Science and Transcendence: Advanced Research Series

Summary and Details of the Program

How immense the ocean of our questions, how limited the shoreline of our knowledge.

STARS: Asking new questions of ultimate reality

STARS: Summary

"Humanity stands at the crossroads of destiny. STARS is the most exciting initiative yet on confronting the challenge of who we are and how we fit into the great cosmic scheme."

¤ Paul Davies

The goal of STARS is to sponsor research by small teams of scientists and humanities scholars on the ways science, in light of philosophical and theological reflection, points towards the nature, character and meaning of ultimate reality.

The STARS program consists of two parts: conferences and research.

STARS Conferences: In January 2007, STARS convened a series of three interdisciplinary conferences held on the Yucatan Peninsula. The conferences showcased key ways in which current scientific discoveries relate to our understanding of ultimate reality. Nearly 150 participants were chosen on a highly competitive basis. The conference topics were:

Conference 1: Cosmology, Physics and the Possibility of Life
Conference 2: Evolution, ET, and the Significance of Life in the Universe
Conference 3: Complexity Theory, Emergence and the Influence of Life on Matter

STARS Research: Creating and Implementing a New Research Methodology. What qualifies as fundable STARS research is narrowly defined in two new and important ways: it must be highly interdisciplinary, spanning both qualifying fields in the natural sciences and qualifying fields in the humanities, and that interdisciplinarity must be embodied in a Research Team whose core product must reflect this interdisciplinary team-structured research. This in turn means that the core product must be 'of a piece', i.e., an integrated, multiple-authored text / lecture series / research seminar, etc., stemming from the synthetic and synergistic work of the team as a whole.

STARS:
breaking new ground,
moving beyond familiar questions
to new and innovative research.

STARS Research: Sampling the Results and Anticipating On-going Progress

1. Forty-nine publications and manuscripts in preparation:
Volumes such as:
Schloss, J.P. and Michael Murray, eds. *The Believing Primate: Scientific, Philosophical, and Theological Perspectives on the Origin of Religion* (Oxford University Press: 2009).

Articles such as:
Aharonov, Y., Popescu, S., Tollaksen, J. Vaidman, L. *Physical Review A*, "Multiple-time states and multiple-time measurements in quantum mechanics," **79**, 052110 (2009).

Articles in:
arXiv:gr-qc
Physical Review D
Biology and Philosophy
Journal of the Royal Society
Science
Physics Today
BioScience
Scientific American
Society for Neuroeconomics
Theology and Science
Zygon: Journal of Religion and Science
Physics Letters
Journal of Physics

2. Six doctoral and undergraduate seminars based on STARS research at:
Boston University
California Institute of Technology
Fuller Theological Seminary
Graduate Theological Union
Pontifical Gregorian University, Rome
University of California, Berkeley
University of Maryland

3. One hundred and six professional and public lectures and media articles including:
American Academy for the Advancement of Science
American Academy of Religion
The Economist
Georgetown University
The New Scientist
The New York Times
Oxford University
The Washington Post

STARS is made possible by a generous grant from the John Templeton Foundation to CTNS. The initial conceptualization of STARS was provided by Foundation senior staff.

STARS: rewarding innovative new approaches
to science and transcendence

STARS: Details

.

STARS: Asking new questions of ultimate reality

The goal of STARS is to sponsor research by small teams of scientists and humanities scholars on the ways science, in light of philosophical and theological reflection, points towards the nature, character and meaning of ultimate reality.

STARS is a program designed and administered by the Center for Theology and the Natural Sciences (CTNS), www.ctns.org, located in Berkeley, California and affiliated with the Graduate Theological Union. STARS began by building upon the then twenty-five year track record of CTNS. In CTNS' most recent program, "Science and the Spiritual Quest" (SSQ), over 120 distinguished scientists from the major world religions lectured in public conferences from Boston to Bangalore, describing the many ways in which science serves for them as a path to spirituality.

The initial conceptualization of STARS was developed by senior staff and advisors of the John Templeton Foundation. CTNS expresses its sincere appreciation to the Templeton Foundation for their generous support of this program.

Conferences

The STARS program consists of two parts: conferences and research grants. In January 2007, STARS convened a series of three interdisciplinary conferences in the Mexican Riviera, on the Yucatan Peninsula. Each conference showcased an aspect of how current scientific discoveries and theories relate to our understanding of ultimate reality. Each was led by eminent scientific figures in the field, and ample time was allowed for lectures as well as formal and informal discussions. Participation was on a highly competitive basis, and the number of participants in each of the conferences was intentionally kept low to help facilitate networking and inter-disciplinary dialogue leading to the formation of STARS research teams and their grant applications.

Conference 1: Cosmology, Physics and the Possibility of Life

Lectures:

Don Howard, "The Metaphysics of Entanglement and the Entanglement of Metaphysics"
John Barrow, "The Beginnings of the Universe"
Trinh Xuan Thuan, “Science and Buddhism: Gentle Bridges”
Marco Bersanelli, "Infinity and the Nostalgia of the Stars"

Conference Description:

In order to understand the basis of modern cosmological theories and the observations that sustain them we need to appreciate how general relativity, particle physics and thermodynamics each contribute to the picture of the universe's history that has been built up over the past 40 years. Of particular importance are the key pieces of observational data that establish the expanding universe and test our reconstruction of its past history back to very early times. Much of this observational data is quite new and reflects the remarkable recent developments in instrumental design and satellite technology. We have also found that the properties of the smallest elementary particles of matter are intimately tied up with the properties of the largest structures in the universe, and conversely that astronomical observations shed new light upon the realm of elementary particles. Both of these asymptotic realms, of the very small and the very large, take us far beyond the reach of direct human experience and provoke many of our deepest philosophical, aesthetic, and religious questions about the nature of existence.

According to contemporary cosmology with this basis in physics and observational evidence, the universe is big and old, dark and cold, on track to expand and cool forever. We have observed a brief period of its history and learnt much about its remarkable structure, but many mysteries remain. It may have had an "absolute beginning" at some finite time in the past, or it may be part of some much more complex, infinitely old multiverse. The favored explanation for the unusual uniformity of the universe and the existence of the small fluctuations that gave rise to stars and galaxies is the occurrence of a brief period of accelerated expansion ("inflation") very close to the beginning of its expansion history some 13.7 billion years ago. A remarkable series of observations from Earth and from space have detected the relic radiation left over from the hot early stages of the universe and they appear to confirm the existence of an inflationary interlude in the past. But there have been major surprises as well. Recent discoveries tell us that the expansion began accelerating again when the universe was about three-quarters of its present size. If this acceleration continues, then all parts of the universe will eventually pass out of contact with each other and all forms of information processing in the universe will cease. The existence of galaxies and stars and carbon based life would not have occurred in the universe if this acceleration had begun slightly earlier in cosmic history. What do these discoveries tell us about the ultimate significance of life in the universe, and, in turn, about the source and purpose of the universe?

Ours is also a universe in which the dimensionless constants of nature and the fundamental laws of nature portray it as "fine-tuned" for life. Why do these laws and constants take the form and values they do? If the constants are very slowly changing in time, as some observations imply, could this provide a partial explanation of the "fine-tuning"? Perhaps, but some scholars suggest instead that fine-tuning provides an entry point to the quest for a transcendent, ultimate explanation lying beyond the grasp of scientific methodologies. Meanwhile, recent theories in inflationary and quantum cosmology explain fine-tuning in terms of multiple domains in an inflationary universe or in terms of multiple universes vis. eternal inflation / multiverses, based in part on the prospect for string theory to unify relativistic cosmology and particle physics. But do all these domains and multiverses actually exist, or are they mere theoretical possibilities? In light of all this, what is the ultimate significance of the fine-tuning of our universe? What ultimate questions about the universe might science answer in the future and what questions appear to be unanswerable in principle by science?

Themes and questions:

Can physics and cosmology adequately address the perennial and profound question, why does the universe (however science defines it) exist? Why "something" and not "nothing"?

Does time, as treated in relativistically informed current physical theories and their applications to cosmology (e.g., inflationary Big Bang, eternal inflation, superstring

theory, Brane / multiverses, etc.), have an "origin" or is time "eternal"? What does this suggest about the temporal character of ultimate reality?

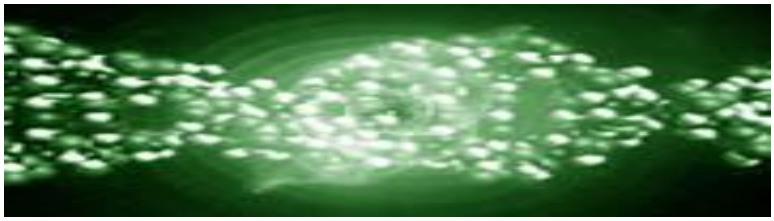
How do the asymptotic realms of the subatomic and the cosmological as revealed by physics point beyond physics to questions of wisdom, beauty and ultimacy?

Is life — terrestrial and extraterrestrial — of genuine significance in a universe that is "big and old, dark and cold," a universe whose accelerating expansion will eventually split it into endlessly isolated spacetime fragments? Can such a universe be purposeful not only from a human perspective but also in cosmological terms?

Does the fine-tuning of our visible universe provide a point of departure in the quest for the ultimate meaning of existence or is it merely an argument for an endless sea of isolated multiverses?

Do physics and cosmology shed any light on the limits to the kinds of questions they can answer?

Conference 2: Evolution, ET, and the Significance of Life in the Universe



Lectures:

Chris McKay, “Mars, ET, and all that: Are we ‘at home’ in the universe?”
Paul Davies, “The Goldilocks Enigma: Why is the universe just right for life?”
Francisco Ayala, "Darwin's Gift to Science and Religion"
Robert John Russell, “Life in the Universe: ‘Back to the drawing board’ or ‘the Cosmic Christ’?”

Conference Description:

Near the end of the 19th century, research into the evolution of species split into two distinct programs: evolutionary biology, including systematics, ecology and comparative anatomy, and developmental mechanics. Out of the former grew the “modern synthesis” or neo-Darwinian evolution; this has today become the predominant field of research. Developmental mechanics led to the study of genetics on the one hand and experimental embryology on the other. The study of genetics bifurcated, with one strand reconnecting with neo-Darwinian evolution through population genetics and the other developing into molecular genetics. Experimental embryology in turn led to developmental biology which combined with molecular genetics to produce the field of developmental genetics. Evolutionary and developmental biology have recently merged into the burgeoning subdiscipline of evolutionary developmental biology known as evo-devo. Today biologists face three broad issues: the egg-to-adult transformation, the brain-to-mind transformation, and the ape-to-human transformation. Perhaps all three can be "solved" at the conjunction of evolutionary and developmental biology plus the rapidly advancing disciplines of neurobiology and genomics.

Human distinctiveness in the context of evolutionary biology: Both neo-Darwinism and developmental genetics shed light on the perennial question: What is distinctive about being human in the context of evolutionary biology? An important response from within the neo-Darwinian paradigm is that intelligence evolved in homo sapiens as an adaptive advantage driven by the pressures of natural selection. But what about the capacity for ethical behavior such as altruism? Some scholars argue reductively that such behavior is just “mentalized instinctive altruism.” Others, however, argue that the capacity for ethical behavior evolved not because it was adaptive but as a surplus consequence of human

intelligence. Thus while ethics is grounded in biology, the specific forms it takes, and the diverse normative contents found throughout human cultures and world religions, are shaped by, but might not be determined by, or derivable from, evolutionary biology (the "naturalistic fallacy"). What then is its source: human culture per se, or an ultimate reality that is coincident with and immanent in nature, or an ultimate reality which transcends (while including) nature and culture? How do scientists in developmental genetics and evo-devo respond to these questions and issues about human distinctiveness and, in turn, about humanity's relation to ultimate reality?

Human typicality in the context of life in the universe: Exobiologists believe we will eventually discover rudimentary forms of life within our solar system, perhaps on Mars or the moons of Jupiter or Saturn. But suppose we discover much more than that: evidence of the existence of intelligent life elsewhere in the universe, the goal of the SETI project. What can we learn about human nature from this discovery that we can not learn without it? The discovery of a recognizable signal from ET suggests that its capacity for reason, science and technology, is similar to ours or perhaps much more advanced than ours. But would ET's moral behavior and spirituality also be similar to ours or radically different from ours? If it is similar, would that imply that the struggle between virtue and moral failure that characterizes the human condition is more than a random byproduct of terrestrial evolution? But if it is different, will ET be essentially benign and "saint-like," as some scientists argue, or remorselessly malignant and "demonic"? What, in turn, would these discoveries tell us about the ultimate source and grounds of reason, ethics, morality and spirituality? In sum, would the discovery of ET undercut the religions and spiritualities of humankind, sending them "back to the drawing board," or would it complement and synergize human religious experiences and beliefs?

Themes and questions:

If these three broad issues can be solved to the satisfaction of biologists, would this reduce these issues entirely to the domain of biology or would we still value a broader and complimentary context of explanation that includes the transcendent issues of philosophy, aesthetics and religion?

Which of three following options provides the most robust argument for the source of actual human norms: human culture per se, an ultimate reality that is coincident with and immanent in nature, or an ultimate reality which transcends (while including) nature and culture?

What can we learn about human nature from the discovery of extraterrestrial intelligent life that we can not learn without it? Will this point to a transcendent source of life or to life as entirely the result of the processes of nature?

Would the discovery of ET undercut the religions and spiritualities of humankind or would it complement and synergize human religious experiences and beliefs?

Conference 3: Complexity Theory, Emergence and the Influence of Life on Matter

Lectures:

Alicia Juarrero, "Top-Down Causation as the Operation of Second-Order Context-Sensitive Constraints"
Paul Davies, “Downward Causation: Can wholes affect parts?”
George Ellis, “The emergence of complexity and the causal efficacy of the mind: how is this consistent with physics?”
Terrence Deacon, “Emergent dynamics: A path from mechanism to teleology”
Nancey Murphy, "Downward Causation and the Emergence of Morality and Free Will"

Conference Description:

According to many scientists the phenomenon of emergence is characteristic of hierarchically-ordered structures and self-organizing systems, and these structures and systems can be found ubiquitously at all levels of complexity ranging from those studied by physics and chemistry to neurophysiology and ecology. In describing emergence, complexity theory seems at a minimum to require epistemic non-reducibility or "weak emergence": the presence of properties and processes at higher levels of complexity which cannot be explained entirely in terms of the properties and processes at the lower levels which underlie them.

But can we go further? Do some forms of complexity require "strong emergence": truly robust features which exhibit a degree of downward causality on their component systems? If so, how does this take place without violating the "causal closure" of nature at the level of physics as represented by the conservation laws, such as the conservation of mass-energy, momentum, and so on? What form of emergence — weak, strong, others — is exhibited in the context of the mind/brain problem and the phenomenon of religion and spirituality? And does the phenomenon of the human spirit, with its capacity for freedom, relationality, compassion and self-transcendence, point to an ultimate, transcendent source of spirit, or is it an inherent property of nature expressed in time through the biological evolution of life?

Themes and questions:

If the case for strong emergence is unsuccessful will it be a defeat for the validity of disciplines such as psychology, philosophy, and religion?

If the case for strong emergence is successful, will it address the problem of causal closure in physics by appealing to a transcendent source of causality or to a natural source that is inaccessible to physics — or to neither option?

Does the self-transcendence of the human spirit point to an ultimate, transcendent source of spirit, or is it an inherent property of nature?

STARS: A New Research Methodology

STARS: rewarding innovative
new approaches to science and transcendence

Qualifications for STARS research

What qualifies as fundable STARS research is narrowly defined in two important ways: it must be highly interdisciplinary, spanning both qualifying fields in the natural sciences and qualifying fields in the humanities, and that interdisciplinarity must be embodied in a Research Team. This interdisciplinarity means that the core of STARS research cannot be limited to either a single field or to multiple fields, whether they are within the sciences or the humanities. STARS research must be undertaken by small teams of researchers drawn from both qualifying fields in the sciences and qualifying fields in the humanities. This means it is not the result of individual research or of research accomplished through conferences. Finally, the core product / desired outcome must reflect this interdisciplinary team-structured research. It must be 'of a piece', i.e., an integrated, multiple-authored text / research result / lecture series / research seminar, etc., stemming from the synthetic and synergistic work of the team as a whole.

Definition of a STARS Research Team.

a) A STARS Research Team consists of at least 2 and not more than 6 members. At least one must be a scientist and at least one must be a humanities scholar, and in each case their primary research must be in the following qualifying fields:

The scientific fields that qualify include the following and closely related fields: physics; astronomy; cosmology; chaos and complexity theory; astrophysics; physical chemistry; chemistry; biochemistry; molecular biology; evolutionary biology; astrobiology; computer science; artificial intelligence; cognitive sciences; neuroscience; psychology; and mathematics.

The fields that qualify in the humanities include the following and closely related fields: philosophy; philosophy of science; philosophy of religion; history of science; history of religion; phenomenology of religion; religious studies; and the theology of a living religious tradition.

b) Each Research Team member must have a Ph.D. or equivalent, or be an exceptionally well qualified ABD ("all but dissertation") graduate student.

c) Each Research Team member must have a record of publications in refereed professional journals. Exceptions will be made for publications in non-refereed journals only if a strong case is produced.

STARS offers a unique vision of the way its particular form of interdisciplinary research is to be undertaken: STARS research must move from science to transcendence and ultimate reality. This further narrows the kind of interdisciplinary research that STARS will fund while it also broadens the possibilities for innovative research by qualified Research Teams.

In STARS, the primary fields are the natural sciences. The humanities scholars provide a scholarly philosophical and/or theological analysis of the theories and discoveries of the sciences in order to point to and reflect on the nature, character and meaning of ultimate reality as revealed by the sciences through the lens of such scholarly analysis. In this sense, STARS research is not "interdisciplinary" in the usual way the term is used. Although members of the team must be drawn from both the natural sciences and the humanities, the terms "transcendence" and "ultimate reality" do not, obviously, denote a field of research or academic discipline. Instead they denote a type of question being asked and a reference to that which most generally embodies it. In very general terms these expressions stand for the underlying ontology which grounds and makes possible the realities attended to by the natural sciences and the humanities and whose data range from the varieties of empirical evidence to the diversities of religious, ethical, aesthetic, spiritual and mystical experience. In STARS the central research areas for philosophical and theological analysis are the natural sciences, while philosophy and theology enter into the research primarily by way of facilitating the movement from the sciences to that which ultimately transcends the sciences even while being the ground and deepest reality of the empirical world the sciences study.

STARS encourages qualified teams to put together highly creative proposals for STARS research grants — proposals that break new ground and explore the frontier of this uniquely interdisciplinary research into ultimate reality. We anticipate that STARS research will follow one or more distinctive methods which move from science to its implications for what is ultimately real, true, good, and beautiful. This research should exhibit lavish creativity, elegant innovation and the exhilarating discovery of new knowledge about the ways ultimate reality both grounds and transcends the extraordinary universe in which we live and provides the wealth of spiritual, mystical, aesthetic, ethical and religious dimensions of our experience of this universe and its ultimate ground and goal.

STARS thus calls for a variety of new research methods that include but potentially go far beyond those normally employed in the international, intercultural and inter-religious dialogue called "science and religion." In science and religion, each field is typically an equal partner in a common research project consisting of dialogue and mutual interaction. The discoveries of science are then integrated into the theologies of a world religion either directly or indirectly through their philosophical interpretation, leading to a critical reconstruction of these theologies. Occasionally the philosophical and theological assumptions underlying and infusing science are studied by philosophers and theologians from the perspectives offered by world religions, and these scholars then bring new, critical insights to these assumptions. In STARS, however, the primary "data" that points

towards ultimacy is drawn from the sciences. It is then interpreted through both philosophical and theological analysis by the Research Team as a whole without an a priori and normative commitment to the sources and categories found in the world religions. The term “transcendence" has been intentionally chosen to allow for a striking diversity in the meaning of ultimacy ranging from God to emptiness and from nature qua nature to those categories which are presupposed in philosophical ethics and aesthetics, reflecting the wider scope for STARS research compared to the kind of discussions typifying science and religion.

Of course, some of the ongoing research in science and religion might qualify for STARS funding, particularly as it results from what are, in effect, early examples of STARS Research Teams. See for example the writings of Nancey Murphy and George Ellis, David Bohm and Jiddu Krishnamurti, Matthieu Ricard and Trinh Xuan Thuan, and Ted Peters and Martinez Hewlett. Another clear example is the broad avenue of natural theology, reflected in many of the recent Gifford Lectures focused on science and religion. More generally, many forms of ongoing research in science and religion might fit within STARS if they can be reconstructed to start with the discoveries and theories in the natural sciences and only then raise wider questions about transcendence. (See the section, “Science as offering intimations about ultimate reality,” below). Preliminary examples of some of these questions raised by science are listed below, but we expect that a much wider diversity of new and highly promising questions will be developed by future STARS Research Teams. We also list some of the analytic methods for relating science and transcendence below; these might serve as points of departure for research that moves gradually from science to the nature and meaning of ultimate reality. In sum, the ‘net’ STARS is casting is much wider than “science and religion” even while including at least some of its ongoing research as possible candidates for STARS funding.

<u>Four examples of potentially fundable STARS research</u>

1. Science and the philosophy of science: epistemological and ontological implications concerning ultimate reality

A. Time and ultimate reality in:

i) Special relativity
ii) Quantum mechanics
iii) Special and general relativity
iv) Big Bang cosmology
v) Quantum gravity and quantum cosmology
vi) Thermodynamics

B. Causality and ultimate reality
C. Complexity, self-organization and ultimate reality
D. Mind, matter and ultimate reality

2. Science as offering intimations about ultimate reality ("natural theology")
    A. Natural theology
    B. Approaches to "theology and science" if reconstructed along the lines of STARS research
    C. Science as the basis for the religious quest for ultimate reality
    D. Science and aesthetics: nature and the ultimate reality of the beautiful

3. Science and axiology / ethics: nature and the ultimate reality of the good

4. Science and spirituality / mysticism: ultimate reality through nature-based mystical experience

Examples of *non*-fundable types of research

The following examples illustrate the type of research that is not fundable by STARS either because the research is not carried out by a team and/or because it is not interdisciplinary research between qualifying fields in the sciences and humanities (see the Table below).

Note again, some of these examples are self-described as involving "ultimate reality" when in fact the text is almost if not entirely restricted to science. Apparently the tacit assumption is that science as such is about "ultimate reality." It should be clear from all that has been said above that that is a philosophical assumption outside the competency of science per se; if the import of science to ultimate reality is to be sustained it requires clear, explicit and scholarly philosophical and theological assessment.

1. Individual researcher in a single field
2. Individual researcher in multiple fields in science
3. Individual researcher in multiple fields in the humanities
4. Individual researcher in multiple fields in both science and the humanities.
5. Conference of researchers in a single field.
6. Conference of researchers in multiple fields in science.
7. Conference of researchers in multiple fields in the humanities.
8. Conference of researchers in multiple fields in both science and the humanities.
9. Team of researchers in a single field.
10. Team of researchers in multiple fields in science.
11. Team of researchers in multiple fields in the humanities.

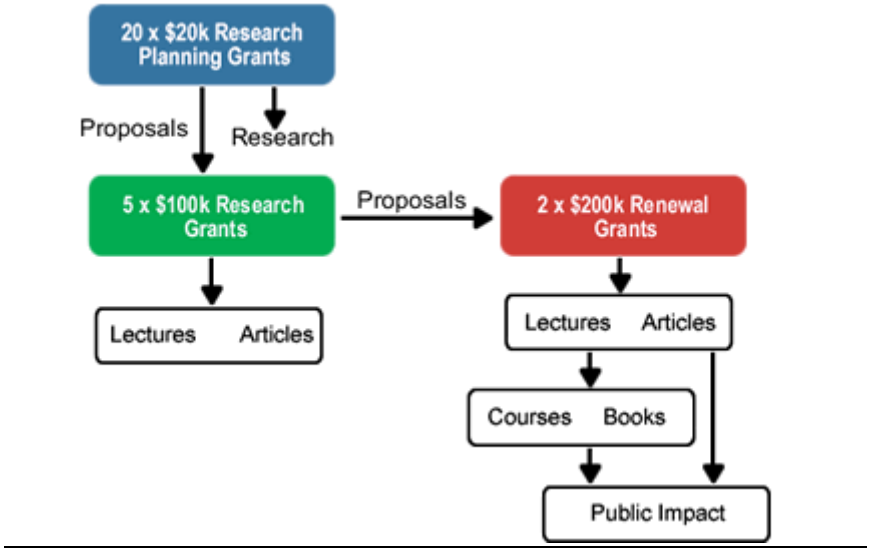
Summary Table: Eleven types of research that are non-fundable and one type of research which is potentially fundable by STARS

	Individual Research	Conference Research	Team Research
Single Field	No	No	No
Multiple Fields in the Sciences	No	No	No
Multiple Fields in the Humanities	No	No	No
Multiple Fields in the Sciences and the Humanities	No	No	**YES**

Research Grants

Following the three conferences in 2007, research grants were awarded to inter-disciplinary teams in amounts ranging from $20,000 to $200,000. A total of $1.3 million in research grants has been awarded as follows:

Twenty planning grants of $20,000 each were awarded. These grants were to assist teams in the formation of their full research proposal for the $100,000 grants and/or to provide modest support for research by the teams even if this does not lead to a full research proposal. Next, five grants of $100,000 each were awarded. Finally, two research grant renewals of $200,000 were awarded from among the five winners of the $100,000 grants. The awards at every level were based on the recommendations of a panel of distinguished judges. (See the Flow Chart below.)



Flow Chart: Showing the purposes of and relations between the $20K Planning Grants, the $100 K Research Grants and the $200K Renewal Grants

Distinguished scientists funded through STARS grants include:

Yakir Aharonov
Jeffrey Bub
Raymond Chiao
Paul Davies
George Ellis
David Finkelstein
Brian Greene
Chris McKay
Sue Savage-Rumbaugh
Jeffrey Schloss
Henry Stapp
William Stoeger
Hugh Woodin

STARS Research Topics include:

Emergence theory in evolutionary biology
Evolution of morality and values
Extraterrestrial contact
Genetics, neuroscience and transcendence
Human and bonobo cultural evolution
Infinity in mathematics, philosophy, and theology
Mind and personal identity
Morality, evolution and embodiment
Neuroscience and contemplative experience
Observation of gravity waves and the origins of the universe
Prebiotic origin of life and the role of environmental information
Quantum mechanics, causality and possibility
Rationality and ultimate value
Time, subjectivity and reality in physics
Top-down causation and the mind/brain problem
Transcending the boundaries of scientific research

STARS Research Teams and Their Topics

*Awarded $100,000 Research Grants
** Awarded $200,000 Research Renewal Grants

A Scientific Approach to Divine Infinity
Wolfgang Achtner, Justus-Liebig-Universität Gießen
Klaus Mainzer, University of Augsburg
Eric Steinhart, William Paterson University of New Jersey
Hugh Woodin, University of California, Berkeley

Brain Connectivity and Contemplative Experiences
James Fallon, University of California, Irvine
Aaron Kheriaty, University of California, Irvine
Adrian Preda, University of California, Irvine

Did Sympathy and Morality Evolve?
Marie George, St. John's University
Oliver Putz, Jesuit School of Theology at Berkeley

Dynamic Forms for Systems and Molecular Biology
Alejandro Garcia-Rivera, Jesuit School of Theology at Berkeley
Mark Graves, Graduate Theological Union
Carl Neumann, European Molecular Biology Laboratory

Emergence Theory Applied to Biological Systems
Gennaro Auletta, Pontifical Gregorian University
George Ellis, University of Cape Town
Luc Jaeger, University of California, Santa Barbara

Extraterrestrial Contact (ETC): Considerations on Human (Dis) Placement in the Cosmos
George Annas, Boston University
Devon Burr, SETI Institute
John Hart, Boston University
Thomas Kunz, Boston University
Margaret Race, SETI Institute

Genetics, Neuroscience, and the Nature of Being: A Dialectic, Natural Philosophical Approach That Seeks to Preserve the Notion of Transcendence

Kevin FitzGerald, Georgetown University Medical Center
James Giordano, Georgetown University Medical Center

Human Values, Mind and Brain

Miquel Capo, University of Balearic Islands
Camilo Cela-Conde, University of Balearic Islands
Marcos Nadal, University of Balearic Islands
Tomas Ortiz, Complutense University of Madrid

*** **Information and the Origin of Life**

Andrew Robinson, University of Exeter
Christopher Southgate, University of Exeter

Intense Experiences and Ultimate Reality

Patrick McNamara, Boston University
Wesley Wildman, Boston University

Material and Nonmaterial Cultural Evolution in Human and Bonobo

Patricia Gray, University of North Carolina-Greensboro
Gregg Henriques, James Madison University
Nancy Howell, Saint Paul School of Theology
Dave Pruett, James Madison University
Sue Savage-Rumbaugh, Great Ape Trust
Stuart Shanker, York University

Mind and Personal Identity from a Dynamical Systems Perspective

James Reggia, University of Maryland
Allen Stairs, University of Maryland

***Observation of the Gravitational-Wave Analog of the CMB and Its Implications for the Origin of the Observable Universe**

Raymond Chiao, University of California, Merced
Kirk Wegter-McNelly, Boston University

***On the Nature of Top-Down Causation**

Gennaro Auletta, Pontifical Gregorian University

Erin Calkins, University of California at Santa Barbara
Paulo D'Ambrosio, Pontifical Gregorian University
George Ellis, University of Cape Town
Luc Jaeger, University of California, Santa Barbara
William Stoeger, Vatican Observatory & University of Arizona

Note: An expanded team starting from "Emergence Theory Applied to Biological Systems"

Organic Embodiment of Transcendent Moral Commitments

Edward Larson, Pepperdine University School of Law
Stephen Post, Case Western Reserve University School of Medicine
Jeffrey Schloss, Westmont College
Paul Zak, Claremont Graduate University

Quantum Mechanics and the Appearance of Reality

David Albert, Columbia University
Brian Greene, Columbia University
Maulik Parikh, Inter-University Centre for Astronomy and Astrophysics

Quantum Physical Investigations into the Causal and Logical Orders and the Physical Basis of Possibility

Tim Eastman, Plasmas International, Silver Spring, Maryland
Michael Epperson, California State University Sacramento
David Finkelstein, Georgia Institute of Technology
William Kallfelz, University of Maryland
Henry Stapp, Lawrence Berkeley National Laboratory

***Subjective Experience as a Window on Foundational Physics**

Yakir Aharonov, George Mason University
Paul Davies, Beyond: Center for Fundamental Concepts in Science, Arizona State University
David Albert, Columbia University
Brian Greene, Columbia University
Maulik Parikh, Inter-University Centre for Astronomy and Astrophysics
Jeff Tollaksen, George Mason University

Note: The teams from "Quantum Mechanics and the Appearance of Reality" and "Time and Reality: New Insights from Quantum Non-Locality and Gentle Measurements" merged to form this new research program.

The Nature of Ethics and the Ethics of Nature: The Ultimate Reality of the Good, the Transcendent, and the Flourishing of Life

Lori Beaman, University of Ottawa
Chris McKay, NASA Ames Research Center
Timon McPhearson, Columbia University
Richard Randolph, Kansas City University of Medicine and Biosciences

*** **The Rationality of Ultimate Value: Emotion, Awareness, and Causality in Virtue Ethics and Decision Neuroscience**

Warren Brown, Fuller Theological Seminary
Greg Peterson, South Dakota State University
Kevin Reimer, Azusa Pacific University
Michael Spezio, California Institute of Technology
James Van Slyke, Fuller Theological Seminary

Time and Reality: New Insights from Quantum Non-Locality and Gentle Measurements

Yakir Aharonov, George Mason University
Joseph Berkovitz, University of Sydney
Jeffrey Bub, University of Maryland
Menas Kafatos, George Mason University
Jeff Tollaksen, George Mason University

Transcending the Boundaries of Scientific Research: Exploring Reality and the Search to Know

Rodney Holder, St Edmund's College, Cambridge University
Angeliki Kerasidou, Oxford University
Chris McKay, NASA Ames Research Center
Margaret Yee, Oxford University

STARS: Sample of Research Outcomes and Ongoing Research of *all* STARS Teams

The following is a sample of the kinds of research outcomes sponsored by the STARS program. This sample is drawn primarily from the $100K research and $200K research renewal grants, some of which is ongoing, but it also includes some citations from the $20K planning grants. In this way this sample spans the many accomplishments of the entire cadre of STARS research teams while still giving due prominence to the research of the two teams winning the $200K renewals. It has been our privilege at CTNS to support all of the research projects which have benefitted from STARS funds and thus from the generosity of the John Templeton Foundation.

1. Publications and manuscripts in preparation:

Aharonov, Y., Tollaksen, J., "New insights on Time-Symmetry in Quantum Mechanics," in VISIONS OF DISCOVERY: New Light on Physics, Cosmology And Consciousness, ed. R. Y. Chiao, M. L. Cohen, A. J. Leggett, W. D. Phillips, and C. L. Harper, Jr. Cambridge: Cambridge University Press, 2010 (in press).

Aharonov, Y and Tollaksen, J., "Deterministic Operators, Weak Measurements and Interference Phenomenon" to appear in *Journal of Physics*, Institute of Physics, 2010.

Aharonov, Y., Popescu, S., Tollaksen, J. Vaidman, L. *Physical Review A*, "Multiple-time states and multiple-time measurements in quantum mechanics," 79, 052110 (2009).

Auletta, G.; Ellis, G. F. R.; Jaeger, L., "Top-down causation by information control: from a philosophical problem to a scientific research programme", *J. R. Soc. Interface* (2008) 5, 1159-1172.

Auletta, G.: *Information Acquiring, Controlling, and Interpreting through Biological Systems* (ms in preparation).

Brown, W. S., Reimer, K.S., Spezio, M.L., Peterson, G. and Van Slyke, J. "A Science of Love: Behavioral and Neuroscience Study of the Virtue of Compassion," M. Welker and Xutong Qu, eds., *Law and Love: Philosophy, Religions Studies, and Sciences in China and the West* (to be published in English, German, and Chinese).

Cela-Conde, Camilo Jose, Tomas Ortiz, Miguel Angel Capo, Marcos Nadal, Julia Christensen & Nadine Gut, "The Influence of Religious Values on Responses to Moral Dilemmas" (ms).

Chiao, Raymond, "'Millikan Oil Drops' as Quantum Transducers between Electromagnetic and Gravitational Radiation," *arXiv:gr-qc/0702100* (accessed October 19, 2007).

Ellis, George F. R. "On the nature of causation in complex systems", *Transactions of the Royal Society of South Africa* 63 (2008) [Centenary Issue], 69-84.

Garcia - Rivera, A., M Graves, C. Neumann. “Beauty in the Living World”. *Zygon: Journal of Religion and Science* 44.2 (June 2009).

George, Marie. "Descartes' Language Test for Rationality: A Response to Miller." *American Catholic Philosophical Quarterly* (in press).

George, Marie. "On Whether Language Usage, Knowledge of Others' Beliefs, and Knowledge of Others' Emotion Indicate that Humans and Apes Differ When it Comes to Rationality," in *Nature, Science and Wisdom: The Role of Natural Philosophy*, Guiseppe Butera, ed.. (To be published by the American Maritain Association.)

Giordano J. “Chronic pain and spirituality,” *Practical Pain Management*, 7(2): 77-80 (2007).

Giordano J., Kohls N. “Suffering, the self, and spiritual experience”, to appear in the *International Journal Mind and Matter.*

Gray, J.E., Tollaksen, J., “The Aharonov-Vaidman formula, its justification, and implications for signal enhancement,” Quantum Information and Computation VI, Proceedings of SPIE Volume: 6976, pp. 69760S-69760S-11 (2008), editor(s): Eric J. Donkor; Andrew R. Pirich; Howard E. Brandt.

Johnson, Elizabeth A., P. Timon McPhearson. “Protecting Nature in Your Community.” Center for Biodiversity and Conservation, American Museum of Natural History: New York (2007) available at: http://cbc.amnh.org/center/pubs/pubsnew.html.

Larson, Edward J., "The Creation-Evolution Debate: Historical Perspectives” (Athens: Univ. of Georgia Press, 2007).

McPhearson, P. Timon, Stuart P.D. Gill, Robert Pollack, and Julia E. Sable. “Increasing Scientific Literacy in Undergraduate Education: A Case Study from ‘Frontiers of Science’ at Columbia University, *Towards a Modern Humanism*, eds. Frédéric Darbellay, Moira Cockell, Jérôme Billotte, and Francis Waldvogel (Crans-Montana, Switzerland: World Knowledge Dialogues, 2008).

McPhearson, P. T., R. O. Randolph, L. Beaman, and C. McKay. “The importance of cooperation.” To be submitted to *BioScience*.

Mintner, Stephen J., Wegter-McNelly, Kirk, Chiao, Raymond Y. “Do mirrors for gravitational waves exist?” 30 June, 2009. http://arxiv.org/abs/0903.0661

Murphy, Nancy and Jeffrey Schloss. "Biology and Religion." In *Oxford Handbook of the Philosophy of Biology*, Michael Ruse, ed. (Oxford University Press, 2008), p. 545-569.

Nussinov, S, Tollaksen, J. *Physical Review D*, "Color transparency in Q.C.D. and post-selection in quantum mechanics," 78, 036007 (2008).

Peterson, G., Van Slyke, J., Spezio, M.L., Reimer, K.S., and Brown, W. S., "The Rationality of Ultimate Concern: Moral Exemplars, Theological Ethics, and the Science of Moral Cognition." Submitted to *Theology & Science*.

Putz, Oliver. "In the Image of God: Moral Apes and Special Creation." *Zygon* (in press).

Randolph, R.O., P.T. McPhearson, L. Beaman, and C. McKay. "Towards new methodological approaches in the science and religion dialogue." Submitted to *Theology and Science*.

Reimer, K.S., Spezio, M.L., Brown, W. S., Peterson, G. and Van Slyke, J. "Will I Survive the Polling Station? Psychological and Neuroscientific Approaches toward Virtuous Courage in Political Behavior." In revision for *Political Research Quarterly*.

Schloss Jeffrey P. "Is There Venus on Mars?: Bioenergetic Constraints, Allometric Trends, and the Evolution of Life History Invariants" in *Fitness of the Cosmos for Life: Biochemistry and Fine Tuning*, John Barrow, Simon Conway Morris, Stephen Freeland, and Charles Harper, eds. (Cambridge University Press: 2007), p. 318-346.

Schloss, Jeffrey. "He Who Laughs Best: Religious Affect as a Solution to Recursive Cooperative Defection." Forthcoming in *Evolutionary Explanations of Religion*, Richard Sosis and Joseph Bulbulia, eds. (Collins Foundation Press: 2007), p. 205-215.

Schloss, J.P. and Michael Murray, eds. *The Believing Primate: Scientific, Philosophical, and Theological Perspectives on the Origin of Religion* (Oxford University Press: 2009).

Spezio, M.L., Brown, W. S., Peterson, G., Reimer, K.S., and Van Slyke, J. "Virtuous Decision: Exemplarity in and out of the laboratory," submitted to the *Society for Neuroeconcomics*.

Southgate, Christopher, Robinson, Andrew. "Interpretation and the Emergence of Life," submitted to *Biology and Philosophy*.

Tollaksen, J., Aharonov, Y., Casher, A., Kaufherr, T., Nussinov, S., "Quantum interference experiments, modular variables and weak measurements," *New Journal of Physics*, 12 (2010) 013023.

Tollaksen, J., Gray, J.E., "Memory, contextuality, instrumentality, and quantum mechanics," Quantum Information and Computation VI, Proceedings of SPIE Volume: 6976, pp. 69760R-69760R-11 (2008), editor(s): Eric J. Donkor; Andrew R. Pirich; Howard E. Brandt.

Tollaksen, J., "Pre- and post-selection, weak values, and contextuality" in *Journal of Physics A: Mathematical and General*, Institute of Physics, 40 (2007) 9033-9066.

Tollaksen, J. "Robust Weak Measurements on Finite Samples," *Journal of Physics: C*, 70, (2007), Institute of Physics, 012014 (featured in O. Hosten, P. Kwiat, *Science*, "Observation of the Spin Hall Effect of Light via Weak Measurements," 319, 787 (2008) which was featured in K. J. Resch, *Science*, "Amplifying a Tiny Optical Effect," 319, 733 (2008), both of which were featured in *Physics Today* , April 2008, C. Day, "Light exhibits a spin Hall effect," Volume 61, Issue 4, pp. 8-96, see also Popescu, S. "Weak measurements just got stronger," *Physics* 2, 32 (2009) ".

Tollaksen, J., "Novel Relationships between Super-oscillations, Weak Values, and Modular Variables," *Journal of Physics: C*, 70, (2007), Institute of Physics, 012014.

Tollaksen, J. "Quantum properties that are extended in time," Quantum Information and Computation V, Ed by E Donkor, A Pirich, H Brandt, Proc of SPIE Vol. 6573 (SPIE, Bellingham, WA, 2007), CID 6573-35.

Tollaksen, J, Ghoshal, D "Weak Measurements, Weak Values and Entanglement," Quantum Information and Computation V, Ed by E Donkor, A Pirich, H Brandt, Proc of SPIE Vol. 6573 (SPIE, Bellingham, WA, 2007), CID 6573-36.

Tollaksen, J "Non-statistical weak measurements," Quantum Information and Computation V, Ed by E Donkor, A Pirich, H Brandt, Proc of SPIE Vol. 6573 (SPIE, Bellingham, WA, 2007), CID 6573-33.

Tollaksen, J., "Pre- and post-selection, weak values, and contextuality" in *Journal of Physics A: Mathematical and General*, Institute of Physics, **40** (2007) 9033-9066.

Zak, P. J., Stanton, A. Ahmadi, S.: "Oxytocin increases generosity in humans," *Public Library of Science ONE*. (to appear, November 7, 2007)

Zak, P. J., "The Neurobiology of Trust," *Scientific American*, June (2008) p. 88-95.

Zak, P. J., *Moral markets. Journal of Economic Behavior and Organization* (in press).

Additional publications forthcoming by the Southgate / Robinson team:

The Southgate / Robinson team will convene a 4-day intensive summer school to be held at CTNS / the Graduate Theological Union and the University of California, Berkeley in June 2010. A complete Special Issue of *Zygon: Journal of Religion and Science* will be devoted to the results of the Southgate / Robinson research and the June 2010 conference at CTNS/GTU and UCB. This will contain two jointly authored articles by the PI's, one on the philosophical and scientific content of the project thus far, and one on the theological content. Each of the articles will be followed by responses written by the

team's Co-Investigators and other consultants to the team who will have participated in the conference. The fruitfulness of the reciprocities engendered by the STARS model of interdisciplinary working will be further reflected and illustrated by a section of the issue consisting of a 'conversation' between the contributors. Part of this conversation will explore the participants' experience of working on the novel STARS interdisciplinary model, where the aim has not simply been rapprochement between the disciplines but development of constructive work in each of the fields through the interdisciplinary interactions of the participants.

Following discussion of the scientific portion of their STARS research at the AAAS, the Southgate / Robinson team anticipates submitting scientific papers covering their work on the RNA and vesicle systems to *Science* in mid-2010. An article summarizing the interplay of theological with philosophical and scientific work will be submitted to *Teaching Theology and Religion* in mid-2010. An additional scientific paper on further study of the autocell is being planned as co-authored by their team's PhD student, the Principal Investigators, and the Scientific Collaborators. It will be submitted to *Origins of Life and Evolution of Biospheres* by November 2010. Finally, an article summarizing the scientific work at a non-technical level will be submitted to *Scientific American* at the conclusion of the project in 2011.

2. Doctoral and undergraduate seminars based on STARS research:

A new doctoral course was offered by G. Auletta and I. Colagè on "Top-Down Causation" during the second semester, 2007-2008, at the Pontifical Gregorian University, Rome.

John Hart offered a new undergraduate course, "Encountering ET: Spirit, Science, and Space," at Boston University in 2008. Margaret Race was a guest lecturer.

William M. Kallfelz taught a new course, "New Methodological Horizons for Old Questions Concerning Inter-theoretic Reduction," at the University of Maryland.

The Southgate / Robinson summer school in June, 2010, at CTNS/GTU and UCB will include 15 doctoral students selected on a competitive, international basis.

The Brown - Peterson - Spezio team will offer both doctoral and masters level courses. A new doctoral level course will be offered at Fuller Theological Seminary based on their STARS research in ethics, science and theology. This course will include ten to fifteen students who will engage material related to virtuous exemplars, the neuroscience of moral action, the philosophy and theology of virtue, and the role of religion in virtue. Each of the investigators will participate in giving lectures for the class. A new masters level course will be offered at Fuller Theological Seminary and be open as well to Caltech students. The class will consist of lectures from the investigators and some of the consultants addressing issues raised by the thinking and research of this project. This course will enable their ideas and research to be circulated among a larger academic

audience and facilitate a broader discussion regarding the philosophical, theological, and scientific work within these two prominent institutions.

3. Lectures & media events / public impact:

The Aharonov – Tollaksen team was featured in the April, 2010, edition of *Discover* magazine. Also one of their publications (Aharonov Y, Botero A, Popescu S, Reznik B, Tollaksen J, "Revisiting Hardy's paradox: counterfactual statements, real measurements, entanglement and weak values," *Physics Letters A* 301 (3-4): 130-138) has also received impressive media attention. The novel effect the team discovered has been verified in several independent experiments which have or will be featured in popular science journals including *Scientific American* (Japan), *New Scientist* "They said it couldn't be done but now we can see inside the quantum world," *The Economist*, *The Wall Street Journal*, etc.

Auletta's team will create a website www.topdowncausation.org for the public dissemination of their work.

Cardinal W. Kasper and Sir Anthony Kenny, FBA entered into a public debate on the topic: "Human Beings" (2009).

In a public lecture, Chris McKay explored the frontier topic "In which ways can current findings from the Phoenix probe of Mars and the possibility of extra-terrestrial life contribute to an understanding of the question 'What is Life?'" at Oxford University.

Ronald Cole-Turner offered a public lecture / seminar titled "Human Enhancement and Christianity. A case of friendly fire?" in New York. It was widely disseminated by ipod and made available audioline on the web (2009).

Ed Larson has given a variety of public lectures at Oxford University, Cambridge University, U. K., and at Franklin and Marshall College, USA.

Hugh Woodin spoke on "Truth and beauty in mathematics" at *The Aesthetics and Mathematics Symposium*, 9 - 10 November 2007, Louis Hartlooper Complex, Utrecht.

Kevin Fitzgerald and James Giordano gave a public lecture on "Science, spirituality and the notion of transcendence" (2007) aimed for hospital and medical students at Georgetown University.

Marie George lectured on "C. S. Lewis on Extraterrestrials" and "Aquinas on Trust and Our Social Nature" at the Annual Meeting of the Society of Catholic Social Scientists, October 20-27, 2007, New York. An interview with Marie George on "How apes and humans differ in regard to the cognitive and affective abilities underlying moral agency" was published in *MercatorNet*, July 12, 2007 (http://www.mercatornet.com/articles/monkey_business) and *The Torch* (http://www.torchonline.com/home/index.cfm?event=displayArticle&uStory_id=effbdcc6-498c-4d62-9c9f-4584c5920ccf).

P. Timon McPhearson *et. al.* have produced a very helpful website on their research: http://cbc.amnh.org/center/pubs/pubsnew.html

P. J. Zak has produced 49 print articles and interviews, including for the *Washington Post*, *The New York Times*, *Scientific American*, *The Economist*, *Discover*, the *LA Times*, and *The New Scientist*. He has made 20 radio and television appearances and interviews, and he has a regular blog on oxytocin, trust, and human nature - "The Moral Molecule" - on *Psychology Today* with approximately 20 feature essays to date.

The Brown - Peterson - Spezio team: The highlight of an upcoming 2010 conference will be two evening public lectures given by an eminent philosopher and an eminent theologian on the subject of virtue ethics and science. One public lecture will take place on the campus of the California Institute for Technology with a respondent from Fuller Theological Seminary. The second lecture will take place at Fuller with a respondent from Caltech. Both lectures will be advertised on the Caltech and Fuller campuses, as well as to the broader Los Angeles Metropolitan area. The local press, such as the *Los Angeles Times*, will be invited to attend and report on the event. It is the team's hope that this event will promote wider community discussion and reflection on the important issues related to neuroscience, virtue, and transcendence. During this conference they will also explore the possibility of forming a new professional society for the neuroscientific and philosophical study of moral action. The team believes that this outcome may be the most significant and long-lasting product of their research project.

The Southgate / Robinson team: They delivered a lecture at the UK Science and Religion Forum (SRF) in September 2009 at the Forum's annual conference in Cambridge (which celebrated the 150th anniversary of the publication of *The Origin of Species*). Lecture title: "Towards a New Theology of Nature: From Origin of Life to Incarnation" was jointly delivered by Drs Robinson and Southgate. Their team also gave a lecture at the "Science, Technology and Religion" Group at the American Academy of Religion Meeting in Montreal, November 2009. At the American Association for the Advancement of Science in San Diego in February 2010 they lectured on their scientific work to date in an accessible way, and sought feedback before the work is submitted for publication.

They are making approaches to TV / film production companies to produce a PBS-type documentary film highlighting the fruitfulness of STARS' novel methodology: the reciprocal interaction of philosophers, scientists and theologians. The film will include footage from the high-level fish-bowl conference and from interviews with the STARS investigators who will reflect on the experience of cross-disciplinary working on the STARS model. The conceptual content of the project will be illustrated with video simulations commissioned from specialist scientific video-illustrators. This material will also be used in public lectures as well as in the PBS-type film. A professionally designed project website will be set up to communicate the STARS methodology and outcomes of the project to the wider public audience. This will include video illustrations of the concepts, interviews with the STARS team, and a facility to receive and respond to

feedback from the public. This film and website will also offer the opportunity to counter the much-publicized view that evolutionary science and theology are necessarily in conflict. Finally, jointly-authored articles will be submitted to non-technical media such as *The New Scientist*, building on the publicity obtained from making the PBS-type documentary.

Science and transcendence
The quest continues …