

## **UROP Project: Building a Black Hole Telescope**

The MIT Haystack Observatory is assembling a network of high frequency radio telescopes that will be used to image the Event Horizon of a black hole. The technique is called Very Long Baseline Interferometry (VLBI), and it involves recording radio waves from a distant cosmic source at many telescopes simultaneously, and then combining the data streams to produce a virtual telescope as large as the Earth. We have a UROP project that involves technical work on this network and can also include astrophysics content. We call this Global network of radio dishes the Event Horizon Telescope (EHT).

To increase sensitivity of the EHT, we are working on a system that can combine several telescopes that are very close together so that they can function as a single element of our VLBI network. This phased-array system has been installed at the Submillimeter Array (SMA) on Mauna Kea, Hawaii, and it coherently aggregates the collecting area of the SMA and other submillimeter observatories on the mountain to form a single sensitive aperture in the EHT. A substantial amount of software work is required in making the new system operational and to interface it to existing SMA instrumentation.

An existing prototype software suite written in Python performs all necessary functions but is by no means user-friendly or efficient; in addition it does not take full advantage of existing facilities provided by the SMA. The UROP student will architect replacement code with a cleaner and more sophisticated user interface (possibly graphical) that can provide control of various elements of the system and display relevant information and data from both the retrofit system and the SMA. This requires interfacing to numerous Field Programmable Gate Array (FPGA) based data processing engines, as well as SMA data/control computers, using Remote Procedural Calls, shared memory, and other protocols. The ultimate goal is to provide an easy-to-use, unified application to enable streamlined VLBI observations.

A background in software design, and proficiency in Python and C is required. Any experience designing graphical user interfaces is desirable. Also of interest, though not required, is experience in digital signal processing and programming FPGAs.

This will be an exciting opportunity for a motivated EE/CS or technically minded physics student to make significant contributions to cutting edge Astronomical observations. There is a possibility for travel to the SMA site in Hawaii for observations. The UROP student will be supervised by an MIT Principal Research Scientist, but most of the work will be done at a collaborating laboratory at the Harvard Center for Astrophysics under the direction of a research engineer there. Continuation of employment through the Summer is possible.

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