Active Project (2014 - 2015)

FY15 Gravitational-Wave Mission Activities Project

Center Independent Research & Developments: GSFC IRAD Program

ABSTRACT

The gravitational-wave (GW) team at Goddard provides leadership to both the US and international research communities through science and conceptual design competencies. To sustain the US effort to either participate in the GW mission that ESA selected for the L3 opportunity or to initiate a NASA-led mission, the Goddard team will engage in the advancement of the science and the conceptual design of a future GW mission. We propose two tasks: (1) deliver new theoretical tools to help the external research community understand how GW observations can contribute to their science and (2) explore new implementations for laser metrology systems based on techniques from time-domain reflectometry and laser communications.

ANTICIPATED BENEFITS

To NASA unfunded & planned missions:

One benefit is to provide easy access to tools that help researchers realize the benefits of GW observations.

A second benefit is that an enhanced metrology system could vastly simplify the requirements on the optical metrology system of a future. The same metrology methods with lesser performance could have important applications in large segmented/deformable mirror systems or coronagraphs.

To other government agencies:

Other agencies developing space systems needing stabilized optical systems, such as large segmented/deformable mirror systems, could benefit from the study results.

To the commercial space industry:

Industries developing space systems needing stabilized optical systems, such as large segmented/deformable mirror

Table of Contents

Management Team

Program Executive:
- Peter Hughes

Program Manager:
- Julie Crooke

Project Manager:
- Stanley Hunter

Principal Investigator:
- Robin Stebbins

systems, could benefit from the study results.

To the nation:

Academic researchers working on astrophysical systems where extreme gravity occurs will be able to augment their research results through easy access to a multi-messenger approach.

Advances in optical metrology frequently have benefits in a wide range of applications.

DETAILED DESCRIPTION

This proposal has two broad objectives: To sustain and expand Goddard's unique capabilities in the science and design of space-based gravitational-wave observatories; To facilitate the access of the broader astrophysics research community to the potential science return from a gravitational wave mission.

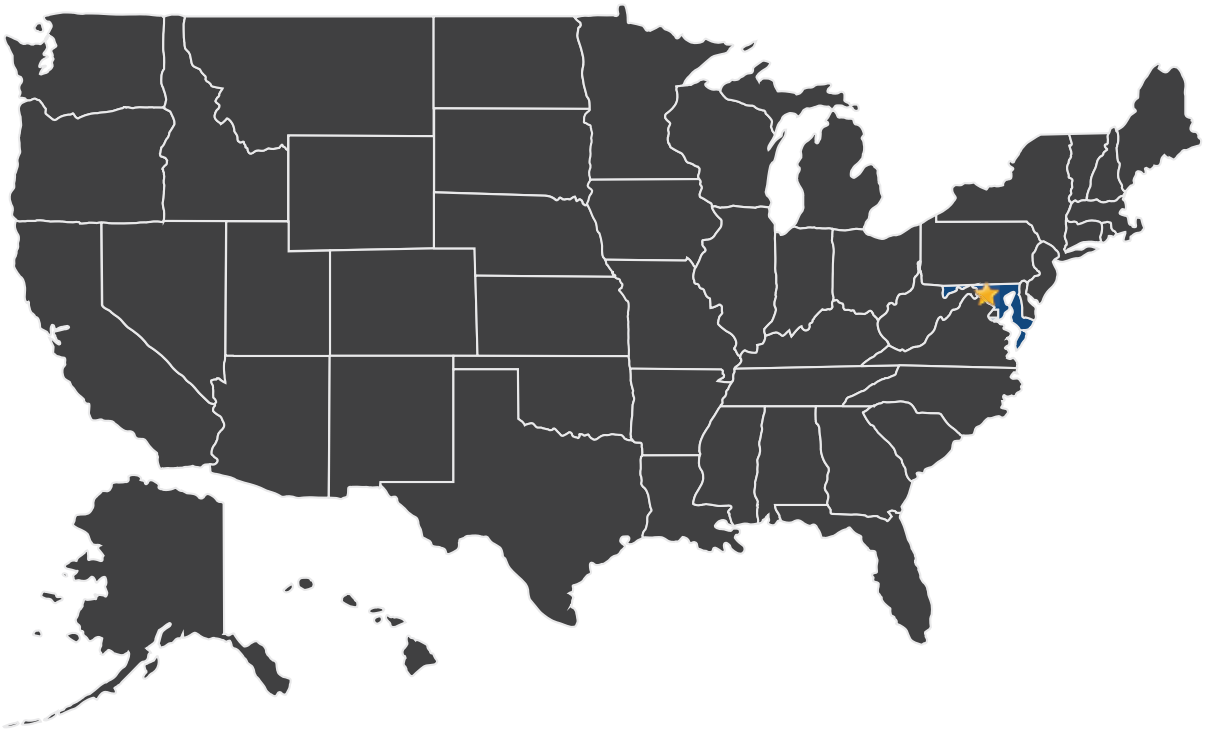
The two tasks described in the Research and Development Plan each have innovative elements. The first task, "LISA in a box," will capitalize on prior research by Goddard scientists and a large group of external GW researchers to provide accessible tools for an astrophysicist, who is not a specialist in GW observations, to quantitatively predict how gravitational wave observations will enhance their research. In most circumstances, the scientific return from the study of astrophysical objects where extreme gravity is at work (e.g., compact stars, massive black holes, galactic nuclei, early cosmology, etc) is maximized by a combination of electromagnetic and gravitational-wave observations, so-called multi-messenger astronomy. Currently, astrophysicists who are not knowledgeable about GW detectors and data analysis are challenged to understand what can be learned about astrophysical objects with GW data from a realizable GW observatory. The innovation here is to provide easy access to tools that help researchers realize the benefits of GW observations.

The second task will explore innovative application of techniques from time-domain reflectometry and laser communications to optical metrology. This technology exploits the power of digital signal processing to measure optical pathlengths throughout an optical system with a single laser beam. If this technology can achieve the resolution of LISA-like interferometry (~1 pm), it could vastly simplify the requirements on the optical system. Lesser performance could have important applications in other technologies of interest to the NASA, such as large segmented/deformable mirror systems or coronagraphs.

FY15 Gravitational-Wave Mission Activities Project

Center Independent Research & Developments: GSFC IRAD Program

U.S. LOCATIONS WORKING ON THIS PROJECT



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Supporting Centers:

- Goddard Space Flight Center