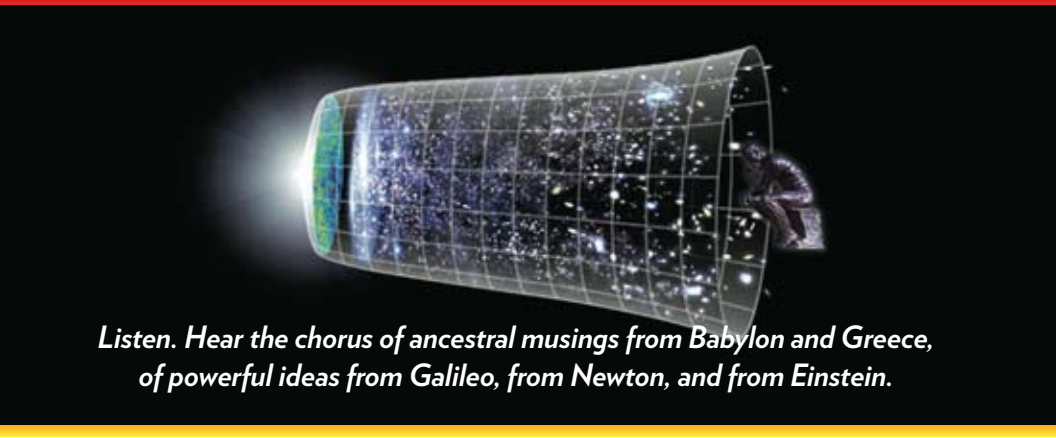


Listen. Hear the chorus of ancestral musings from Babylon and Greece, of powerful ideas from Galileo, from Newton, and from Einstein.

*Cosmic*Reflection

World Premiere

The John F. Kennedy Center for the Performing Arts
Concert Hall

November 2, 2009

8:00 PM

Produced by

*Classical*Archives™

COSMIC REFLECTION: A HISTORY

A few years before the launch of the Gamma-ray Large Area Space Telescope ("GLAST"—renamed the "Fermi Gamma-ray Space Telescope" after the launch), Dr. Peter Michelson, the principal investigator of Fermi's main instrument, approached his friend Pierre Schwob, founder of Classical Archives, and mentioned that he would be pleased if a musical offering could be organized for the launch. Recognizing that it was problematic to have a symphony orchestra stand by at the Kennedy Space Center in Florida for a launch which, in all probability, might be delayed, the two agreed that the scheduling of a live concert would be more appropriate for the first science symposium after launch, devoted to discussing results from Fermi's first year in orbit. Schwob then commissioned his friend, Dr. Nolan Gasser, to compose a prelude (the *GLAST Prelude for Brass Quintet*) to be played, via a recording made by the American Brass Quintet, at the launch itself, in June 2008. That recording was accompanied by a video that NASA Goddard Space Flight Center (GSFC) prepared for the occasion. In addition, Schwob asked Dr. Lawrence Krauss to co-write with him the narration of a full symphony, likewise composed by Dr. Gasser, which would illustrate the history of the Universe in roughly 40 minutes. *Cosmic Reflection* is the result of these efforts, and is accompanied by a video prepared by GSFC. The World Premiere of *Cosmic Reflection* will be performed by the Boston University Symphony Orchestra, under the baton of Maestro David Hoose, and narrated by Carey Harrison – who happens to be Pierre's step-step brother. All of us are delighted to be involved in this signal endeavor which expresses our awe of nature, and our thanks to the arts and sciences for giving us a glimpse of our place in it.

BOSTON UNIVERSITY SYMPHONY ORCHESTRA
David Hoose, conductor

AMERICAN BRASS QUINTET
Raymond Mase, trumpet
Kevin Cobb, trumpet
David Wakefield, horn
Michael Powell, trombone
John D. Rojak, bass trombone

PROGRAM

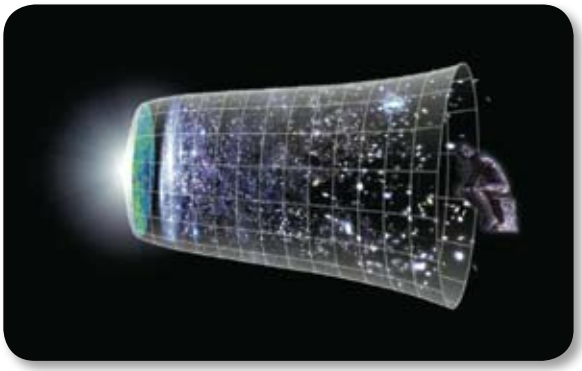
Erasmus Widmann, *ed.* Mase (1572-1634)	Canzona
Antonio Troilo, *ed.* Mase (fl. 1600)	Canzona
William Brade, *ed.* Mase (1560-1630)	Canzona
Nolan Gasser (b. 1964)	GLAST Prelude, op. 12, *for Brass Quintet with* NASA-Goddard Space Flight Center video
Carl Nielsen (1863-1931)	Symphony No. 4, op. 29, "The Inextinguishable" Allegro Poco allegretto Poco adagio quasi andante Allegro

INTERMISSION

Fermi Ambassadors Recognition

Nolan Gasser *Narration by* Pierre R. Schwob Lawrence M. Krauss	Cosmic Reflection: A Narrated Symphony, op. 15 *Prologue* Creation, from the Big Bang to First Light First Light to First Stars Starlight to Enlightenment *World Premiere* Carey Harrison, narrator *with* NASA-Goddard Space Flight Center video

NARRATION



Pierre R. Schwob & Lawrence M. Krauss

Hush. A child is asking: "Where did I come from? How did it all begin?"

These questions echo the wonder expressed by hundreds of generations of shepherds and savants, of sibyls and scholars who used their senses and their imagination to tell stories, to test theories, and now at last, to apprehend many of the answers.

Listen. Hear the chorus of ancestral musings from Babylon and Greece, of powerful ideas from Galileo, from Newton, and from Einstein. Listen to the music of time…

I. Creation, from the Big Bang to First Light

In the beginning, there is no space. There is no time. There are no atoms, planets or stars…

13.7 billion years ago, the precursor of everything that now exists in our Universe emerges from a single point, formless and infinitely dense, in a titanic explosion of energy we call the Big Bang.

As this energy erupts into its self-created space, the Universe experiences an extraordinary spasm. In far less than the blink of an eye, it swells instantly from its original point to a volume not much larger than your cupped hands in which energy can then begin its conversion into matter. This tiny volume of space will eventually expand to hold the entire visible Universe of today.

The fireball expands and cools, and in another fraction of a second, protons and neutrons are formed. These protons still exist today. Indeed they are the most abundant constituents of our own bodies.

During the first second, neutrons and protons collide incessantly and sometimes combine. But in the blistering temperature of the emergent Universe these fleeting unions are almost invariably destroyed. Eventually, as the cosmos continues to expand and cool, some fusions do survive and the neutrons and some of the protons combine as nuclei of helium.

The raw materials of the stars now exist, and the Universe is just five minutes old.

Yet the Universe is still so hot that it is opaque – a dense fog through which light cannot advance. But time passes. The Universe continues to expand and cool.

380 thousand years after the Big Bang, the temperature has eased enough to allow the formation of neutral atoms. The Universe becomes transparent. The fog dissipates. Light from the edge of creation can now begin its journey toward the future, and to us.

II. First Light to First Stars

The Big Bang has settled into a gentle expansion. Tiny ripples in the density of matter dating back to the dawn of time are amplified. A tenuous web of dark matter slowly emerges to create the framework upon which visible galaxies will ultimately form and evolve.

Over the course of hundreds of millions of years, primordial gas is drawn by gravity towards these folds of dark matter. Small proto-galaxies condense. As they fragment, smaller regions coalesce yet further. Volumes of gas, containing perhaps 100 times the mass of our Sun, contract and begin to glow, first in the dull warmth of infrared, then in visible light, heralding our Universe's earliest dawns.

The first stars are born.

Deep within the core of each nascent star, intense pressure and temperature trigger nuclear reactions.

Hydrogen fuses into helium, releasing ten million times as much energy as when a match is lit. Then, inexorably, lighter elements fuse into heavier ones. This prodigious energy source can power stars for millions or billions of years.

The Universe begins to resemble the one we see today, offering its familiar tableau of glorious galaxies, illuminated from within by the effusive brilliance of their stars.

III. Starlight to Enlightenment

With the emergence of starlight, our Universe teems with incandescent activity. In an endless cosmic ballet, massive galaxies collide and merge, fostering rippling stellar nurseries in which countless new stars ignite.

But stars are not only born, they also die, often in terrible violence.

At the end of their lives, in a single day, nuclear reactions rise to a roaring frenzy, converting the entire core of the star to sweltering iron. But iron cannot burn while liberating energy and stellar fusion ends. Without fuel, the star loses its long-standing fight against gravity and it collapses suddenly, producing a cataclysmic explosion. This extraordinarily violent detonation expels the outer shell of the star into space, carrying with it all the elements created during the star's lifetime, together with those forged within the explosion itself.

At least once every second, somewhere in our Universe, a star dies in such paroxysms. Over the 12 billion years that our Galaxy has existed, hundreds of millions of stars have exploded in apocalyptic supernovae, seeding the interstellar medium with their enriched expirations, so that we might be.

Nearly all atoms in our bodies, other than hydrogen and helium, were forged inside stars. Indeed, we are all children of the stars and grandchildren of the Big Bang, connected to the cosmos by our very substance.

Yet, as we study the Universe and learn more of its history and composition, we find that its dominant ingredient may not be visible ordinary matter, or even phantom dark matter. The bulk of creation seems to be an exotic form of energy permeating empty space itself which, on a cosmic scale, drives everything apart ever faster.

In the far future, all the galaxies we now see will have disappeared, as they recede beyond our visible horizon. Our own Milky Way and its nearest neighbor Andromeda will have merged into one massively large galaxy that will exist alone, an island of fading embers in an otherwise cold, dark, and unknowably vast space.

We must wonder why we are fortunate enough to live at a time when we can still witness the splendid effervescence of our dynamic Universe and ask: “How did a self-aware life-form evolve on our planet, in a galaxy in the middle of nowhere in particular? Are we alone?”

We should celebrate the long chain of marvelous cosmic events that allowed us to be here, compelling us to ask these transcendent questions now.

We salute our brief, remarkable moment in the Sun, during which rational thought and our hearts must inform our curiosity, our creativity and our compassion.

For now, we watch, we think, we learn and we share, aware of the minuscule but nonetheless sentient part we play in this cosmic drama – within, indeed, a Universe whose center is everywhere, and boundary nowhere.

We are most grateful for the suggestions and advice offered by
Peter Michelson, Roger Blandford, Robert Wagoner,
Isabelle Grenier, Scott Hubbard, Seth Shostak,
Mustafa Amin, Kelen Tuttle, and Carey Harrison.

American Brass Quintet

Founded in 1960, the American Brass Quintet is the longest performing brass quintet on planet earth. The "high priests of brass" *(Newsweek)* have recorded over 50 albums and premiered well over 100 works. Dubbed the "Rolls Royce of Brass Quintets" by the *Baltimore Sun*, ABQ has been Ensemble-in-Residence of the Aspen Music Festival since 1970 and The Juilliard School since 1987. The ABQ have defined serious brass chamber music in America for five decades.

Boston University Symphony Orchestra

Assumes an integral role in the education of the instrumentalists in the BU School of Music, whether they aspire to professions as chamber musicians, orchestral musicians, teachers, or to musical lives that combine all three. The orchestra repertoire reaches wide and deep, from vital standard repertoire, to compelling if less familiar compositions, and to music from this and past centuries. Each year, the orchestra presents six concerts in Boston, including an annual performance in Symphony Hall. The BU Symphony Orchestra will appear in the Kennedy Center as part of the InCite Arts Festival, a moveable feast designed to showcase the dynamic artistic strengths and synergy of the BU College of Fine Arts' schools of Music, Theatre, and Visual Arts.

David Hoose, conductor

Is Professor of Music and Director of Orchestral Activities in the School of Music in the College of Fine Arts at Boston University. He also serves as Music Director of Boston's critically-acclaimed professional ensembles Collage New Music and Cantata Singers and Ensemble. In 2005, Professor Hoose was the recipient of the Alice M. Ditson Conductors Award, given in recognition of exceptional commitment to the performance of American music, succeeding past award recipients

Leonard Bernstein and Aaron Copland, among others. Among the orchestras Professor Hoose has conducted are the Chicago Philharmonic, Singapore Symphony Orchestra, and the Saint Louis Symphony, as well as the orchestras of the New England Conservatory, the Shepherd School of Music at Rice University, and the Eastman School of Music at Rochester University.

Nolan Gasser, composer

Is a critically acclaimed composer, pianist, and musicologist. His original works have been performed at Carnegie Hall, the Kennedy Center, Alice Tully Hall, La Salle Pleyel in Paris, the Rose Bowl in Pasadena, etc. Among recent triumphs, his World Concerto for Cello and Orchestra received its premiere in 2009, and his symphonic oratorio, American Festivals, was performed at IMG Artists' 2008 Festival del sole. Upcoming projects include an overture commissioned by the Santa Rosa Symphony. Dr. Gasser is the Artistic Director of Classical Archives and the chief musical architect of the Music Genome Project (Pandora Internet radio). He received his Ph.D. in Musicology from Stanford University, and lives with his wife and two children in Petaluma, CA.

Carey Harrison, narrator

Was born in London to actor parents Sir Rex Harrison and Lilli Palmer. He is Professor of English at the City University of New York, and is a prize-winning novelist and dramatist whose comedy about Freud and Jung, *Scenes From A Misunderstanding*, played off-Broadway this year. He has written 16 novels and over 100 plays for radio and television, including 17 hours of Masterpiece Theatre. Harrison frequently appears in his own plays; he has been heard on the BBC, playing Isaac Newton in his play *Newton In Love*; and opposite Sir John Gielgud in *A View Of St Paul's*, written by Harrison specially for Gielgud, then aged 90, about the architect Sir Christopher Wren at the age of 90.

Image Credit:
Peter Schaaf (Top Left)
Michael Lutch (Middle & Bottom Left)

Pierre R. Schwob, co-writer

Was born in Los Angeles and raised in Geneva, Switzerland. He has lived in New York, Hong Kong, and now in Palo Alto, California. He has taught computer science and licensed his intellectual properties in radio data and internet technologies. He has written books on chess, calculators, and history. He runs Classical Archives, the largest classical music site on the web and he spends quite a bit of time at the Kavli Institute for Particle Astrophysics and Cosmology at Stanford/SLAC. He is a grateful supporter of the heroic work done by the scientists who are developing and testing theories by analyzing data at a time which may be characterized as the golden age of cosmology.

Lawrence M. Krauss, co-writer

Is Foundation Professor in the School of Earth and Space Exploration and Physics Departments, Associate Director of the Beyond Center, Co-Director of the Cosmology Initiative and Director of the new Origins Initiative at Arizona State University. Krauss received his PhD from MIT and then joined the Society of Fellows at Harvard. He joined Arizona State after appointments at Yale and Case Western Reserve Universities. A Fellow of the American Physical Society and the American Association for the Advancement of Science, he is an international leader in cosmology and astrophysics. The author of seven popular books, Krauss is also a radio and television commentator and essayist for major newspapers. Krauss crosses the chasm between science and popular culture and he has been particularly active in issues of science and society.

Image Credit: Jessica Lifland (Bottom)

Rich Melnick, video producer

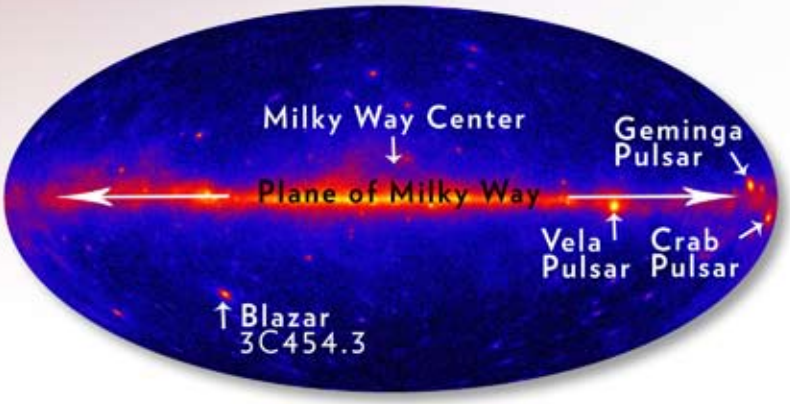
As one of NASA's senior producers, Rich Melnick has a reputation for taking challenging subject matter and turning it into the stuff of wonder. The winner of multiple national awards for exciting productions about a variety of science and technology stories, Melnick's craft often serves as the final step between NASA research and public understanding about that research. Commissioned pieces he's produced have played at the Smithsonian National Air and Space Museum, Congressional committees, executive staff levels of government, and a list of national television outlets too numerous to mention. Presenting science and technological subjects with a smart synthesis of artistic craft and verve, Rich Melnick's work often solves a vital step for audiences to understand and become enthused about hard stories they might not otherwise encounter.

Classical Archives, producer

Classical Archives (www.classicalarchives.com), the ultimate online classical music destination, is the largest music subscription service dedicated to classical music. It features a breakthrough in musicology-based site navigation allowing users to search and cross-reference music by any relevant criteria: composer, work title, artist, albums, historical period, instrument, and genre. Classical Archives offers subscriptions for unlimited play of any track, complete work or album; all tracks/works/albums may be purchased for DRM-free download, encoded at at the highest MP3 quality. The site also offers its own large catalog of contributed tracks, which includes many performances from world-class talents and free access to the largest collection of classical music MIDI files.

THE FERMI GAMMA-RAY SPACE TELESCOPE

Launched on June 11, 2008, Fermi is one of several state-of-the-art observatories currently observing the Universe across the electromagnetic spectrum from radio to high-energy gamma-rays. The Fermi mission was built by a partnership of particle physicists and astrophysicists from the United States, France, Germany, Italy, Japan, and Sweden. It is providing new information about sources of high-energy radiation from neutron stars in our galaxy to super massive black holes in distant galaxies. Fermi's enormous leap in capability compared to previous observatories has opened a window of discovery that may provide information about the identity of the invisible and unidentified "dark matter" of the universe.



A map of the entire sky as seen by the Large Area Telescope on the Fermi Gamma-ray Space Telescope after the first three months of its sky survey. The bright horizontal band in the center is our Milky Way Galaxy. Image credit: NASA / DOE / Fermi-LAT collaboration

The revolution in understanding of our universe that is now underway has come about because of the large amount of new information that has come from observatories, both ground and space-based, that are only possible because of continuing advances in technology that have allowed us to view the universe across the electromagnetic spectrum. For example, from space, WMAP and now Planck are measuring the properties of the microwave radiation left over from the birth of the universe; the infrared vision of the Spitzer Space Telescope allows us to peer into regions of space which are hidden from optical telescopes such as the center of our Milky Way Galaxy containing newborn stars; the refurbished Hubble Space Telescope continues to provide unprecedented deep and clear views of the Universe, ranging from our own solar system to extremely remote fledgling galaxies forming not long after the Big Bang; the Chandra X-ray Observatory and the XMM-Newton satellite observe X-rays from high-energy regions of the universe, such as the remnants of exploded stars or from the hot gas gravitationally trapped by clusters of galaxies; and the Fermi Observatory covers the highest energies ever observed from a space-based observatory, allowing us to see an otherwise invisible universe.

More about Fermi

fermi.gsfc.nasa.gov
www-glast.stanford.edu
glast.sonoma.edu
gammaray.msfc.nasa.gov/gbm
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Top Right to Bottom: Space-based observatories provide views of the cosmos inaccessible to us from the ground. Chandra, Hubble, Spitzer, and WMAP.

Image credit: NASA / Sonoma State University/ Aurore Simonnet/ TRW/ JPL-Caltech/ WMAP Science Team

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