

## Scientific Foundations of Mormon Theology

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A 1974 article published in *Science* identified the Mormon culture as an unusually productive source of American scientists and scholars, an achievement linked to such distinctive tenets of Mormon theology as rationalism, natural law, and its elevated concept of man (Hardy 1974). Unfortunately, the Church now appears to be backing off from these distinctive theological tenets and taking a more conservative stance towards science, perhaps due in part to the influence of fundamentalist Christian creationist groups. Many Latter-day Saints have become suspicious of science and consider a number of currently accepted scientific theories irreconcilably at odds with the teaching of the faith. Compounding this difficulty is the fact that the scientific aspects of Mormon theology have not been thoroughly studied, especially in the last few decades during which a virtual explosion of scientific knowledge has occurred. Over twenty years ago Sterling McMurrin lamented that no one had yet seriously attempted to place Mormon theology on a scientifically rigorous and philosophically acceptable foundation (McMurrin 1965, 46). In light of what has happened in fields of science since 1965, as well as the recent trend towards conservatism in the Church, perhaps it is time to systematically examine this subject.

Before embarking on a detailed discussion of the implications of modern science for Mormon theology, a short review of some recent scientific developments is in order. It is, of course, impossible in this limited space to completely explore these discoveries, but I will highlight a few of the major developments of modern science that have significant implications for LDS theology. The following information is based on the current state of both scientific and theological knowledge; new information could offer new insights on these issues.

### The Theory of Relativity

Albert Einstein's theory of relativity, like all significant scientific developments, was not the product of one man-- considerable groundwork had been laid by others. The development during the late nineteenth century of a highly accurate method of measuring the speed of light laid the foundation for Einstein's work. Numerous measurements revealed the startling conclusion that the speed of light incoming from distant stars did not appear to vary in the slightest as the earth moved in its orbit around the sun, whereas a difference of about 67,000 miles per hour due to the motion of the earth would be expected. In addition, physicists had previously noted the puzzling fact that the speed of light was directly calculable from Maxwell's electromagnetic equations, without regard to any considerations of relative motion.

For years physicists attempted unsuccessfully to accommodate these facts within the scheme of traditional Newtonian physics. Finally in 1905 Einstein took a different approach. Rather than trying to explain away the constancy of the speed of light, he proposed that this fact be an axiom of a new system of physics. Using his new theory he was able to show that calculations of the motions of everyday objects agreed with the results of Newtonian mechanics to a very high precision; in ordinary situations his theory did not contradict these well-established laws. However, his theory predicted that in exotic situations certain bizarre phenomena would occur. His assertions include the following:

- \* There is no such thing as an absolute reference frame. All motion is only relative.
- \* Rapidly moving objects increase in mass, contract in length, and experience a slower passage of time.
- \* Two events that appear to be simultaneous to one observer may not appear simultaneous to another observer.
- \* The speed of light is the ultimate speed limit of physical objects in the universe.
- \* Mass can be created and destroyed (converted to energy).
- \* Space and time are distorted near massive bodies.
- \* The collapse of a star can create a "black hole," in which space and time warp to a singularity.

It took years for these counterintuitive notions to gain acceptance. However, as striking experimental evidence began to appear, opposition evaporated. Since 1905, the theory of relativity has been confirmed in a large number of highly precise and exacting experiments. For instance, the increase in mass and dilation of time mentioned above are routinely observed in nuclear particle accelerators. As a result of this experimental evidence and the theory's appealing logical consistency, relativity is now considered to be among the most universal and firmly grounded of all scientific theories

#### Quantum Theory

While not as well known as relativity, quantum theory is at least as fundamental and has far more applications in the "real" world. Quantum theory essentially tells us that our whole notion of the universe as a collection of tiny particles zipping around in well-defined, deterministic paths is fundamentally inaccurate. An electron, for instance, can only be regarded as a wave function with a corresponding probability distribution. This means that we can accurately calculate the probability that an electron will be found at a particular location, but that is about all.

One striking consequence of quantum theory is the Heisenberg uncertainty principle. This principle states, for instance, that the position of a particle and its momentum (the product of its mass and velocity) cannot simultaneously be determined with absolute precision. Although this principle applies for all objects, large and small, its effects are most noticeable at the atomic level. It is important to note that this inability to measure both position and momentum simultaneously is not in any sense a failing of current instrumentation technology. Rather, it is a fundamental limitation that transcends any possible means of measurement.

A related consequence of quantum theory is that there is a small but nonzero probability that a particle entirely confined in a force field will suddenly appear on the outside of this barrier and escape. This is like saying that a marble confined inside a wooden box can suddenly appear on the outside, without even penetrating the wood. Indeed, the radioactive decay of a nucleus is an instance of such a phenomenon: an alpha particle suddenly appears outside the nuclear force field (which normally confines it) and escapes.

Another quantum effect, one which has profound philosophical consequences, is known as Einstein-Podolsky-Rosen (EPR) effect. The most commonly studied instance of this effect is the polarization of two photons (light particles) simultaneously emitted from a nucleus in opposite directions. Experiments indicate that when the polarization angle of one photon is determined at a

detector, this orientation is somehow instantly communicated to the other photon (i.e., faster than light).

The traditional quantum theory interpretation of this paradoxical result is that the polarization of the photons, like the position of an electron, simply does not exist in any sense until it is measured. This implies that there is no such thing as an objective reality--the act of observation is an essential part of the phenomenon being observed.

While the philosophical and cosmological implications of quantum theory are still being sorted out, its basic notions are, like relativity, on extremely firm ground. These quantum phenomena have been observed and agree precisely with theory in countless experiments. Further, there is strong evidence that these same principles are obeyed throughout the universe and have not changed over billions of years. For example, the spectra of atoms observed in light from distant stars have the same pattern as on the earth, in spite of the fact that the stars are in other galaxies and their light was emitted many millions of years ago.

### Cosmology

The term cosmology refers to theories of the origin and development of the universe and encompasses astronomy, fundamental physics, and, to a certain extent, biology. Although it certainly has strong theological and philosophical overtones, cosmology is rooted in concrete scientific evidence. Most pertinent to this discussion is the theory that the entire observable universe (space, time, and matter) was created roughly 15 billion years ago in a single cataclysmic event, known as the "big bang."

The big bang theory is an outgrowth of a discovery made about sixty years ago by astronomer Edwin Hubble. He observed that the farther away a galaxy was, as measured by its absolute brightness, the faster it appeared to be receding from the earth, as measured by the "red shift" of its light spectra. This implies that the universe is expanding and was thus at some previous time much denser than it is today. In 1964 a theoretical physicist showed that if the big bang had really occurred, then a remnant of the initial fireball should still be observable as low-level microwave radiation characteristic of that emitted by a body a few degrees above absolute zero (- 460 degrees Fahrenheit). At about the same time and completely independently, two scientists at Bell Laboratories were attempting to reduce the level of noise in an experimental microwave antenna. After eliminating every conceivable source of noise in their equipment, they concluded that this noise was microwave radiation of extraterrestrial origin. Astrophysicists immediately recognized that it fit the pattern predicted by the big bang theory.

Since then other persuasive pieces of evidence have been uncovered. For instance, the observed relative abundance of hydrogen and helium in the universe today is accurately predicted by the big bang theory. The big bang has also been very closely tied to the fundamental concepts of relativity and quantum theory. As a result of such evidence, this theory is now generally accepted as the correct description of the origin of the universe. I must emphasize that the big bang theory is not as fundamental and well-established as relativity and quantum theory. However, the weight of evidence supporting the theory has increased to the point that it must be taken seriously by anyone attempting to form a scientifically tenable theology.

Some rather remarkable aspects of the current big bang theory have frankly theological overtones. Physicists have concluded in recent years that the fundamental constants of physics, such as the gravitational constant and the masses of protons and electrons, all seem to be exceedingly finely tuned for the universe to exist as we know it today. For example, if gravitation were just very slightly stronger, the universe would have long ago stopped expanding and would instead have fallen back and obliterated itself in the opposite of a big bang. On the other hand, if gravitation were significantly weaker, then after the big bang matter would have dispersed too rapidly for stars and planets to have formed. Some scientists have even claimed that the balance between some of these fundamental constants is so sensitive that a change of one part in 1040 would have rendered the universe uninhabitable as we know it (Davies 1982). Cosmologists usually explain that such extreme coincidences are to be expected in any universe containing beings intelligent enough to pose the question. In other words, if the fundamental constants of the universe were slightly different at the big bang, we wouldn't be around to discuss the subject. Many scientists consider the fact that our universe is conducive to the formation of stars, planets, biological evolution, and ultimately us as a highly significant piece of data leading to the conclusion that the universe we reside in must have certain characteristics.

However, this notion, which is known as the "anthropic principle of cosmology," cannot be verified experimentally in a strict sense. In fact, some have criticized it as a tautology, a pathetic attempt to preserve a completely naturalistic universe at all costs. It is certainly as much a religious belief as the notion that an intelligent being carefully crafted the big bang in order to establish a perfect environment for the formation of worlds such as ours.

#### Geology and Paleontology

The currently accepted outline of the history of the earth is as follows: The earth coalesced out of a cloud of stellar material about 4.5 billion years ago. Within approximately one billion years after the earth was formed, primitive single-celled organisms appeared, leaving traces in some of the oldest rock formations. Some while later oxygen appeared in the atmosphere, originating primarily from the photosynthesis of primitive plants. Beginning about 700 million years ago, there was a dramatic increase in the variety and complexity of life. Some members of the animal kingdom developed skeletons, and many new species of plants and animals eventually appeared, including dinosaurs and primitive mammals. Over the years many species appeared and disappeared, all the time increasing in complexity and approaching the species currently on earth. About four or five million years ago, new primate species arose that bore striking resemblance to modern man, featuring a moderate-sized brain and bipedal locomotion. By about 40,000 years ago, the descendants of these hominids had changed into beings virtually indistinguishable in form from modern man.

How strongly does evidence support the dates in the foregoing account? Geological dating is now very firmly grounded. Studies of rates of deposition long ago established an age for the earth in the hundreds of millions of years. In the last fifty years, any remaining reasonable doubt has been removed by the development of a number of very reliable dating methods. Many of these are based on radioactive decay, which, as mentioned earlier, is a fundamental, well understood quantum phenomenon. The rate of radioactive decay of a particular nucleus can be measured with high precision and is essentially invariant with time, temperature, pressure, and chemical combination. Thus dates obtained by radioactive dating techniques must be taken very seriously indeed.

Since the development of radioactive dating methods several decades ago, a number of other highly reliable techniques have been discovered. One of the most interesting of these new methods is known as "fission track" dating. It is based upon the fission (splitting) of a uranium nucleus, which again is a basic quantum phenomenon. When a fission occurs in a certain crystalline rock, it leaves a distinctive track that is directly visible under a microscope. By counting the number of these tracks in a sample of known uranium content, a reliable date for the specimen can be determined. Geologic dates measured in this manner are entirely consistent with dates obtained by other techniques. Of course, there is room for error in any laboratory measurement, and certain known effects can alter the measured dates. However, detailed laboratory procedures have been developed to greatly reduce the possibility of such errors. Also, even though errors have been made in some cases, we cannot dismiss the highly consistent results of thousands of other measurements. For example, the fact that rock samples taken from the same geologic formation level from all over the world give the same dates strongly indicates that these techniques are both reliable and accurate. Thus any scientifically tenable theology must acknowledge the above outline of the earth's history.

#### Evolution and Molecular Biology

Surveys still show nearly half of adult Americans do not accept the basic notions of the theory of evolution. This skepticism is even greater within the LDS church. A survey of Latter-day Saints in the Salt Lake City area showed that 72 percent thought the theory either surely or probably false (Mauss 1972). The theory of evolution basically states that living organisms have developed through the ages from very simple one-celled organisms to the vast variety of plant and animal life on the earth today. Darwin observed that the offspring of a single generation exhibit random variations and that only a fraction of them can survive. He reasoned that those offspring best suited to their ecological niche have the greatest chance of surviving and passing their inherited traits to the next generation. He also recognized that all biological organisms can be organized into a "family tree," and he proposed this fact as evidence that all species are biologically related. Indeed, this notion has been referred to as the "grand prediction" of the theory of evolution (Eldredge 1982, 36).

Much has happened since Darwin first outlined his theories in *The Origin of Species* in 1859. Some early conjectures have been proven incorrect, such as Lamarck's suggestion that acquired traits might be transmitted by heredity to the next generation. Recently scientists have questioned Darwin's general assumption that evolution is a uniform, steady process. However, the basic notions that species have changed and are continuing to change, and that the entire biological kingdom is related, are now firmly established.

The fossil record continues to provide strong evidence for evolution. Any objective analysis indicates that a wide variety of living organisms has inhabited the earth over vast periods of time and that these organisms have increased in variety and complexity until the present day. True, there are troublesome gaps in the record, but an increasing number of these gaps are being filled in as the years go by. For example, some highly credible transition species between birds and reptiles have recently been discovered, and the transition between reptiles and mammals is now well understood (Hopson 1987). In addition, when these gaps are viewed in terms of molecular biology, many of them no longer appear discontinuous. The abrupt transitions between some species indicate to many paleontologists that evolution advanced in fits and starts, with long periods of relative stasis in between. But none of this changes the

basic conclusion that life has evolved on planet earth over many millions of years.

The discovery in the 1950s of the structure of the nucleic acids DNA and RNA marked a turning point in evolutionary biology. Since DNA sequences direct the synthesis of amino acids to form proteins, the mechanism of genetics could now be studied at the molecular level. Among the most significant recent developments in the tabulation of amino acid sequences for certain proteins across a wide variety of species. These tabulations provide a reliable, quantitative measure of the evolutionary distance between organisms. Now biologists no longer have to rely on subjective anatomical criteria to justify the evolutionary organization of the biological kingdom. For instance, the close relationship that had been theorized between man and higher primates has been fully confirmed: the alpha chain of human hemoglobin, which is 141 amino acids long, is identical in chimpanzees, differs in only one amino acid location in gorillas, and yet differs in twenty-five locations in rabbits and in over 100 locations in fish (dukes 1983). Since these sequences apparently reflect the degree of genetic relatedness, they provide a reliable measure of the length of time elapsed since two groups of species diverged.

Several aspects of the theory of evolution, however, can still justifiably be considered tentative and conjectural. One of these is the determination of the precise history and genealogy of an individual species. An example of this uncertainty is the recent highly publicized disagreement between Richard Leakey and Donald Johanson over which early hominid led to Homo sapiens. Another unsettled area is the actual causes and mechanisms of genetic change, such as determining the precise roles of environment and mutations. For instance, one recent popular theory is that comets or asteroids colliding with the earth at regular intervals were responsible for the relatively sudden extinction of certain previously successful species (Alvarez 1980). Such ideas must, of course, be considered speculative until more evidence is forthcoming.

One important aspect of the theory of evolution that is still very much in the realm of hypothesis and speculation is explaining the development of the original, primitive, one-celled organisms. In 1956 much attention was focused on the Miller-Urey experiment, in which some simple organic compounds, including traces of two amino acids, spontaneously formed in a flask of "primordial soup" chemicals. Although thirty years later provocative research continues in the field, scientists concede that they have not established a complete credible scenario for the origin of life (Shapiro 1986).

An interesting note in this regard is the fact that scientists are still debating the meaning of the experiments performed by the Viking spacecraft on Mars. It is popularly believed that these experiments did not detect life, but according to scientists familiar with this project, a more accurate statement is that the results were inconclusive. They point out that exhaustive analysis of this data has still not ruled out the hypothesis that living organisms produced the observed effects. Clearly the confirmation of any biological system on Mars would profoundly affect the discussion of the origin of life on earth. Perhaps the Mars missions that NASA is now planning for the 1990s will settle this question once and for all.

#### The Panspermia Theory

A few years ago, some astronomers proposed a rather ingenious argument to prove that intelligent, civilized life does not exist elsewhere in our galaxy. They argued that in the not-too-distant future, it should be technologically feasible

for us to construct a robotic probe, together with sufficiently advanced computer programming, that would be capable of constructing a replica of itself given the raw materials. When that is achieved, the exploration of the galaxy could be commenced by launching a few of these probes to nearby stars. Once a probe arrives in the vicinity of a star, it could be programmed to search for planets or asteroids, mine raw materials, construct several copies of itself, and launch these copies to yet more distant stars. Detailed analysis of such a scheme (Barrow and Tipler 1986, 576-601) has shown that the entire Milky Way galaxy could be thoroughly explored in tens of millions years, which is a short time compared to the multi-billion year age of the galaxy.

Now suppose that anywhere else in the galaxy there is another civilized species of any sort. It is exceedingly unlikely that after billions of years of development they are exactly as far advanced as we are. They could not be significantly less advanced, or else they would not yet even be civilized. Thus they are almost surely thousands or millions of years more advanced, at least enough to manufacture interstellar probes of the type mentioned above. It is hard to see how a society could forever restrain the deployment of such technology. For instance, it has been pointed out that a civilization in danger of nuclear annihilation would have even greater impetus to launch such probes. Thus it follows that probes of this sort have been launched and have already visited our solar system, including the earth.

However, no scientifically credible evidence has ever been found of visits by an alien civilization. Claims of extraterrestrial UFOs or of prehistoric visits by alien intelligences, for instance, have not stood up to serious scientific inquiry (Klass 1974; Sagan 1973). Thus, these scientists claim we are alone, at least within the confines of the Milky Way galaxy.

One way to refute this disturbing line of reasoning is to acknowledge that perhaps there have been visits by extraterrestrial beings ( or at least by their self-replicating emissaries), but we have not yet learned to recognize the evidence. Frances Crick, the co-discoverer of the structure of DNA, suggested that some advanced civilization may have dispersed simple bacteria or other biological material throughout the cosmos and that the arrival of such material on the ancient earth started the chain of evolution that led to man. Such bacteria could be considered microscopic versions of the probes mentioned above. This speculative notion is known as the theory of "directed panspermia" (Crick 1981; Hoyle and Wickramasinghe 1984) . I mention this for its clearly theological overtones, which I will discuss later.

#### Creation Science

Running counter to the rigorous scientific methodology supporting the above scientific theories are teachings of certain Christian fundamentalist groups, who attack the basic facts of science attempting to justify a literal interpretation of the Bible. In spite of the outward scientific appearance of their work, it has not stood up to serious scientific scrutiny. Nonetheless, these arguments have persuaded large numbers of people, including a surprising number of Latter-day Saints. This is in spite of the fact that most Latter-day Saints would presumably disagree with many of the basic doctrines of these groups, especially their notion that the earth was created ex nihilo (out of nothing) a few thousand years ago. It is particularly ironic that the fundamentalist sects behind the creationist movement are in many instances the same groups that are most active in the current anti-Mormon crusade.

The major center of the creation "science" movement is the Institute for Creation Science, at the Christian Heritage College in San Diego. Any person joining the institute must sign a statement that affirms, among other things, that the Bible (including Genesis) is historically and scientifically accurate in all details and that living species currently on earth were created in separate acts of creation by God during creation week ("Creation," 1982a, 243). Most of their staff of researchers have degrees in engineering or physical science fields; they have few genuine biologists or geologists. Henry Morris, the leading figure and head of the institute, has a degree in hydraulic engineering.

Some of their ideas are utterly unscientific. They explain the incontrovertible fact that light from distant galaxies has been traveling millions (not just a few thousand) years by the time it reaches the earth by claiming that God created the light rays and set them in paths heading towards the earth (Morris 1972, 61). They analyze the Grand Canyon, with its well-defined layers of fossils, as a product of Noah's flood, claiming the fossil layers exist because the more advanced species could swim better and so are found closer to the top (Whitcomb and Morris 1964).

A slightly more sophisticated argument is their claim that evolution is impossible because it contradicts the second law of thermodynamics (Morris 1974). This law, which is a basic principle of physics, states that any closed system tends to increase in entropy (level of disorder). Since evolution implies that living systems increase in level of order and complexity, they argue that evolution simply cannot occur. However, the earth, together with its biosphere, is not a closed system. It is continually receiving prodigious amounts of energy from the sun, and it is precisely this influx of energy that makes evolution (and life itself) possible. Thus this law does not apply to terrestrial evolution (Patterson 1983). The creationists could argue with equal logic that it is impossible for snowflakes to exist, since the spontaneous formation of these highly ordered structures superficially violates the second law of thermodynamics.

Some of their arguments have the outward appearance of serious scientific work, but they fall apart when carefully examined. For instance, they claim that the earth-moon system could not be as old as geologists claim, or else the moon would be covered with more than fifty feet of meteoritic dust ("Creation," 1982b). Apparently this claim is based on a very rough initial estimate, published in the 1960s, of the amount of meteoritic dust flowing through space. However, this measurement has long been superceded by accurate measurements made with spacecraft, and the more recent scientific results agree with the modest amount of dust that the astronauts found on the moon's surface.

These groups base their most persuasive arguments against evolution on probability. They argue that various steps of the accepted theory of evolution, particularly the molecular evolution of proteins or enzymes, are impossible because they are prohibitively improbable. They compare the random evolution of human beings, or even of a simple one-celled organism, to the chance assembly of a fully functioning jet airplane out of a jumble of spare parts.

However, the probability calculations cited by the creationists are riddled with serious errors (Doolittle 1983). These arguments also suffer from the fallacy of concluding that an event cannot happen if its probability is sufficiently remote. For example, the probability that some particular sequence of 100 coin tosses will occur is only about one part in 1030. This probability is so remote that it should not occur even if billions of people tossed coins for billions of

years. Nonetheless, when we toss a coin 100 times, some sequence does occur. If the particular sequence had been specified ahead of time, then it truly would be a remarkable event. But it is not meaningful to compute such probabilities after the fact.

So it is with virtually all arguments that invoke probability theory to prove a point about some aspect of evolution. There may be numerous tenable routes for the origin of biomolecular systems on the primeval earth. There are probably trillions of alternate biochemical systems for life on earth today, each with a different set of proteins and enzymes. There are certainly equally numerous routes for the evolution of advanced organisms. However, with our current understanding we cannot enumerate or compare the different possibilities. Only when many possible scenarios have been analyzed in detail will anyone be able to meaningfully estimate probabilities. Until that time comes (many years hence) anyone who invokes probability in a discussion of these issues is on very slippery ground.

Most of the creationist arguments against scientific theories are not new--most have been around for decades. Several of the weaknesses that creationists cite in the theory of evolution were originally suggested and discussed by Charles Darwin himself. The few creationist claims that are both novel and scientifically meaningful have been soundly refuted by the scientific community. While we must not dismiss the possibility that some day the creation scientists may produce some valid scientific studies that successfully challenge accepted theories, at this point they have failed to do so.

#### Historical LDS Approaches to Science and Religion

Early Church leaders were surprisingly progressive when discussing science and religion. Joseph Smith made numerous positive statements about secular learning in general and science in particular. Several Church leaders and writers expressed complete confidence that truth learned through revelation could eventually be accommodated with that learned through secular means. Doctrine and Covenants 88:79 advises us to learn about "things both in heaven and in earth, things which have been, things which are, things which shall shortly come to pass." A related concept is expressed in the passage, "If a person gains more knowledge and intelligence through his diligence and obedience than another, he will have so much the advantage in the world to come" (D&C 130: 19) . Of the early Church leaders, Brigham Young had probably the most progressive attitude towards science. "My religion is natural philosophy," he declared (JD 4: 202-3) . His discourses contain many variations on this theme:

\* All of God's productions came according to natural principles (JD 8:115).

\* There is no such thing as a miracle, except to those who do not understand (JD 2:91)

\* Our religion embraces chemistry; it embraces all the knowledge of the geologist, and then it goes a little further than their systems of argument, for the Lord Almighty, its author, is the greatest chemist there is (JD 15:127). In these respects we differ from the Christian world, for our religion will not clash with or contradict the facts of science in any particular. You may take geology, for instance, and it is a true science; not that I would say for a moment that all the conclusions and deductions of its professors are true, but its leading principles are; they are facts--they are eternal; and to assert that the Lord made something out of nothing is preposterous and impossible. God never made something out of nothing; it is not in the economy or law by which the worlds were, are, or will exist. There is an eternity before us, and it is full of matter; and if we but understand enough of the Lord and his ways, we would

say that he took of this matter and organized this earth from it. How long it has been organized it is not for me to say, and I do not care anything about it. As for the Bible account of the creation we may say that the Lord gave it to Moses, or rather Moses obtained the history and traditions of the fathers, and from these picked out what he considered necessary, and that account has been handed down from age to age, and we have got it, no matter whether it is correct or not, and whether the Lord found the earth empty and void, whether he made it out of nothing or out of the rude elements; or whether he made it in six days or in as many millions of years, is and will remain a matter of speculation in the minds of men unless he give revelation on the subject (JD 14:116).

Other Church authorities at the time also advocated remarkably proscience views. The following is due to Orson Pratt: The study of science is the study of something eternal. If we study astronomy, we study the works of God. If we study chemistry, geology, optics, or any other branch of science, every new truth we come to the understanding of is eternal; it is a part of the great system of universal truth. It is truth that exists throughout universal nature; and God is the dispenser of all truth--scientific, religious, and political. Therefore let all classes of citizens and people endeavor to improve their time more than heretofore--to train their minds to that which is best calculated for their good and the good of the society which surrounds them (JD 7:157).

However, statements by the early Church leaders on this subject were not entirely positive. For example, Brigham Young once sharply criticized geologists (JD 13:248). Nonetheless, a generally pro-science attitude prevailed in the Church during the nineteenth century. Even into the twentieth century, prominent scientists and scholars, such as John A. Widtsoe, James E. Talmage, Brigham H. Roberts, and Joseph F. Merrill, sat in the highest councils of the Church, and their influence helped preserve a progressive posture in the Church's teachings (Sherlock 1980) .

The Church's stance towards science changed in 1954, with the publication of *Man, His Origin and Destiny* by Joseph Fielding Smith. Although David O. McKay, who was then president of the Church, disclaimed any official sanction on the controversial material in the book (Stokes 1979), nonetheless it has been quoted frequently ever since by those who prefer a literalistic interpretation of scripture, even if it is at odds with scientific knowledge. For example, using both scriptural and creationist arguments, this book teaches that the earth is only a few thousand years old and that there was no life or death of any sort before Adam. Bruce R. McConkie continued this literalistic approach, advocating basically the same doctrines in his books, Ensign articles, and in public speeches (McConkie 1966, 1980, 1982), although he relaxed his stance on the age of the earth in his 1982 article. Other General Authorities, including Boyd K. Packer (1984) and Mark E. Petersen (1983), have also made negative comments about science in recent years.

Though McConkie and Petersen have now passed away, because President Ezra Taft Benson and the senior apostles seem to favor a literalistic approach to the scriptures, it is unlikely that this philosophy will change soon. Perhaps the ascendancy of men such as Dallin H. Oaks, who defended the teaching of evolution while president of Brigham Young University (Bergera and Priddis 1985, 161-71), will eventually result in a moderation of the Church's modern teachings in this area. But for the time being it is clear that the open-minded approach of past years is not encouraged.

A Scientific Approach to LDS Theology

Let's examine some of the basic doctrines of Mormon theology in the light of modern scientific knowledge.

### The Nature of God

For many Church members, the doctrine that God (Elohim) and Christ are separate personages is the most significant way their theology differs from traditional Christianity. However, other aspects of the Mormon concept of God are even more unusual. For example, the God of traditional Christianity is considered to be the totality of original existence, a being who created all natural laws and is beyond time and space. The LDS concept of God instead posits that God is a real, tangible being who co-exists with natural laws in the universe (McMurrin 1965; Ostler 1984). Probably the most extreme Latter-day Saint "heresy" in the minds of fundamental Christian sects is the law of eternal progression ("as man is, God once was, and as God is, man may become"). This doctrine, first enunciated by Joseph Smith (Larson 1978) and later elaborated by other Church presidents, is now a fundamental tenet of the faith.

B. H. Roberts, who gave the first clear explanation of this finitistic concept of God in 1903, stated in effect that God's powers and intelligence are not infinite in a literal, absolute sense. God cannot contravene natural law--like us, he is apparently subject to natural laws himself. Thus there is no such thing as a miracle; God works through natural laws that he understands but that we do not yet. This doctrine provides a highly satisfying explanation to a host of philosophical dilemmas, such as why God, with his presumably infinite power, is apparently unable to prevent human sin and suffering. Church members do not agree about whether or not God continues to progress in intelligence. Recently some authorities have insisted that he does not (McConkie 1980), but many members continue to agree with the teachings and official statements of the early leaders that his growth is a natural corollary to the law of eternal progression (Bergera 1980; Clark 1965, 222-23; White 1987).

From a scientific viewpoint, the notion of a finite, naturalistic, material God is an extremely appealing idea, far more easily accommodated within scientific thought than an abstract immaterial being who contravenes natural law. It strongly suggests that studying scientific laws can help us understand God's handiwork more clearly. And while scientific knowledge alone cannot prove the existence of such a God, neither can it prove that such a being cannot exist. One example of how a finitistic God makes more sense from a scientific viewpoint is given by analyzing the concept of God's omniscience. For if we presume that all information requires at least some material for storage, then God's mind would have to be of infinite physical extent and mass to contain infinite information. An absolutely omniscient being also appears to contradict quantum theory, as I will later discuss.

It is difficult, however, to determine how a finite, material God might traverse the large distances between stars in a reasonable amount of time. The theory of relativity asserts that the speed of light is an absolute upper bound for the motion of physical objects in the universe. However, an answer to this question may lie in some recent work in astrophysics. Though their work is highly speculative, some scientists suggest that black holes may be "wormholes" to another part of the universe. If passage through some of these wormholes is possible, interstellar space travel may be accomplished much more speedily.

### The Eternal Nature of God and Man

There is a story circulating in scientific circles that one day a professor was describing the currently accepted theories of the origin and destiny of the sun. When he mentioned that the sun will likely exhaust its nuclear fuel and die within five billion years or so, one of the students asked the professor to repeat the statement. Relieved, the student said, "Whew! I thought you said five million."

The notion that everything in our universe originated in a big bang approximately 15 billion years ago creates some problems for Mormon theology (Norman 1985). A God who exists in space and time should reside within the observable universe, not without it. In that case God is not eternal in a literal and absolute sense but instead came into being after the big bang. A straightforward solution to this dilemma is to abandon a strict interpretation of the word eternal, as is suggested in Doctrine and Covenants 19:6-12. After all, 15 billion years may not be forever, but it is so far beyond our comprehension as to be eternal for all practical purposes. In that event God (Elohim) is not the being who crafted the universe at the big bang. If there is such a being, it is a deity beyond Elohim. Mormon theology, of course, allows the possibility of a hierarchy of deities ( D&C 121:28).

Not all LDS scientists are satisfied with the concept of a material God that resides within the observable universe. Russell T. Pack, for example, has argued that God does not reside in the universe created in the big bang and is not limited by the natural laws of our universe (Pack 1987). This theory allows God to craft the universe in the big bang and also to create numerous other universes about which we have no knowledge. Further, it allows us to interpret God's omnipotence and omniscience in a completely different light than B. H. Roberts suggested.

While such a belief cannot be scientifically falsified, it does presuppose the existence of currently unknown scientific principles to avoid a mere deist concept of God, because current theories of fundamental physics and cosmology forbid any communication with or intervention by inhabitants of universes beyond the one created in the big bang. Clearly there are no easy answers to such questions, but perhaps further developments in physics and cosmology will shed some light (Davies 1984).

The traditional LDS concept of eternal elements (D&C 93:33) runs into a similar difficulty if it is literally interpreted to mean that matter has always existed and cannot be created or destroyed. The conversion of mass to energy and the transmutation of matter, even of nuclear particles, are well established physical phenomena. Furthermore, all matter originated in the big bang. A more tenable interpretation of this scripture is that it was intended to rebut the notion of the ex nihilo creation of the earth. This doctrine too might be reexamined in the light of new scientific knowledge.

#### Determinism Versus Free Will

Quantum theory affirms the distinctively Mormon doctrine of free will and indeterminism. Though most of the effects of probabilistic quantum principles are restricted to the atomic and subatomic level, they can definitely have macroscopic effects. For example, a Geiger counter clicks when it detects the random decay of a single radioactive nucleus. Perhaps similar random quantum effects occur among neurons in the human brain, possibly inducing us to alter decisions. Thus human behavior, as well as all other macroscopic phenomena, may be fundamentally indeterminate. If this is true, then God's foreknowledge of

mankind's actions is not infinite in a literal and absolute sense, and he can occasionally be surprised by the outcome of some human events.

Quantum theory certainly does not imply that prediction of the future is impossible, either by God or man. For example, a knowledge of Newtonian mechanics (perhaps with some minute relativistic corrections), together with accurate astronomical observations, allows engineers to predict with high precision the moment when an interplanetary spacecraft will reach its destination. Similarly, parents are not exercising supernatural prescience when they predict that their teenage son will have an auto accident if he continues to drive in a daredevil manner. Quantum theory does, however, limit the accuracy with which such predictions can be made. Thus, God may be able to communicate to prophets glimpses of the future, but there must be a limit to the detail of such prophecy.

There is one difficulty in concluding that quantum physics is a basis for human free will. Even if certain quantum phenomena can change the course of human actions, how can a person be held responsible for truly random events? For example, if a neuron fires because of a quantum physics effect and induces a person to commit a crime, is that person really responsible for that crime? Perhaps the answer lies in the explanation that since quantum effects are generally of rather small scale, the person must have been already very close to a decision to commit this crime. We could then argue that the person was irresponsible in allowing him or herself to approach the point of committing a crime so closely as to be affected by a quantum event. In any event, some care must be taken before we conclude that quantum theory is the solution to the determinism free-will controversy.

#### The Creation

One positive aspect of Mormon theology, from a scientific viewpoint, is its unequivocal rejection of the doctrine of the creation of the earth ex nihilo. Primitive Christians also rejected such a notion (Nibley 1973); the creation ex nihilo doctrine was apparently adopted several centuries after Christ. The question of whether or not the entire universe was created "out of nothing," however, is a different matter. Currently some physicists theorize that indeed the entire universe could have been a single quantum accident (Brout, Englert, and Gunzig 1978), although such ideas are at present highly speculative. Even without the doctrine of creation ex nihilo, any scientifically tenable system of theology must abandon the notion that the earth, complete with its rich layers of fossils and its intricate biological system, was organized in toto a few thousand years ago. Similarly, the notion that species are fixed and have not evolved with time must be abandoned. Such notions have not been tenable for at least fifty years. Interpreting the creation periods as literal days should have died with the book of Abraham, which uses the word time instead of day to describe each of the creation periods. Nonetheless, the belief that the creation took place in either seven days or 7,000 years appears to be fairly widespread in the Church and is occasionally suggested even by modern Church authorities (McConkie 1966, 255), although McConkie, as mentioned earlier, subsequently backed away from this view.

Early Church leaders apparently had much more progressive views of the age of the earth. W. W. Phelps wrote to Joseph Smith's brother on 1 January 1845: Well, now, Brother William, when the house of Israel begin to come into the glorious mysteries of the kingdom, and find that Jesus Christ, whose goings forth, as the prophets said, have been from old, from eternity: and that eternity, agreeably to the records found in the catacombs of Egypt, has been going on in this system

(not this world) almost two thousand five hundred and fifty five millions of years: and to know at the same time, that deists, geologists and others are trying to prove that matter must have existed hundreds of thousands of years; it almost tempts the flesh to fly to God, or muster faith like Enoch to be translated (Times and Seasons 5 [I Jan. 1845]: 758).

The puzzling phrase "not this world" unfortunately clouds this very interesting statement. Duane Jeffrey has pointed out that the word world may have meant society or civilization, since Joseph Smith defined it that way (1973). In any event, the context clearly indicates a belief in a physical system much older than a few thousand years. The figure 2.555 billion years implied in this quotation is particularly curious because it was not known until this century that the earth and the solar system are several billion years old. This figure, by the way, may be obtained by interpreting the seven periods of creation as 7,000 years, each day of which is a day according to Kolob (equivalent to one thousand years) (Stokes 1965).

Many ideas have been proposed to reconcile LDS scriptures on the creation with science. Some have hypothesized that the basic materials of the earth are perhaps ancient, but that God assembled them together a few thousand years ago. Others speculate that the rocks and fossils are the remnants of a previous existence, and plants and animals currently on the earth were transported here recently. Unfortunately, such notions are in hopeless contradiction with scientific observations. There is no hint of a recent assemblage of the earth, and each of these theories founders upon the observed progression of ancient species up to and including those currently on earth today. Others have suggested that God chose to create the earth (and the universe) with a great apparent age, and with the appearance of an evolutionary development of living things, in order to test the faith of mortals. While such a notion cannot be scientifically falsified, it openly contradicts the belief that God works according to natural principles and implies that God has performed an incredible and intricate deception.

Two aspects of the creation definitely permit the possibility of a divine hand altering the natural course of events. One of these is that evolution on earth was guided by a supreme being, whose ultimate goal was to produce a species resembling himself. Nothing in current scientific knowledge would rule out this notion. Some would even argue that such divine intervention is a logical explanation of the sudden spurts and branches that are observed in the fossil record. The recently popular theory that asteroids or interstellar comets colliding with the ancient earth precipitated sharp evolutionary changes is a no less dramatic explanation of the sudden disappearances of previously successful species.

Another tenable possibility is that God planted the original seed of life on the ancient earth, precipitating the evolution that led to man. This idea is very close to the suggestion of the panspermia theory previously described. It strongly implies that humans are the direct biological offspring of God and thus have the same ultimate potential as God, each a uniquely Mormon doctrine. This theory also appeals to those who prefer to regard natural evolution as God's means of performing the creation. However, care must be taken with any theological theory that depends on gaps in current scientific knowledge. As others have pointed out, the "god of the gaps" approach to science and religion runs the risk of theological suicide.

A principal stumbling block in reconciling LDS creation scriptures with scientific knowledge is Moses 3:7: "And I, the Lord God, formed man from the

dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul, the first flesh upon the earth, the first man also." Some have interpreted this passage as a definitive statement that there was no life of any sort on the earth before Adam. However, others have pointed out that Adam is not explicitly named in the passage, and thus it might simply mean that mankind originated from the materials of this earth, which is certainly consistent with scientific knowledge. Still others have pointed out the phrase living soul and concluded that Adam was the first of the living organisms on earth to be joined with a previously created spirit. Some suggest that the statement applies only locally to the Garden of Eden. Perhaps the scriptural account of the creation of Adam and Eve is figurative, as is briefly suggested in the endowment ceremony.

Recently some prominent Church writers have begun to display a considerably more open-minded approach than has prevailed during the last few decades. Hugh Nibley's "Before Adam" (1980) argues that pre-Adamites are entirely acceptable. Nibley and others have also investigated the writings of early Christians, who believed in the creation of numerous other worlds with sentient beings and who emphatically rejected creation ex nihilo (Nibley 1973). Perhaps the next few years will see a reopening of the dialogue between LDS scientists and theologians on this topic.

#### Spirits, Bodies, and the Resurrection

Modern discoveries of DNA and molecular biology provide a highly tenable explanation of how the resurrection might occur. Scientists have known for years that each individual human cell contains, encoded in its DNA, sufficient information to, in theory, perfectly reconstruct the individual. However, they often overlook the fact that even DNA material is not required--only a record of this information, which could be entered into a computer file.

A related issue--that we were created spiritually before coming to the earth and that our spirit personage exactly resembles our physical body--poses a difficult problem for those seeking to reconcile theology and science. This notion appears to be sharply at odds with known facts of biological heredity. The only way to explain this resemblance is to assume that God's foreknowledge is so great as to foresee every mortal marriage, in fact every conjugal act that ever occurred, and furthermore to foresee which of the millions of male sperm would unite with a particular ovum. Such a level of foreknowledge (and determinism) not only runs afoul of quantum physics but greatly exceeds even that permitted by Church authorities, who frequently counsel youth that there is no such thing as a unique predetermined marriage partner.

Perhaps the silence of LDS writers on this subject is due to the realization that it is very difficult to reconcile this popularly held belief with known facts of genetics. Perhaps scholars and theologians need to re-examine this doctrine. Is it really necessary and scripturally well founded? Can it be moderated? Is the visual appearance of a spirit being merely a fluid quality that can assume the form of an assigned physical body?

#### Conclusion

Latter-day Saint theology, with its rich tradition of naturalism and open-minded attitudes toward science, is to many intellectually minded members a major factor in their continued faith (Smith 1986). There is no question that its foundation of natural law and rationality permits a significantly cleaner accommodation of the principles of science than most other theological systems.

However, this tradition may be in danger as the Church continues to experience exponential growth, bringing in converts whose beliefs are deeply rooted in the theologies of traditional Christianity. Current Church literature frequently includes statements about God's absolute omnipotence and his ability to alter the laws of nature, even though these sectarian doctrines sharply disagree with traditional Mormon theology (White 1987). Similarly, the conservatism that pervades modern creation beliefs in the Church seems to have more in common with certain Christian fundamentalist sects than with the open-minded philosophies of the early Church leaders.

Perhaps it is time for Latter-day Saints with scientific backgrounds to renew their efforts to establish dialogue with those of other disciplines in order to re-examine the philosophical roots of Mormon theology. This article is written in that spirit. Let the dialogue begin!

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