

# Decadal survey of astronomy and astrophysics

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A new report by the National Research Council identifies the highest-priority research activities for astronomy and astrophysics in the next decade that will "set the nation firmly on the path to answering profound questions about the cosmos." The decadal survey -- the Research Council's sixth -- prioritizes activities based on their ability to advance science in key areas, and for the first time also takes into account factors such as risks in technical readiness, schedule, and cost.

The report identifies space- and ground-based research activities in three categories: large, midsize, and small. For large space activities -- those exceeding \$1 billion -- an observatory the report calls the Wide-Field Infrared Survey Telescope (WFIRST) is the top priority because the [space telescope](#) would help settle fundamental questions about the nature of dark energy, determine the likelihood of other Earth-like planets over a wide range of orbital parameters, and survey our galaxy and others. For large-scale, ground-based research initiatives that exceed \$135 million, the first priority is the Large Synoptic Survey Telescope (LSST), a wide-field optical survey telescope that would observe more than half the sky every four nights, and address diverse areas of study such as dark energy, supernovae, and time-variable phenomena.

"Powerful new ways to observe the universe and bold ideas to understand it have created scientific opportunities without precedent," said Roger Blandford, chair of the committee that wrote the report and Luke Blossom Professor in the School of Humanities and Sciences at Stanford. "The program of research that we recommend will optimize

the science return for future ground-based projects and space missions in a time of constrained budgets and limited resources."

The recommended research activities are encapsulated by three science objectives: deepening understanding of how the first stars, galaxies, and [black holes](#) formed, locating the closest habitable Earth-like planets beyond the solar system for detailed study, and using astronomical measurements to unravel the mysteries of gravity and probe fundamental physics.

Along with WFIRST, other priorities in the large-scale space category recommended in the report are an augmentation to the Explorer program, which supports small- and medium-sized missions that provide high scientific returns; the Laser Interferometer Space Antenna (LISA), which could enable detection of long gravitational waves or "ripples in space-time"; and the International X-Ray Observatory, a large-area X-ray telescope that could transform understanding of hot gas associated with stars, galaxies, and black holes in all evolutionary stages.

Other recommended ground-based research projects include the formation of a Midscale Innovations Program within the National Science Foundation (NSF), which would fill a funding gap for compelling research activities that cost between \$4 million and \$135 million. In addition, the report recommends participation in the U.S.-led international Giant Segmented Mirror Telescope, a next generation large optical telescope that is vital for continuing the long record of U.S. leadership in ground-based optical astronomy. The next priority is participation in an international ground-based high-energy gamma-ray telescope array.

For midsize space-based activities, the first priority is the New Worlds Technology Development Program, which lays the scientific groundwork for a future mission to study nearby Earth-like planets. Top

priority for ground-based midsize research is the Cerro Chajnantor Atacama Telescope (CCAT), which would provide short wavelength radio surveys of the sky to study dusty material associated with galaxies and stars.

Research priorities were selected through an extensive review that included input from nine expert panels, six study groups, and a broad survey of the astronomy and astrophysics community. With the help of an outside contractor, the committee developed independent appraisals of the technical readiness and schedule and cost risks. In addition, the survey reassessed projects that were recommended in past surveys but not formally started alongside newly proposed projects.

The research recommendations represent a cohesive plan with realistic budgetary scenarios, the report says, with ranges based on current projected budgets for NASA, NSF, and the U.S. Department of Energy -- the agencies largely responsible for funding and implementing the research activities. It also identifies smaller, unranked research initiatives to augment core fundamental research. An independent standing committee should regularly advise the agencies on strategy and progress of the projects and produce annual reports.

The report notes that astronomical research continues to offer significant benefits to the nation beyond astronomical discoveries by capturing the public's attention and promoting general science literacy and proficiency. In addition, the research serves as a gateway to science, technology, engineering, and mathematics careers, and a number of important and often unexpected technological breakthroughs. The report makes several recommendations to improve astronomy and astrophysics education and calls for more U.S. participation in international research projects.

Provided by National Academy of Sciences

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