

THE INSPIRATION

Science has finally answered many long-standing foundational questions about our place in the universe – yet the most fascinating discoveries are still to come.

THE CHALLENGE

Traditional sources of funding shy away from interesting issues in favor of low-risk applied research.

THE IDEA

Unite the power of peer review with the boldness of philanthropy to support rigorous research on humanity's deepest questions.

WHAT WE DO

Support top thinkers and outreach specialists worldwide through grant competitions and contests, creating a vibrant community of scientists with a commitment to public understanding of their work.

HOW YOU CAN HELP

Your contribution to FQXi, a non-profit organization, can support research projects, foster an undiscovered genius, or fund an essay contest – it's up to you.

FQXi

FOUNDATIONAL QUESTIONS INSTITUTE

FQXi MISSION

To catalyze, support, and disseminate research on questions at the foundations of physics and cosmology, particularly new frontiers and innovative ideas integral to a deep understanding of reality but not readily supported by conventional funding sources.

EXPLORING THE FOUNDATIONS AND BOUNDARIES OF PHYSICS AND COSMOLOGY

FQXi

“... the whole history of science has been the gradual realization that events do not happen in an arbitrary manner but that they reflect a certain underlying order...”

- Stephen Hawking

The Foundational Questions

Since the beginning of thought, humanity has struggled to answer foundational questions about the behavior, nature and meaning of our world. Today, after great time and effort, many problems once regarded as hopelessly unanswerable have been brought into the fold of our rigorous understanding.

With each hard-won scientific answer, we gained predictive powers of immense practical importance, and experienced profound shifts in our understanding of our place in the universe – dislocations with deep philosophical, spiritual and scientific implications for everyone concerned with the true nature of the world.

Yet, at the dawn of the 21st century, the age of discovery continues: Extraordinary foundational questions remain. How will we answer these questions? Just as importantly, how will we come to understand what these answers mean?

Historically, physics and cosmology have offered a scientific framework for comprehending the core of reality. Yet, many giants of modern science – such as Einstein, Bohr, Schrödinger, and Heisenberg – were also passionately concerned with, and inspired by, deep philosophical nuances of the novel notions of reality they were exploring.

Still, some – now as then – dismiss such matters as meaningless philosophy or empty metaphysics, encouraging colleagues to eschew such thinking and focus on concrete calculations. Most grant-making and research organizations institutionalize this pragmatic approach, primarily funding incremental investigations using known methods and familiar conceptual frameworks, rather than the uncertain and often interdisciplinary methods required to develop and comprehend prospective revolutions in physics and cosmology.

As a result, even eminent scientists are unable to secure funding for some of the questions they find most engaging, and younger thinkers find little support, freedom, or career possibilities unless they hew to such strictures.

The Foundational Questions Institute (FQXi) views foundational questions not as pointless speculation or misguided effort, but as critical and essential inquiry of relevance to us all. The Institute is committed to taking a leadership role as a novel non-profit organization dedicated to redressing these shortcomings.

Some Foundational Questions...

WHAT ARE WE MADE OF?

WHAT MOVES THE PLANETS?

WHAT ARE STARS?

WHAT IS THE SUN?

ARE THERE OTHER WORLDS?

HOW DID THE WORLD BEGIN?
HOW WILL IT END?

...have been answered...

WE ARE MADE OF ATOMS, WHICH IN TURN ARE MADE OF QUARKS AND ELECTRONS.

PLANETS' MOVEMENTS ARE DETERMINED BY GRAVITY, WHICH IS CURVED SPACETIME.

OUR WORLD BEGAN AS DUST ACCRETING AROUND A YOUNG SUN; IT WILL END WHEN THE AGED SUN RUNS OUT OF FUEL.

THE TWINKLES IN THE NIGHT SKY ARE DISTANT STARS, MANY JUST LIKE OUR SUN.

THE SUN IS A FIERY BALL OF GAS POWERED BY FUSION, WHICH CONVERTS MATTER INTO LIGHT AND WARMTH.

THERE ARE OTHER WORLDS, MORE NUMEROUS THAN WE CAN GRASP.

...while others remain...

ARE WE ALONE OR IS LIFE UBIQUITOUS?

CAN WE EXIST IN TWO PLACES AT ONCE?

HOW DID OUR UNIVERSE BEGIN?

WHAT IS THE NATURE OF TIME?

IS OUR OBSERVED UNIVERSE ALL THAT EXISTS, OR IS IT JUST ONE AMONG MANY?

IS THE UNIVERSE ACTUALLY MADE OF INFORMATION?

Impetus: The Physics & Cosmology Research Landscape

A century ago, the twin revolutions of general relativity and quantum mechanics prompted thinkers to grapple anew with conceptions of space, time and matter, and to undertake innovative mathematical and philosophical approaches to understand reality.

But our predecessors' ease with open-ended discovery in a philosophical milieu dissipated as two world wars and a cold war necessitated practicality in scientific endeavors. Deep thinking on foundational questions was relegated to intellectual and fiscal margins in the face of strong pragmatic and anti-philosophical mindsets in mainstream physics. For example, Einstein's general relativity theory, while widely acknowledged to be both revolutionary and true, was unfortunately not immediately useful – and so was virtually ignored in the half-century following its experimental confirmation in 1919.

Even now, decades after the collapse of the Soviet Union, this hard-nosed attitude remains. Further, as research budgets have tightened, innovators rarely expend their intellectual and financial capital on speculative work – no matter how potentially thrilling the search or the outcome.

This out-moded fiscal and sociological atmosphere profoundly affects today's deep thinkers. A pervasive inclination to narrow the line of inquiry – to “downsize” the research questions – means that foundational work is often left to nights and weekends, rather than the concentrated, sustained effort that history shows is necessary. And young researchers, who must compete fiercely for job openings, grants and tenure, find little external reward in tackling controversial matters.

Sadly, this situation occurs at just the moment when foundational thinking is arguably more possible, exciting and necessary than ever. At a moment in history when the potential rewards are finally within our reach, FQXi is dedicated to increasing support – intellectual, organizational and public – for foundational thinking.

FQXi

Background & Foreground

FQXi was founded in 2006 by an international group of visionaries in physics, cosmology and related fields, through a generous four-year seed grant from the John Templeton Foundation. From the outset, the Institute was established as an independent non-profit organization that provides a global network of researchers and others with intellectual, organizational and financial support for the study of foundational questions.

Our research is:

- *Foundational*, with potentially significant and broad implications for our understanding of the deep or “ultimate” nature of reality; and,
- *Unconventional*, enabling research that, because of its speculative, non-mainstream or high-risk nature, would otherwise go unperformed due to lack of funding.

We fulfill our mission through:

- *Worldwide grants competitions*, unique opportunities open to all who seek to answer foundational questions;
- *Our Membership of top scientists worldwide*, for whom we provide supplementary support such as “Mini-Grants” for travel, lecture programs and workshops;
- *International conferences*, uniting our Membership and the wider community in explorations of today’s foundational questions;
- *Essay and other contests*, stimulating work on particular foundational questions; and,
- *A dynamic website* that connects the scientific community and the general public via original articles, blogs and forums.

“The task is not so much to see what no one has yet seen; but to think what nobody has yet thought, about that which everybody sees.”

- Erwin Schrödinger

Facts & Figures

Federal funding for foundational questions is tiny. Although US government expenditures for all physics and astronomy research – from the Department of Energy, NASA and the National Science Foundation – total about US\$1.5B per annum, the vast majority of this sum is directed to applied and experimental work. Further, of the US\$50M or so dispensed specifically to university-based grants for theoretical research in high-energy physics, gravitation, quantum mechanics and cosmology, most goes to important but relatively mainstream science.

Thus, federal grants for theoretical research on foundational questions in physics and cosmology is probably well below US\$10M per year – an incredibly small figure when compared to the expense of necessary related experiments such as the Hubble Space Telescope (US\$8B) or the Large Hadron Collider (US\$4B).

Few outside the field realize the extent to which such fascinating questions are starved of funding – or the impact that additional monies would immediately provide. For example, one round of FQXi grants injects approximately US\$2M every two years into the field, so FQXi programs already constitute a significant portion of all relevant funds.

DEVELOPED A ROBUST INTERNATIONAL COMMUNITY OF FOUNDATIONAL THINKERS.

FQXi has earned broad and deep respect from the scientific community and the general public for its efforts to further scientific inquiry via a global, inter-institutional community of researchers in the fields of our purview. As a result, today, the great majority of top thinkers in foundational questions are FQXi Members.

CONVENED HIGHLY SUCCESSFUL SCIENTIFIC CONFERENCES.

FQXi conferences unite specialists not only for the usual talks and seminars, but also for creative group work and brainstorming in vibrant locales.

In our short history, FQXi has already made noteworthy progress in the engagement of foundational questions.

CREATED A VIGOROUS ONLINE EDITORIAL PRESENCE.

The FQXi website serves as a central resource for information and exchange, including access to original articles, blogs, scientific forums and podcasts.

DIRECTED MILLIONS OF DOLLARS TO CUTTING EDGE RESEARCH.

Employing a scrupulous and independent peer-review process modeled after that of the National Science Foundation, FQXi directs millions of dollars in large and small grants through a donor advised fund (FQXi Fund) to an exceptionally diverse group of top scientists worldwide. This funding has resulted in measurable positive outcomes in a variety of media, including papers and lectures, books and movies, websites and wikis. Moreover, a number of FQXi Fund grantees have been able to leverage their success in and with FQXi grants to attract broader funding from more conventional sources.

INITIATED A UNIQUE SERIES OF INNOVATIVE ESSAY CONTESTS.

These contests focus the minds and efforts of foundational thinkers on deep questions such as, "What is the nature of Time?" and "What is ultimately possible in Physics?" Each contest awards up to twenty prizes via expert judging, and contests so far have attracted hundreds of entries and significant community attention.

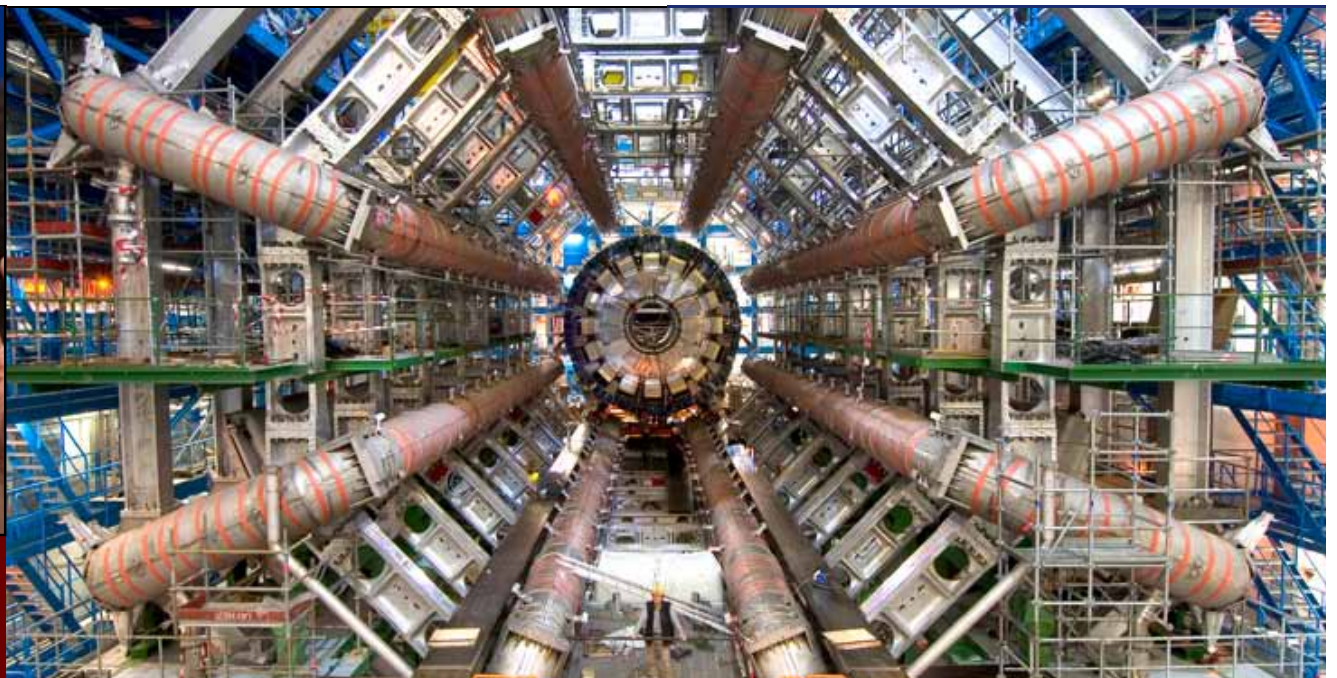


Research Area: Cosmology

Cosmology is that subset of astronomy that asks the biggest questions of all: What is the structure of the universe on the largest scales? How did it begin – indeed, did it begin? Did the universe undergo early “inflationary” expansion, as recent astronomical data appears to suggest? Are there other universes, and what are they like? What are dark matter and dark energy?

FQXi Members Andre Linde, Alan Guth, and Alex Vilenkin pioneered the theory of inflation – but they also showed that if inflation occurred, it probably led to the creation of many “universes.” They and other FQXi Members, including the Institute’s Scientific Directorate, study these multiple universes and how their properties may vary.

Others (including awardees Raphael Bousso, Brian Greene, Justin Khoury and Maulik Parikh) investigate the hidden but fascinating ways in which the super-structure of the universe may underlie such disparate phenomena as why you remember the future and not the past, and why you have mass!



Research Area: Quantum Foundations

After a century of debate, we still do not understand the central aspects of quantum mechanics. Bizarre “quantum questions” are among the most fascinating and popular in science, and the most important for understanding our world. Yet FQXi remains one of the few sources for support of quantum foundations research.

What happens when we make a measurement? FQXi Member Wojciech Zurek studies whether “Quantum Darwinism” explains how our sturdy macroscopic world emerges from observing delicate quantum systems.

Is reality unique? FQXi Members Simon Saunders and David Wallace attempt to clarify the philosophical basis of the famous “Many Worlds” interpretation, in which quantum reality is an endlessly branching tree of universes.

Research Area: Technology

Transformational technologies often follow revolutions in physical understanding, so progress is generally made by investing in nominally “pure” research. FQXi grantees Keith Schwab, Markus Aspelmeyer and Paul Kwiat separately probe the limits of quantum “superposition” and “entanglement.”

Conversely, experiments in physics and cosmology invariably require sophisticated techniques that push the technological envelope. FQXi grantees Ekkehard Peik and Dmitry Budker separately search for variations in fundamental “constants” of nature through different but innovative precision laboratory experiments.

In all of these cases, existing hardware, often developed for other purposes, has been redirected to “foundational use” at minimal cost.



“It is said that there’s no such thing as a free lunch. But the universe is the ultimate free lunch.” Alan Guth

Who We Are

Scientific Director Max Tegmark is an associate professor of physics at MIT specializing in cosmology, with interests in quantum mechanics, parallel universes and the relation between mathematics and physics.

Associate Scientific Director Anthony Aguirre is an associate professor of physics at UC Santa Cruz who has worked on a wide variety of topics in theoretical cosmology, ranging from gravity physics, the large-scale structure of the inflationary universe and the arrow of time.

The FQXi Advisory Council consists of top thinkers in physics and cosmology, as well as leaders in philanthropy and business who share a passion for foundational questions.

It includes cosmologists John Barrow, Alan Guth, and Martin Rees, physicists Eva Silverstein, Lee Smolin, Frank Wilczek, and Dieter Zeh, philosophers Nick Bostrom and David Chalmers, mathematician Gregory Chaitin, science and business journalist Robert Kuhn, business leaders and philanthropists Patricia M. Gruber, Christopher Liedel, Bruce McWilliams, and Melanie Swan.

FQXi is a non-profit, 501(c)(3) organization. In efforts to streamline its programs, FQXi directs grants through a donor advised fund at the Silicon Valley Community Foundation. FQXi is governed by a Board of Directors.

Effective Leadership and Oversight

Our successes so far are in part due to a streamlined approach to management,

a commitment to outsourcing work outside of our core competencies, and extensive use of online and related technologies to seamlessly connect our various components.

Scientists direct the science; our Scientific Directorate sets the Institute’s goals and objectives; expert external reviewers direct funding decisions; and world-renowned scientists on our Advisory Council provide scientific vision.

The streamlined organizational structure of FQXi, along with its ability to enforce low overhead costs, ensures that virtually all donations we receive are distributed to researchers and outreach specialists as grants through our donor advised fund or as special prizes through contests, not expended in unnecessary administration or infrastructure.

Your Role

Our Vision for the Future

FQXi was founded through a generous, unrestricted seed grant from the John Templeton Foundation to establish the Institute and begin fulfilling our mission. The time has come to address our need for major philanthropic support from new donors, and to set a foundation for FQXi's long-term existence. We have set a goal to raise US\$20M over the next five years to underwrite critical work on foundational questions and to endow key components of FQXi's programs.

FQXi's mission, structure and innovative approach to funding research through our donor advised fund affords a unique opportunity for you to make a significant impact on the worldwide effort to answer some of humanity's oldest and deepest questions.

To reach this goal, FQXi invites your participation at a variety of financial levels. Your ideas are welcomed as well. Our small size and independence from federal agency or university funding rules enable us to freely and flexibly tailor programs. We can also work with you to identify key areas where your support would make maximal impact. And your generous support will make you a true member of the FQXi community, which invites personal involvement and interaction with our global network of emerging and eminent scientists.

Some possibilities include:

Research Project (US\$25,000–US\$100,000 per project)

Make your mark by partially or entirely funding a project of particular interest to you, selected from a menu of worthwhile and peer-reviewed proposals. You will receive frequent progress reports and have multiple opportunities for personal involvement with the researcher team.

Individual Fellowship (US\$50,000–US\$100,000 per person per year)

Foster genius by supporting unrestricted foundational research from a particularly promising scientist. You will receive frequent progress reports and have multiple opportunities for personal involvement with the researcher.

Grant Program (US\$1M–US\$2M)

Spur scientific competition by sponsoring a grant contest in a foundational subject area, such as quantum information, quantum gravity, string theory, cosmology, particle physics, or astrobiology/complexity. You will receive frequent progress reports and have multiple opportunities for personal involvement with the researchers.

The Einstein Endowment (US\$1M+)

Invest in the future of philanthropic science by underwriting the Institute's operations with your endowment. You will receive frequent progress reports and have multiple opportunities for personal involvement with FQXi researchers.

Innovation in Scientific Grant-Making

FQXi's dedication to innovation goes beyond the scientists we fund through our donor advised fund, to our programming, operations and financial model.

- “Mini-Grants” are a unique and fair funding mechanism with a minimal administrative burden in which small amounts of money are awarded to FQXi Members via a lottery
- Juried essay and other contests with significant prize packages are open to professionals and independent researchers alike
- Donated funds are efficiently and strategically disbursed with careful oversight to those doing or interpreting work at the cutting edge

For the first time in history, humanity is poised to discover answers to some of the most profound questions about life and the universe. FQXi offers scientists and the philanthropists who support them the unrivaled opportunity to play a decisive role in the future of physics, cosmology and the quest for understanding.

If you'd like to get involved, please contact us:

The Foundational Questions Institute

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Twitter: @FQXi

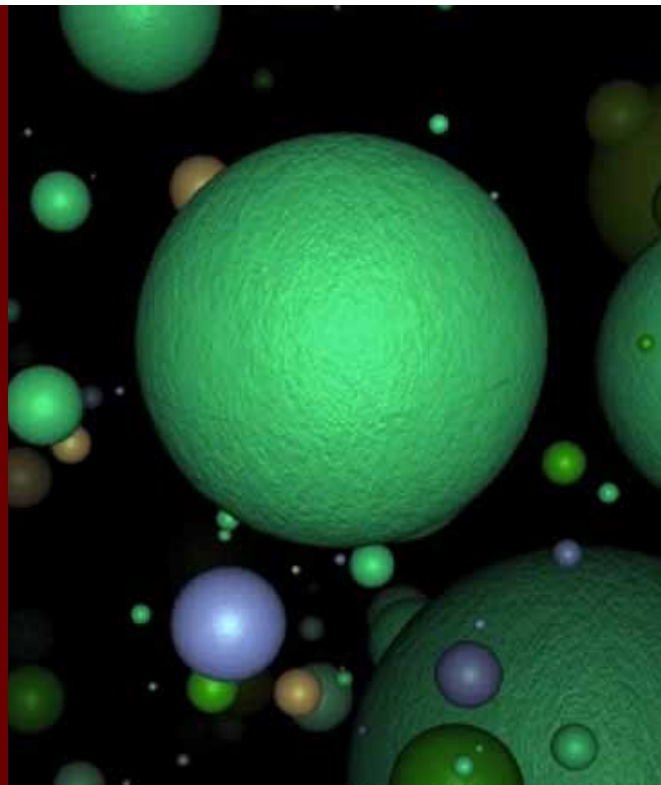
Facebook: fqxinstitute

Research Area: Ultimate Reality

In a category not usually found in other funding agencies' dockets, FQXi Members boldly ask questions at the foundations of reality itself. What do "parallel universes" mean physically and philosophically? What does it mean for something to be physically real? Why does physics work, and why is it mathematical? Are there truths that physics can never determine?

FQXi investigator Janna Levin asks, in analogy to Gödel's theorem in mathematics, if one can show that there are physical truths that cannot be proven. FQXi Scientific Director Max Tegmark wonders if reality itself is purely a mathematical object.

Other FQXi Members, such as Nick Bostrom and Paul Davies, ask if we might unknowingly be part of a computer simulation – and, if we were, what that would mean. And many FQXi Members often debate the deeper implications of what it means to "measure," to "observe" or even to "be," in light of the upheaval quantum theory has created in all of those notions.



Research Area: High Energy Physics

The Standard Model of particle physics, a subset of high-energy physics, is a pillar of our current understanding of the universe. Several FQXi Members – such as Nobel laureates Gerard 't Hooft, Steven Weinberg, and Frank Wilczek – helped assemble the Standard Model and are at the center of worldwide efforts to extend it.

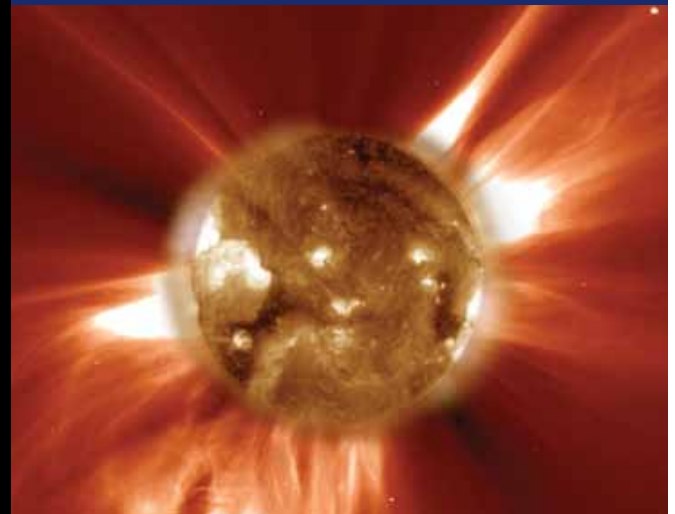
Joining them are other FQXi Members such as Garrett Lisi, who works to find a description of the many particles and forces in terms of a single, simple mathematical object. Others, like Giovanni Amelino-Camelia, use the Standard Model's experimental success as a window into the realm of quantum gravity.

Research Area: Quantum Gravity and Quantum Cosmology

General relativity and quantum mechanics successfully explain most phenomena but in separate domains: The very large and the very small. And where they should overlap – at the big bang, for instance – no complete joining of the theories has yet been found.

The Holy Grail in physics is a union of these two theories in one all-encompassing quantum-gravitational "Theory of Everything." Many FQXi Members have their eyes on this goal. Christopher Isham, Jenny Harrison, and John Baez, for example, all work to develop new mathematical tools to overcome technical obstacles. Meanwhile, FQXi essay-contest winner Julian Barbour works to clarify fundamental concepts of quantum gravity, such as time and motion.

Other FQXi Members focus on new issues in cosmology implied by quantum gravity. Ted Jacobson, for instance, explores how "atoms of spacetime" could be born as the universe expands, while Jonathan Dowling asks how to make sense of "measuring" a quantum universe, for which there can be no external observers.



For the first time in history, humanity is poised to discover answers to some of the most profound questions about life and the universe. FQXi offers scientists and the philanthropists who support them the unrivaled opportunity to play a decisive role in the future of physics, cosmology and the quest for understanding.

Your Place in the FQXi Universe

At *The Foundational Questions Institute* (FQXi), we're engaged in an extraordinary enterprise: rigorous scientific exploration into some of the most profound questions imaginable, by a global network of leading thinkers who, in their search for answers, advance the limits of understanding.

The Foundational Questions we pursue have always been central to the human quest for knowledge: How did the universe begin? Is our experience but one among many? What defines *reality*, *existence*, *consciousness*, and other familiar but richly complex concepts?

Big Questions like these have historically motivated *paradigm-altering discoveries*. Yet, most traditional science funding today is directed toward low-risk research with clear applications.

Government and other support of high-risk, high-reward inquiry into *Foundational Questions* is quite small, and as a result, many of the most *fascinating, fundamental* issues remain unexplored.

That's why we established FQXi – and that's why we invite you to join the adventure.

Since 2006, FQXi-backed scientists and others passionate about examining the enigmas at the frontier of science and at the foundation of our conception of the universe, have produced remarkable results, intensifying enthusiasm about physics, cosmology and related fields among both scientists and the general public.

But there is more – much more – to be done.

FQXi offers you a unique opportunity *to make a significant difference* in our worldwide effort to investigate some of humanity's oldest riddles. As our partner, you will *experience first-hand the science* of those you sponsor.

FQXi thrives at the leading edge of an *exciting intellectual adventure* – one that is as old as humankind, and as new as tomorrow. *Become a fellow explorer* in probing the deepest mysteries of all time... and perhaps beyond.

Please join us.