# Joint Dark Energy Mission a Top Priority for NASA, Says NRC

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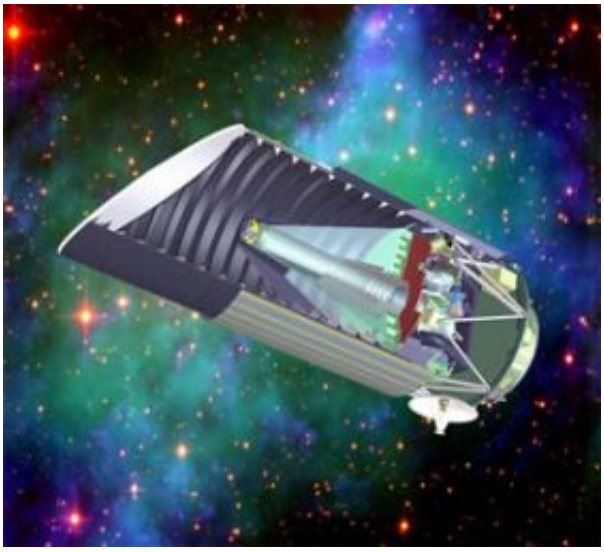

SNAP, the SuperNova/Acceleration Probe, is one of three concepts competing for NASA and DOE's Joint Dark Energy Mission (JDEM).

The National Research Council's Beyond Einstein Program Assessment Committee has recommended that the Joint Dark Energy Mission (JDEM), jointly supported by the National Aeronautics and Space Administration and the Department of Energy, be the first of NASA's Beyond Einstein cosmology missions to be developed and launched.

One of the three competing projects in the JDEM program is Lawrence Berkeley National Laboratory's SuperNova/Acceleration Probe, or SNAP, a versatile space-borne observatory with a powerful two-meter-

class telescope and a half-billion pixel imager, designed to study dark energy by recording the distance and redshift of some 2,000 Type Ia supernovae a year and mapping the sky with unprecedented resolution. Dark energy is the name given to the mysterious entity which is causing the universe to expand ever more rapidly. It accounts for nearly three-quarters of all the energy in the universe.

The recommendations of NRC's Beyond Einstein Program Assessment Committee (BEPAC), posted on the internet Sept. 5, follow nearly a year of intensive study of the five proposed missions in the Beyond Einstein program. Due to budget constraints and technological readiness only one such mission can be started at this time, so NASA and DOE requested in August, 2006 that the NRC, while assessing the program as a whole, recommend which mission should be developed and launched first.

"NASA and DOE have moved forward together since joining forces on the Joint Dark Energy Mission four years ago, including their support for Berkeley Lab's approach to the mission, SNAP," says Steven Chu, Director of the Department of Energy's Lawrence Berkeley National Laboratory. "By recommending that JDEM be the first Beyond Einstein mission to be launched, the National Research Council has assured that the two agencies will be partners in investigating one of the most pressing scientific questions of the 21st century. We look forward to the agencies' moving forward upon receiving the NRC Committee Report."

"It's wonderful to know that NASA will be moving forward with this exciting project as a result of the committee's recommendation that JDEM be the first mission to fly," says Saul Perlmutter, a member of Berkeley Lab's Physics Division and Professor of Physics at the University of California at Berkeley. "Each of the highly ranked Beyond Einstein projects will contribute greatly to our understanding of the universe, yet few questions are more fundamental or pressing than the

mysterious nature of dark energy, which accounts for some three-quarters of the energy density of our universe — but about which we know almost nothing."

"It is not surprising that the BEPAC reaffirmed the importance of the exciting science that connects quarks with the Cosmos — the stunning scientific opportunities, from understanding how the Universe began to unraveling the mystery of the dark energy to probing black holes, speak for themselves," says Michael Turner, Professor of Physics and of Astronomy and Astrophysics at the University of Chicago, who led an NRC Quarks-to-the-Cosmos study which stimulated the Beyond Einstein program. However, says Turner, "Today's real milestone is the selection of the Joint Dark Energy Mission as the first of multiple missions in NASA's Beyond Einstein program.... JDEM will harness the powerful combination of two science agencies, DOE and NASA, and the scientists they support, to shed light on the most abundant and most mysterious stuff in the Universe. JDEM will set a high mark for the Beyond Einstein missions that follow."

## The JDEM Mission to Explore Dark Energy

Three concepts for a JDEM mission have been proposed: the SuperNova/Acceleration Probe (SNAP), the Dark Energy Space Telescope (DESTINY), and the Advanced Dark Energy Physics Telescope (ADEPT).

SNAP is being developed by an international collaboration led by principal investigator Perlmutter and by co-principal investigator and project director Michael Levi, of Lawrence Berkeley National Laboratory's Physics Division and UC Berkeley's Space Sciences Laboratory. In addition to Berkeley Lab, partner institutions include the Space Sciences Laboratory; the French Space Agency, the Centre National D'Etudes Spatiales; and a number of U.S. and Canadian

universities. DESTINY is led by Tod Lauer of the National Optical Astronomy Observatory, and ADEPT is led by Charles Bennett of Johns Hopkins University.

Dark energy, which accounts for about three-quarters of the energy density of the universe, was unknown before 1998. Early that year two international teams, the Supernova Cosmology Project based at Lawrence Berkeley National Laboratory and led by Perlmutter, and the High-Z Supernova Search Team led by Brian Schmidt of the Australian National University, independently announced their discovery that the expansion of the universe is not slowing from the contracting force of gravity but is in fact growing more and more rapidly. The cause of accelerating expansion was soon named dark energy.

Perlmutter and Schmidt and the members of their teams share the 2007 Gruber Cosmology Prize for their discovery. Perlmutter, Adam Riess of Johns Hopkins University, and Schmidt shared the 2006 Shaw Prize in Astronomy for this discovery. Perlmutter also received the 2006 International Antonio Feltrinelli Prize in the Physical and Mathematical Sciences, awarded once every five years, for his work leading to the discovery of dark energy.

"Evidence for dark energy came almost ten years ago," Michael Turner remarks, "and the mystery of this weird stuff with repulsive gravity which controls the expansion of the Universe and its destiny has captured the attention of physicists, astronomers and the public alike." Scientists still cannot say whether dark energy has a constant value or is changing over time — or even whether dark energy is an illusion, with the accelerating expansion of the universe a consequence of a failure of general relativity.

## SNAP, the SuperNova/Acceleration Probe

It was in 1999, soon after the discovery of dark energy, that members of the Supernova Cosmology Project joined with their colleagues to devise a space-based experiment, SNAP, to reveal its nature. Intensive research and development efforts for SNAP have been vigorously supported by DOE's Office of Science since it was proposed, and by NASA since 2003, when it joined with DOE to pursue the Joint Dark Energy Mission.

In May, 2006, NASA, DOE, and NSF's Dark Energy Task Force reported that different techniques for measuring dark energy in combination "have substantially more statistical power, much more ability to discriminate among dark energy models, and more robustness to systematic errors than any single technique."

"SNAP will investigate dark energy using two independent and powerful techniques," says Perlmutter, SNAP's principal investigator. "The best proven and most powerful current technique is to determine changes in the universe's expansion rate by comparing the redshift and distance of Type Ia supernovae, of which SNAP will find some 2,000 a year. But we are also targeting the most promising complementary technique, called 'weak gravitational lensing.'"

Levi, SNAP's co-principal investigator, explains that "Weak gravitational lensing has been part of the SNAP concept since its beginning in 1999. SNAP will make a high-resolution map of the sky covering an area 2,000,000 times larger than the Hubble Deep Field. This map will be sensitive to the minute distortions of distant galaxy shapes when their light passes through uneven distributions of matter — a phenomenon called 'weak lensing.' Weak lensing promises a powerful way to measure the distribution of dark matter and to probe dark energy's effect on the growth structure of the universe. The huge survey map will also provide astronomers with an unparalleled wealth of high-resolution images never before seen."

NASA incorporated JDEM into the Beyond Einstein program when it was formulated by the agency's Astronomy and Physics Division in 2004. The program eventually focused on five such missions: to detect gravitational waves, provide a more powerful x-ray telescope, investigate models of cosmic inflation, find black holes, and study the nature of dark energy.

Growing interest in dark energy, which in 2006 was called "among the very most compelling of all outstanding problems in physical science" by the Dark Energy Task Force that had been commissioned by NASA, DOE, and the National Science Foundation, prompted consideration of the relative urgency of the five Beyond Einstein missions, leading to NASA and DOE's request in August, 2006, that the National Research Council produce a report by September, 2007 assessing the five missions and recommending which should be developed and launched first.

ADEPT and DESTINY, like SNAP, also use more than one measuring technique, and partly for this reason NASA chose these three proposals for concept development in 2006. Now that the NRC Beyond Einstein Program Assessment Committee has recommended that JDEM be the first Beyond Einstein mission launched, NASA and DOE must jointly choose among the JDEM proposals.

Says Perlmutter, "The Committee's recommendation that JDEM be the first Beyond Einstein mission to be developed and launched is gratifying to the many collaborators of SNAP. The whole SNAP team worked for thousands of hours to answer the Committee's almost 100 questions about the mission, generating hundreds of pages of written responses and documentation."

Source: Berkeley Lab