (Theerman; Koestler)

Scientific journals of this century still referred to the relation between God and the physical world. The purpose of the *Physical Review*, the journal of the American Physical Society, was to understand the physical character of nature. These efforts were similar to those of the Silliman Lectures on Science, which had begun at Yale University: "to illustrate the presence and providence, the wisdom and goodness of God, as manifested in the natural and moral world." (Adair and Henley) Sir J. J. Thomson's inaugural presidential address to the British Association is recorded in the August 26, 1909 issue of *Nature*. He concludes by saying,

> As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasized by every advance in science, that "Great are the Works of the Lord."

Present day examples include John Polkinghorne, a former mathematical physics professor at Cambridge University and Fellow of the Royal Society, who trained for the Anglican priesthood. He believes that:

> The rational order that science discerns is so beautiful and striking that it is natural to ask why it should be so. It could only find an explanation in a cause itself essentially rational. This would be provided by the Reason of the Creator ... we know the world also to contain beauty, moral obligation and religious experience. These also find their ground in the Creator—in his joy, his will and his presence.

A recent book describes interviews with 60 leading scientists, including 24 Nobel prizewinners, on their beliefs about God. (Margenau and Varghese) One is Arthur L. Schawlow, a Professor of Physics at Stanford University. He shared the 1981 Physics Nobel Prize with two others for their contribution to the development of laser spectroscopy. Schawlow says:

> It seems to me that when confronted with the marvels of life and the universe, one must ask why and not just how. The only possible answers are religious. . . . I find a need for God in the universe and in my own life.

William C. Phillips, who works at the National Institute of Standards and Technology, was one of the three who received the 1997 Nobel Prize in physics "for the development of methods to cool and trap atoms with laser light". He attended Juniata College in Pennsylvania before doing his doctoral work at MIT. It was at Juniata were he learned to respect both science and faith. He is a gentleman of the highest order and with equal enthusiasm mentors high-school students and leads Bible study sessions for children in his church.

PHYSICS HISTORY SUGGESTS SOME LIMITATIONS OF SCIENCE

Historically, the properties of light have been explained in terms of both discrete, particle models and continuous, wave models. (Gamow) In the late 17th century, Isaac Newton developed a particle model for light that became the accepted model during the 18th century. During Newton's time, Christian Huygens felt that light was better described as a wave. This wave model of light gained favor in the early 19th century, and was the only accepted model by the end of that century. Light is produced from changing electric and magnetic fields, so the wave model of light includes electricity and magnetism as well.

Almost all of the observed phenomena of light, electricity, and magnetism were described a century ago by James Clerk Maxwell using a set of four equations. His wave model of electromagnetic radiation was comprehensive, unifying, elegant, and logical. Considering all the phenomena that the wave model of light could explain, it obviously seemed much better than the obsolete particle model of light suggested by Newton. In the late 19th century, scientists believed that the wave model of light was complete, and in need of no more than minor modifications. This reflected a general attitude in science at the time, as expressed in 1894 by Albert Michelson at the University of Chicago: (Badash)

> While it is never safe to affirm that the future of Physical Science has no marvels in store even more astonishing than those of the past, it seems probable that most of the grand underlying principles have been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all the phenomena which come under our notice. It is here that the science of measurement shows its importance—where quantitative results are more to be desired than qualitative work. An eminent physicist [probably Lord Kelvin] has remarked that the future truths of Physical Science are to be looked for in the sixth place of decimals.

Several pieces of data, however, had not yet been explained. Attempts to deal with these remaining problems led to two major revolutions. (Kuhn; Cohen; Morris)

Relativity. The first difficulty had to do with the medium in which light travels. Water waves travel in water and sound waves travel in air. But light waves travel through space on their way from the sun to the earth where there doesn't seem to be any medium. An all-pervading substance called aether was postulated to provide a medium. Many experiments were performed in an attempt to detect it, but no evidence for an aether was found. The extrapolation from water waves to light waves resulted in an approximate model that worked well in explaining many phenomena, but not in predicting a medium for light. Albert Einstein solved the problem in about 1905 by simply assuming that light waves cannot be exactly modeled after other waves. In his special theory of relativity, he postulated that light waves travel independently of any medium (or reference frame).

This special theory of relativity made some very non-intuitive predictions that have since been experimentally confirmed. The equations of special relativity are now routinely used to describe experiments at particle accelerators. Observations at "every-day" speeds cannot be used to understand what happens at the extremely high speeds at which light travels.

Quantum Mechanics. The second difficulty had to do with whether light is actually a wave. Newton's particle model had long since been superseded by the wave model, but there were some observations, such as the ultraviolet catastrophe, that could not be explained by modeling light as a wave. Overtones, sound waves with frequencies higher than the fundamental, are produced from a single vibrating piano string. However, light waves from red hot iron include very little high frequency ultraviolet. The explanation for this discrepancy came in 1900 when Max Planck modeled light in terms of particles of energy, with higher frequency light having more energy per particle. High frequency ultraviolet light would require too much energy per particle to be readily produced.

The model of light as a particle or quantum of energy was part of the development of quantum mechanics that made some very non-intuitive predictions about the physical world at small sizes. Particles such as electrons must sometimes be treated as waves, thus making it impossible to know exactly where they are located. Quantum mechanics is now used to understand chemical bonding, the electron microscope, the laser, the transistor, nuclear power, and radioactivity, but in so doing it has incorporated some of Newton's discarded particle model. Today we find that light is treated as a wave under certain conditions and as a particle under others. A simple understanding of water waves cannot be extrapolated to the extreme of small size.

From studying these two revolutions, several limitations of science become apparent, even if the possibility of supernatural intervention is ignored.

Even in the natural world, much data is unavailable. A century ago there had been no observation of particles traveling close to the speed of light or of the small particles in the atom or nucleus. Since science is inductive, a model can be correct (in that it explains all the present observations) without being complete (in that it is unable to explain all future observations or past unobserved occurrences).

Even for some of the available data, explanations are lacking. Light arriving from the sun could not be explained without a medium for light. The ultraviolet catastrophe could not be explained in terms of a wave model for light.

Even for good explanations, simplified approximations (models) are used. The wave model of light was only an approximation. As science progressed to the unusual and extreme conditions of high speeds and energies and small sizes, different laws became important and intuition and reasoning from everyday events were no longer sufficient. Extrapolation from the known and understandable to the unknown and extreme was useful, but only approximate.

Even though one model is used, other models are possible. The wave model for light worked well a century ago, but now it is known that a particle model must be used to explain some observations.

PHYSICS THEMES THAT RELATE TO THEOLOGICAL CONCEPTS

A Mechanistic Universe. Galileo's observations of sunspots, mountains and seas on the moon, the phases of Venus, the moons of Jupiter, and the myriad stars of the Milky Way led him to realize that the heavens are not perfect and that the earth has no unique place in the universe. These conclusions seemed to conflict with the then current scriptural understanding of a stationary earth and a moving sun, a location for hell, Christ's ascension, and the anthropocentric purpose of creation. The church's condemnation of Galileo's heliocentric worldview is probably one of the best known incidents in the history of the relation between science and religious faith. In describing this conflict one author states:

> "Honest seekers after truth have been shocked by the attempt to suppress the claim that the earth moves and have seen in the trial of Galileo decisive evidence that religion is dangerous, ... especially, when pursued by sincere men who consider themselves the stewards of God's revealed truth." (Lindberg and Numbers, p.114)

However, there are two sides to this story and Galileo was not without fault. He made enemies by his sarcasm; his book made the pope look like a fool; and he disobeyed reasonable orders. His science had problems as well with his use of astrology, a rejection of the elliptic orbits of Kepler, his wrong arguments about tides and comets, a dogmatic faith in math, an overstatement of his case, and no direct evidence for the earth's motion until much later. Discussions of this important part of science history should include the issues of progressive truth, making invalid scientific claims from Scripture, and dealing with the science/religion controversy. (Hummel)

Newton discovered the laws of gravity for both terrestrial and celestial motion, but believed that God needed to occasionally adjust the orbits of the planets. However, once it was seen that nature obeyed certain fixed laws, the trend was to explain everything by natural law without a need for God. Laplace used the nebular hypothesis to explain the origins of the solar system. He made a deliberate substitution of a physical explanation for what had long been explained by a Creator God. When asked by Napoleon why he didn't include God in his model, Laplace is reported to have said that he had no need for that hypothesis.

This trend led biology to seek a naturalistic origin for life and the use of natural selection to explain all changes. It removed purpose, teleology, miracles, the supernatural, and any need for God. Mechanistic laws often work, but not for everything. An understanding of how God works in nature is also important.

A Beginning for Time. The scientific concept of linear time parallels the biblical account of time progressing in one direction from a creation to an apocalypse. This contrasts with some cultures where time is viewed as cyclical.

Scripture (Psalm 102:25,26) influenced Lord Kelvin in his development of the second law of thermodynamics. The second law states that the amount of useful energy in the universe is decreasing, thus suggesting a beginning for time and the need for a "Beginner." (Smith and Wise)

Similarly, the Big Bang theory points to a beginning for the universe, space, and time. As a result, it was initially resisted for philosophical reasons. Arno Penzias states that,

> . . . astronomy leads us to a unique event, a universe which was created out of nothing, one with the very delicate balance needed to provide exactly the conditions required to permit life, and one which has an underlying (one might say 'supernatural') plan. Thus, the observations of modern science seem to lead to the same conclusions as centuries-old intuition. (Margenau and Varghese)

One of the most frequently quoted statements comes from Robert Jastrow as he concludes a chapter about the philosophical resistance to a Big Bang theory:

> Now we would like to pursue that inquiry farther back in time, but the barrier to further progress seems insurmountable. It is not a matter of another year, another decade of work, another measurement, or another theory; at this moment it seems as though science will never be able to raise the curtain on the mystery of creation. For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries.

Design. The universe appears designed, with the constants of nature apparently fine-tuned for life. Life and humans are more than the natural result of physical law. The ratio between the strong force (that holds the protons in the nucleus together) and the electromagnetic force (that would cause them to fly apart) is finely tuned. If the strong force were larger, the protons would more readily clump together forming only the heavier elements, with no hydrogen for water and life. If the strong force were smaller, the protons would less readily clump together forming no heavier elements, and thus no carbon or oxygen that is necessary for life.

The mass of the universe must have been correct to 1 part in 10^{40} at an early stage: a larger mass would have caused collapse, while a smaller mass would have resulted in no accretion. Two terms in the cosmological constant must cancel to zero to 120 decimal places. The neutron/proton mass ratio also appears to be finely tuned. Naturalistic science has attempted to explain these evidences for design in several ways: The Anthropic Principle states that what we expect to observe is restricted by the conditions necessary for the presence of an observer. The multiple universes suggestion states that our universe just happened to be the one out of many with just the right constants. Hugh Everett suggested multiple parallel universes in 1957; whereas, an oscillating universe would give multiple serial universes. However, a multiple universe model is not testable or falsifiable.

Historical Geology and Geophysics. Many issues about earth origins require physical principles to understand: viscosity and plate tectonic rates, paleomagnetism and changes in the earth's magnetic field, heat flow and cooling of large bodies of magma, gravity effects for isostasy of continents and the ocean floor, seismic wave determination of the earth's interior, modeling meteor impacts, change in earth's rotation rate due to tidal friction, Milankovich cycles in the earth's revolution around the sun, and radiometric dating.

Relativistic Effects. The philosophical implications of special and general relativity can lead to a discussion of several theological issues. Einstein's theories have been used to support the removal of absolute standards, although he himself resisted the concept of relative truth. The famous equation for the conversion between mass and energy, $E=mc^2$, suggests that a God with infinite energy could easily create matter *ex nihilo*. General relativity suggests additional dimensions for space (see Abbott) making understandable the supernatural appearances of angels and the walking through walls. Both the special and general theories address the relativity of time and have lead to speculations about how God experiences time. (Ross)

Our understanding of extreme conditions is limited by human experience. Normal intuition is insufficient to visualize the relativistic consequences. At the high speeds and energies described by special relativity mass increases, time slows down, and length shortens. In the strong gravitational fields described by general relativity light bends and time slows, suggesting the possibility of time travel and of being outside of space and time. Models explain the unknown using the known, but reality is more than the scientific model. The 6 blind men and the elephant are a good example of this limitation.

Ethics of Weapons Development. Unprecedented devastation and pollution are possible. Science often improves life, but science without morals can be destructive. Numerous examples can be given from nuclear bombs to Chernobyl's radioactive fallout. J. Robert Oppenheimer, in talking about the atomic bomb said:

> In some sort of crude sense which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin; and this is a knowledge which they cannot lose. (Thorne, p.223)

Determinism and Freewill. Under some situations described by the new physics, cause and effect relations break down. Nature was once understood to be totally deterministic. Newton's laws of gravitation were used to predict the return of Halley's comet in 1757 after it was observed in 1682. The planet Neptune was discovered where it was predicted based on small irregularities in the orbit of Uranus. Laplace went so far as to suggest that the future behavior of the universe was absolutely predictable in principle, if the present positions and forces on all particles were known. However, the more recent Heisenberg uncertainty principle of quantum mechanics states that the exact position and speed of any particle can't both be known exactly at the same time.

Complexity theory has found that there are many situations, such as the hydrodynamics of fluid flow, that are far too complex for every effect to be traced to its cause:

> "...all the general features attributed to classical mechanics are in general wrong. The exactly soluble examples are not generic; they are in fact quite atypical." "... chaotic behavior, contrary to earlier beliefs, was a rather general property and not a pathological feature of some contrived system" (Dresden)

Complexity is due to slight variations in initial conditions, where imprecise initial conditions can totally change final results. A practical example from meteorology is known as the "Butterfly Effect":

> It's 10:15 in the Amazon, and a butterfly flaps its wings,
> Which creates a subtle breeze that spreads pollen throughout the air,
> Causing a caribou to sneeze and send its massive herd into a stampede,
> Which adds wind and dust to a mounting storm that then becomes a hurricane,
> Which alters the global pattern of weather.

The past scientific concept of complete determinism made an understanding of man's freewill and God's intervention difficult. The indeterminism of the new physics simplifies the problem.

Objectivity is incomplete. Science assumes an unbiased observer of an objective reality, but occasionally that's not true. An often seen example of the lack of objectivity is the dual picture of the young lady and the old granny.

Quantum mechanics finds that light as well as electrons are both a wave and a particle until observed. What is seen depends on the experiment—you see what you are looking for. Radioactive atoms are both undecayed and decayed until observed, which led to the famous Schrödinger's cat paradox. Einstein didn't like these results of quantum mechanics and emphasized the problems with this view, but quantum mechanics seems to be right and Einstein wrong. Quantum mechanics is not about what is, but about what happens when we observe.

Scientists comment on the "new physics"

The usual scientific world view holds that the natural world is completely self-sufficient, with no need for the supernatural. This opinion is well expressed by Steven Weinberg in his book *Dreams of a Final Theory*. Chapter 3 gives "two cheers for reductionism", argues that there are no fundamentally new laws for complex systems, and decries holism as the "nuttiest extreme". Chapter 4 finds no "messages for human life in quantum mechanics that are different in any important way from those of Newtonian physics". Probabilistic interpretations do not do away with determinism or make room for human free will and divine intervention. Chapter 9 mentions that the constants of nature presently appear to be well suited for the existence of life, but Weinberg believes that a final theory would be able to prescribe values for all these constants of nature without any surprising coincidences, although he recognizes that a cosmological constant of exactly zero to 120 decimal places may still require some kind of anthropic principle for explanation. Finally, he says "it is consciousness that presents us with the greatest difficulty", but even there it "is not unreasonable to hope that ... we shall be able to recognize something, some physical system for processing information, that corresponds to our experience of consciousness".

However, Paul Davies in his book, *The Mind of God: The Scientific Basis for a Rational World* points out that a naturalistic world view is not sufficient:

> ... There is no doubt that many scientists are opposed temperamentally to any form of metaphysical, let alone mystical arguments. They are scornful of the notion that there might exist a God, or even an impersonal creative principle or ground of being that would underpin reality and render its contingent aspects less starkly arbitrary. Personally I do not share their scorn. Although many metaphysical and theistic theories seem contrived or childish, they are not obviously more absurd than the belief that the universe exists, and exists in the form it does, reasonlessly. It seems at least worth trying to construct a metaphysical theory that reduces some of the arbitrariness of the world. But in the end a rational explanation for the world in the sense of a closed and complete system of logical truths is almost certainly impossible. (p.231)

The observations that a totally naturalistic science is insufficient can lead to various metaphysical philosophies such as the New Age, eastern mysticism, Hare Krishna, and theosophy; but they also make Christianity a viable option. The new physics in no way negates the many virtues of science, but it partially undermines science as a stand-alone world view with securely independent foundations of its own.

MISCELLANEOUS TEACHING POSSIBILITIES

Devotional Thoughts. The Bible uses parables, illustrations, and metaphors from nature. Some of these are in the area of physics and the teacher can develop others. Perhaps the most obvious have to do with light and the rainbow. Chapter 51 of *The Desire of Ages*, entitled "The Light of Life", gives examples.

Miracles. Some of the miracles in the Bible are directly related to the abrogation of physics principles: the floating axehead, walking on water, the sun standing still, and lightning as judgement.

Community Involvement. Physics expertise is sometimes needed in the community. Possibilities that have been tried are radon screening, radio station involvement, and civil engineering projects.

Sharing Christianity with Scientists. An encouragement to interact socially with scientists in the secular world opens up numerous opportunities not otherwise available of sharing a lifestyle and a worldview with a colleague. Scientists may be interested in the rational explanation, but the personal touch makes the difference.

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