Opportunity Title: Near Field Interferometry for Space Object Imaging
Opportunity Reference Code: IC-16-06

Organization Office of the Director of National Intelligence (ODNI)

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How to Apply

Create and release your Profile on Zintellect – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Application Deadline 4/15/2016 6:00:00 PM Eastern Time Zone

Description

Earth's orbital debris poses an increasing threat to satellites and manned space missions. Fortunately, dangerous collision events can be avoided and understood by modeling the orbits of debris objects. Unfortunately, much of the debris objects are difficult to detect and track because either they are very small or they do not follow Keplerian orbital dynamics because of high area to mass ratio. The ability to image debris objects and determine their structures can aid detection and tracking and assist in avoiding and investigating dangerous collisions.

The National Radio Astronomy Observatory (NRAO) has used its Very Long Baseline Array (VLBA) in a multistatic configuration to produce high resolution images of interplanetary objects including near-earth asteroids. The VLBA could also be used to image orbital debris objects; however, standard radio astronomy software correlators contain radiometric and signal assumptions which are not optimized for this application and degrade image quality.

The technical objectives of this research are to develop:

- The ability to model and simulate overall system performance for a customizable Very Long Baseline Interferometry (VLBI) system imaging orbital debris consisting of many objects in different orbits.
- The ability to form focused images of space objects and debris from both synthetic and measured multistatic VLBI radar data.

Example Approaches

Mathematical models of communication systems and signals (including interference) are thoroughly discussed in the open literature. These can be used to mathematically model the

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expected radar signals and overall system performance for a customizable VLBI system. Note that the standard VLBA elements are generally fixed, but the number of elements used is customizable and expandable to include additional receivers. Often the transmitter used with VLBA is JPL's Goldstone radar, but the transmitter location, power, and band are also customizable. We desire the ability to model a customizable array of transmitter and receivers.

The mathematical model can be replicated in software, such as Python®, Matlab® or Simulink®, to allow for dynamic modeling of the system signal and overall performance. A similar software approach can be used for orbital debris simulation, radar signal synthesis, and image formation code. In order for the technical objectives to be met, software code can be object oriented with a graphic user interface and sufficient documentation.

Various radio astronomy organizations, including the NRAO, have existing software correlators and signal processing code that might be leveraged. These can be used to help develop and verify the signal model and image formation code. In addition, it may be possible to obtain observation time on the VLBA to obtain measured data. The image formation code can include compressive sensing and modified CLEAN algorithms to optimize image quality even when VLBI array elements are few and the baselines are sparse.

The Event Horizon Telescope (EHT) consists of a growing worldwide network of radio telescope observatories used as a VLBI, with data processed at MIT Lincoln Labs (HAYSTACK Observatory). As part of this postdoc, the utility of the EHT will be explored.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Business** (11 👁)
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (13 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (28 👁)