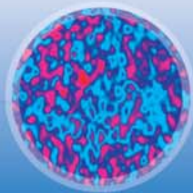
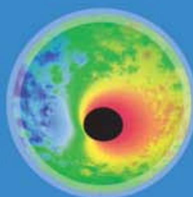


big bang



black holes

dark energy

laser interferometer space antenna

constellation-x

einstein probes

Beyond Einstein:

From the Big Bang to Black Holes

How did the Universe begin? Does time have a beginning and an end? Does space have edges? Einstein's theory of relativity replies to these ancient questions with three startling predictions: that the Universe is expanding from a **Big Bang**; that **black holes** so distort space and time that time stops at their edges; and that a **dark energy** could be pulling space apart, sending galaxies forever beyond the edge of the visible Universe. Observations confirm these remarkable predictions, the last finding only four years ago. Yet Einstein's legacy is incomplete. His theory raises—but cannot answer—three profound questions:

- What powered the Big Bang?
- What happens to space, time, and matter at the edge of a black hole?
- What is the mysterious dark energy pulling the Universe apart?

The *Beyond Einstein* program aims to answer these questions. It will employ a series of missions linked by powerful new technologies and complementary approaches to shared science goals.

Einstein Great Observatories: Facility-class missions

- Constellation-X: Uses X-ray-emitting atoms as clocks to follow matter falling into black holes and to study the evolution of the Universe.
- The Laser Interferometer Space Antenna (LISA): Uses gravitational waves to sense directly the changes in space and time around black holes and to measure the structure of the Universe.

These missions are ready to pioneer technologies and approaches needed for the Vision Missions to reach the ends of space and time.

Einstein Probes: Fully competed, moderate-sized, scientist-led missions launched every three years

- Dark Energy Probe: Determine the properties of the dark energy that dominates the Universe.
- Inflation Probe: Detect the imprints left by quantum effects and gravitational waves at the beginning of the Big Bang.
- Black Hole Probe: Take a census of black holes in the local Universe.

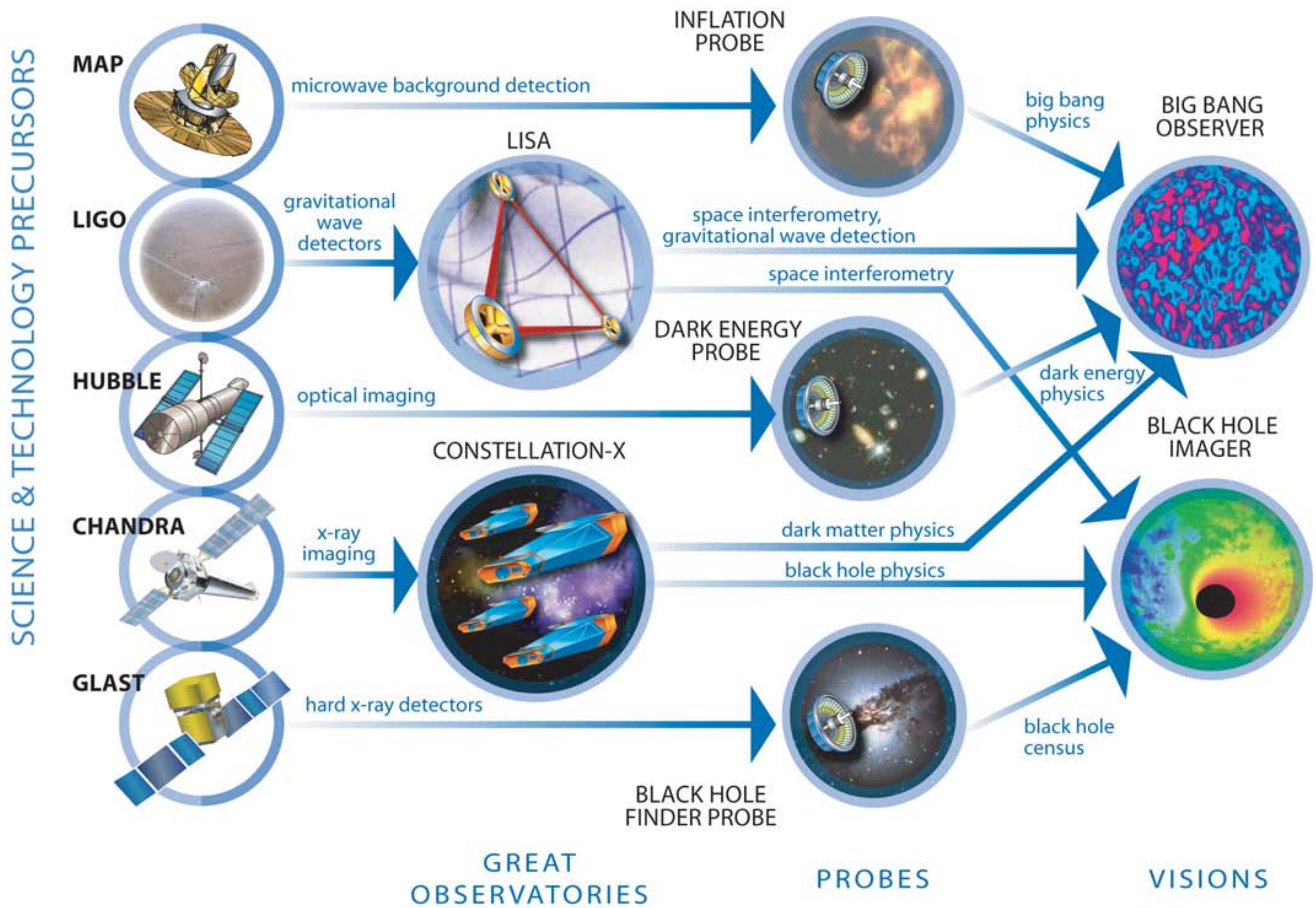
These missions will answer sharply focused questions. Competition ensures flexibility and keeps costs low by selecting methods and technologies.

Programs of technology development and research in preparation for two "Vision Missions" reaching to the ends of space and time

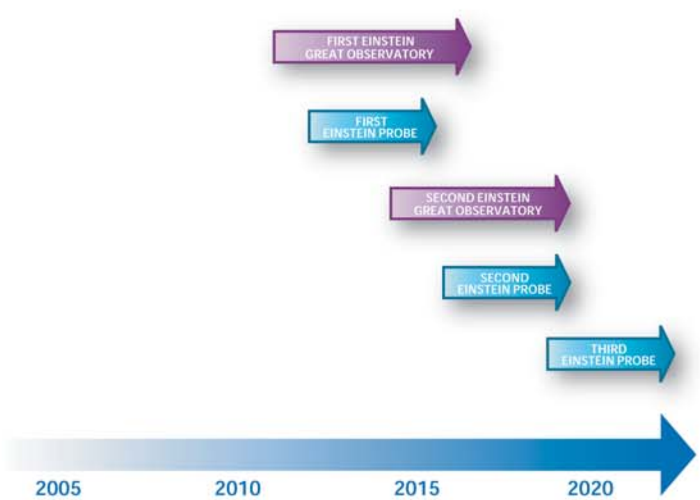
- A Big Bang Observer to detect directly gravitational waves echoing from the earliest moments of the Big Bang.
- A Black Hole Imager to image directly matter near the edge of a black hole and map its motion.

Beyond Einstein fascinates the American public and compels the attention of the news media and the entertainment industry. *Beyond Einstein* amplifies this fascination, developing an education component that enthralls students *and* is aligned with national standards. It will be a potent force with which to enhance science education and science literacy.

BEYOND EINSTEIN PROGRAM

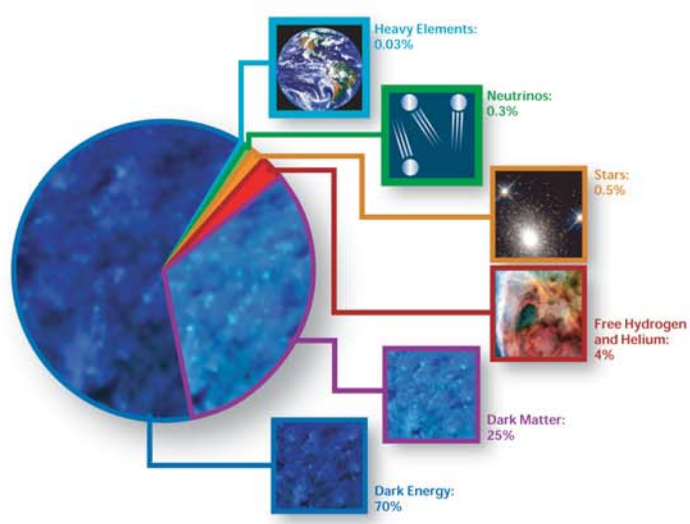


BEYOND EINSTEIN TIMELINE



Launch Date

COMPOSITION OF THE COSMOS



http://universe.gsfc.nasa.gov/

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