Quarks, Chaos, and Christianity

How Will It End?

Sunday, February 10, 2008
10 to 10:50 am, in the Parlor

Presenter: David Monyak

St. John in the Wilderness
Bring us, O Lord, at our last awakening into the house and gate of heaven, to enter into that gate and dwell in that house; where there shall be no darkness nor dazzling, but one equal light; no noise nor silence, but one equal music; no fears nor hopes, but one equal possession; no ends nor beginnings, but one equal eternity; in the habitation of thy glory and dominion, world without end.

- John Donne
Primary Reference

The God of Hope and the End of the World, John Polkinghorne, Yale University Press, 2002
The Rev. Dr. John Polkinghorne KBE, FRS:

- **1955**: PhD physics from Cambridge University
- **1968**: full Professor of Mathematical Physics at Cambridge University
- published numerous papers on theoretical elementary particle physics
- **1974**: Fellow of the Royal Society
- **1979**: resigned his professorship in order to train for the Anglican priesthood
- **1981 to 1986**: served as a deacon, curate and vicar
- began writing numerous papers and books on interface between science and religion
- **1986**: Dean & Chaplain of Trinity College, Cambridge
- **1989-1996**: President of Queens College, Cambridge
- **1994-2005**: Canon Theologian of Liverpool Cathedral
Features of the Present Creation
The Present Creation

Insights from Natural Science

- If we understand the universe as God’s creation, then its characteristics found from the physical sciences must be reflections of the Creator’s will (albeit at times pale reflections)

- What do we see?
  - 1. Process
  - 2. Relationality
  - 3. Information
  - 4. Mathematics
We live in an evolving, fruitful, universe; a universe changing dramatically over time.
In 13.7 billion years, the universe has evolved from an unimaginably hot plasma of quarks and gluons to a world of galaxies, stars, planets, saints and scientists.
1. Process

- This fruitful, evolutionary character of the universe can be understood theologically as a creation endowed by its Creator with a profound potentiality.

- God has allowed the Creation to explore this potentiality and thereby “make itself.”

- God is a loving God, not a tyrannical puppeteer, and is willing to achieve God’s purposes in a way that allows the creation and ourselves to collaborate.
Newtonian physics painted a “common sense” picture of a fundamental world of individuals (particles, objects, people) existing in absolute space, moving through absolute time.

Modern physics paints a picture of a far stranger world that is more holistic and relational:

- Space and time are a single fabric.
  - Gravity for example deforms space-time (space and time).
  - The “space-time interval” and not the time between events is absolute.
    - The time of an event is relative, and varies for observers moving at different speeds.
    - Two events that are simultaneous for one observer will NOT be simultaneous for another observer moving at a different speed.
Modern physics paints a picture of a far stranger world that is more holistic and relational:

- On a quantum level, particles that have interacted become “entangled,” – in a fundamental way they become connected, and remain a single entity no matter how separated they are in space and time.
  - This is called the EPR Effect = Quantum Entanglement = Quantum Nonlocality

- On a macroscopic level, most physical systems are “clouds” rather than “clocks.” That is: they show extreme sensitivity to initial conditions.
  - Whether or not a butterfly in Africa flaps its wings can dramatically effect the weather pattern in North America a week later.
  - Systems with extreme sensitivity to initial conditions are studied in Chaos Theory
“More is different.” Complex systems have coherent behaviors and properties that cannot be guessed at or derived from the knowledge of their constituent parts.

- The way the component particles are arranged and patterned to form the complex system – the “information” of the complex system – appears to be as “fundamental” as the energies and states of the component particles.
- There may be “top-down” forms of causality (the whole influences the parts) as well as the classic “bottom-up” causality (the parts influence the whole).

Aristotle spoke of both matter (byle) and form (eidos). In an analogous way, modern science is beginning to speak about both energy and information / pattern.
The Present Creation

3. Information

- We will use this concept of “information / pattern” later to better understand the “soul.”
It is remarkable that it is possible for us to scientifically understand the world in a scope and breadth that is far beyond what we need for survival.

- **Einstein:** “The only incomprehensible thing about the universe is that it's comprehensible.”

This strange and marvelous power has been largely due to mathematics.

- Physicist have learned to look for beautiful mathematical equations in formulating their theories.
The universe, in its rational beauty and transparency, looks like a world shot through with signs of mind – the “capital M” Mind of God.

Beautiful mathematics manifests itself in the structure of the physical world (the “reason without”), and is comprehended and appreciated by us (the “reason within”) because they both have a common origin in the reason of the Creator, who is the ground of all that is.
Mathematics may also be a tangible hint of a reality we participate in that is outside the physical world.

The majority of mathematicians are Platonists.

Most mathematicians will attest that they do not feel they are creating mathematics, but rather that they are discovering something that has an independent existence in a “Platonic” reality outside them.
Fig. 1.3 Three ‘worlds’—the Platonic mathematical, the physical, and the mental—and the three profound mysteries in the connections between them.
The Fate of the Present Creation

Mass and energy bends space-time:

\[ \text{Geometry of Space-Time} = 8\pi G \times \text{Mass and energy} \]
Fate of the Present Creation

Einstein’s General Relativity

- Mass and energy bends space-time.
- The resultant curvature of space-time gives rise to the trajectories associated with gravity.
A few physicists and mathematicians applied General Relativity to the entire universe, and found General Relativity predicted an expanding universe.

Among them was Fr. Georges Lemaitre, a Belgian Jesuit priest and astronomer, who was the first to propose a theory of an expanding universe beginning from the “Primeval Atom” (later to be called “The Big Bang”).
Einstein preferred a static universe, and privately dismissed Lemaitre’s theory. Instead, he added a weak but diffuse antigravity force ("the Cosmological Constant") to General Relativity so it could be consistent with a static universe.

When Edwin Hubble found experimental evidence for an expanding universe, Einstein removed the "cosmological constant" from the equations of General Relativity, calling it the greatest blunder of his career. He publicly endorsed Lemaitre’s theory.
Fate of the Present Creation
Einstein’s General Relativity

Expansion of space compared to the expansion of raisin bread as it bakes
Fate of the Present Creation

Death by Fire or by Ice

- According to General Relativity, the fate of the universe, as well as its geometry (shape), depend on how the average density of the universe compares to a certain “critical density” calculated from General Relativity.

- If greater than the critical density, the universe’s expansion will come to a halt, and then it will contract back to a death in a fiery “Big Crunch”

- If less than or equal to the critical density, the universe’s expansion will continue forever at a slower and slower rate. It will die “in ice.”
Fate of the Present Creation

Death by Fire or by Ice

“Big Crunch” or “Gnab Gib”
Fate of the Present Creation

Death by Fire or by Ice
Fate of the Present Creation

Death by Fire or by Ice

One of the primary missions of the Hubble space telescope was to determine **how quickly the expansion rate was slowing**, and thereby determine the geometry and fate of the universe.
In 1998, two independent groups reported the first results of Hubble space telescope observations on the rate of expansion of the universe, determined from measuring the apparent brightness of distant type Ia supernovae.

The results shocked the scientific community.
Fate of the Present Creation

Death by Fire or by Ice

Neither of the two predicted possibilities were correct

Rather than slowing down, the expansion rate was increasing, accelerating
Wary Astronomers Ponder An Accelerating Universe

By JOHN NOBLE WILFORD

At their telescopes in the last few years, astronomers have been searching the heavens for evidence that the expansion of the universe is slowing down. The mutual gravitational attraction of all matter in stars, planets and everything else known or hypothesized of California astronomer who has worked on both teams, told colleagues 10 days ago at a meeting in Marina del Rey, Calif. "We get a nonzero cosmological constant."

Translated, that means the astronomers are increasingly confident that they have detected the first strong evidence that the universe is permeated by a repulsive force,
To reconcile General Relativity to the accelerating expansion of the universe, physicists had to put back the anti-gravity “cosmological constant” that Einstein had removed.

The universe is filled by a diffuse anti-gravity force that is causing its expansion to accelerate, now called “Dark Energy” (rather than “cosmological constant”)

Astronomers See a Cosmic Antigravity Force at Work

Seemingly in defiance of common sense, space itself appears to be permeated by a repulsive force that is counteracting gravity on large scales. That, at least, is the reluctant conclusion of an international team of astronomers who have used the brightness of distant exploding stars called supernovae to gauge how cosmic expansion has changed over time. Gravity should have gradually slowed that outward rush. But as team member Alexei Filippenko of the University of California, Berkeley, announced at a meeting near Los Angeles last week,* the dimness of the supernovae—pointing to unexpectedly great distances—implies that cosmic expansion has actually sped up in the billions of years since the stars exploded.

The discovery of an accelerating universe would have a major impact on the reigning theory of how the big bang got started. In the simplest version of this theory, known as inflation, the universe contains just enough matter to make it geometrically “flat”—a mass density that would also slow the cosmic expansion to a halt, given infinite time. Earlier supernova

“My own reaction is somewhere between amazement and horror.”

—Brian Schmidt

The team compared...
The nature of “Dark Energy” is unknown, and is generally felt to be the greatest unsolved problem in physics.

Our accelerating universe will die “in ice,” and far more quickly than we previously thought possible.

All evidence of humanity, of life, will be obliterated. The present creation is destined to ultimate futility.
The New Creation
The New Creation

Reality of Death

- The stark scientific reality that the entire present creation is destined to die in tens of billions of years does not pose a theological problem greatly different than stark reality of our own death within tens of years.

- Our only true and lasting hope must rest in the eternal being of God.

- What is that hope?
Jesus answered the Sadducees lack of belief in a resurrection by recalling:

- [God] said to Moses “I am the God of Abraham, and the God of Isaac, and the God of Jacob.” He is not God of the dead, but of the living; you are quite wrong.” (Mark 12:26-27)
Near the end of Revelation, we read this description of the New Creation:

- Then I saw a new heaven and a new earth, for the first heaven and the first earth had passed away, and there was no longer any sea. I saw the Holy City, the new Jerusalem, coming down out of heaven from God, prepared as a bride beautifully dressed for her husband. And I heard a loud voice from the throne saying, “Now the dwelling of God is with men, and he will live with them. They will be his people, and God himself will be with them and be their God. He will wipe every tear from their eyes. There will be no more death or mourning or crying or pain, for the old order of things has passed away.” (Revelation 21:1-4 NRSV)
The New Creation
Personhood and the Soul

- Just as God is the God of Abraham, Isaac, and Jacob, the God of the living, so too God is our God, and God will not cease to love us as living beings when our life in this present creation ends.

- But what can connect our present life to our future life in a New Creation?

- What can assure us that it is Abraham, Isaac and Jacob that are alive in the kingdom of God, and not just some new beings with old names?
One option has been to imagine our “true selves” to be in a “detachable” soul that has been temporarily imprisoned in a corrupt body. At death, this detachable soul is finally liberated to be with God.

Science gives little support to such a concept:

- We are a product of a gradual, painstaking evolution from the stuff of the universe – matter.
- There is a deep connection between our minds and our physical bodies.
- Science in other words, suggests that we are closer to “animated bodies” than “incarnated souls.”
The view that we are “animated bodies,” mind-body (“psychosomatic”) unities is also more in line with the Hebrew scriptures.

What then gives us continuity into the next life –
- and in this life for that matter? After all, the molecules of our bodies are getting continually replaced in the course of wear and tear, eating and drinking.

What is the “real me” that links the young child with the aged octogenarian?
Polkinghorne suggests the “real me,” the “soul,” must be the immensely complicated “pattern” in which our ever changing molecules are organized.

- This idea recalls science’s nascent recognition of the importance of “information / patterns” in complex systems.

When we die, God fully remembers and sustains the information-bearing pattern (our “soul”) that is our “true selves,” and will re-embody this pattern in the New Creation.

- A crude analogy (because we are more than computers made of meat): God remembers and sustains our “software,” and will load it into the hardware of the New Creation.

- Another analogy: God remembers the information bearing pattern of ourselves analogous to the patterning stored in Star Trek’s transport beams, and will re-materialize it using the matter of the New Creation.
The New Creation

Cosmic Hope

- It is not only ourselves that God cares for, but God surely cares for all creatures and all created things in accordance with their natures.
  - Could God allow anything that is good to perish?
  - Therefore, there must be a destiny for the whole universe beyond its death.
  - Indeed, as embodied creatures made of matter, our own destiny and the destiny of matter must be intimately linked.
The New Creation

Cosmic Hope

- In Romans, St Paul speaks of redemption as including the entire creation:
  - For the creation waits with eager longing for the revealing of the children of God; for the creation was subjected to futility, not of its own will but by the will of the one who subjected it, in hope that the creation itself will be set free from its bondage to decay and will obtain the freedom of the glory of the children of God. We know that the whole creation has been groaning in labor pains until now; and not only the creation, but we ourselves, who have the first fruits of the Spirit, groan inwardly while we wait for adoption, the redemption of our bodies. (Romans 8:19-23 NRSV)

- (Also see Colossians 1:15-20)
The New Creation

Cosmic Hope

- The significance of the empty tomb in Jesus’ resurrection is that Jesus’ glorified body is the transmuted form of his dead body.
  - That is: *matter itself* participated in the resurrection transformation, enjoying a foretaste of its own redemption from decay.
The New Creation

New Versus Old

- Just as Jesus’ glorified, resurrected body came from the transformed matter of the old body, so too then New Creation will come from the transformed matter of the old creation.
  - Such a transformation allows the continuity of the Old Creation into the New Creation.
- Because it is a transformation of the old creation, and because God is a God of “process,” we can expect something like space and time will be preserved in the New Creation.
  - Our new lives will not exist in a static or a timeless eternity, but within a dynamic, changing everlastingness.
The New Creation

New Versus Old

Just as the risen Jesus was no mere resuscitated corpse, so too the New Creation will not be a mere repetition of the old creation:

- The current creation was endowed with physical properties that allowed it to “make itself” over the course of its evolving history.
- The New Creation will be integrated in a new and intimate way with the divine life. It will be wholly sacramental, suffused with the presence of the life of God.
The New Creation will not be boring. Its life will be the exciting and inexhaustible exploration of the riches of the divine life, and of the transformed New Creation suffused with God.

The wounds of this life will be healed, its unfinished business completed – and new business begun.
“Speculative as this chapter has been, I think it is an indispensable part of coherent Christian belief to expect a destiny beyond death, for ourselves and for the universe. Rich and fruitful as this world is, I do not think that it and its history make sense if they are the only story to be told. In the end, I suppose, the best answer to our questions about the ultimate future is ‘Wait and see.’ I believe we can do so, confident in the faithfulness of a God who will not allow anything good to be lost.”

- Polkinghorne, p. 114