Opportunity Title: Probing for Extensive Ice Deposits in Solar System Airless Bodies Using Ultra-High Energy Cosmic Rays
Opportunity Reference Code: 0258-NPP-NOV23-JPL-TechDev

Organization National Aeronautics and Space Administration (NASA)

Reference Code 0258-NPP-NOV23-JPL-TechDev

How to Apply All applications must be submitted in Zintellect

Application Deadline 11/1/2023 6:00:59 PM Eastern Time Zone

Description **Description:**

This opportunity will be focused on the development of sounding for extensive ice deposits in the permanently shadowed regions (PSRs) of Solar System airless bodies using radio signals produced by ultra-high energy cosmic rays (UHECRs) incident on targets of interest.

Extensive deposits of nearly-pure ice (~95%) have been found in the PSRs of polar craters on Mercury (Butler et al. 1993). These radar-bright deposits are observed to be in essentially every surface and subsurface location where water ice is thermally stable and could be up to 30 m thick (Paige et al. 2013). The ice emplacement is estimated to have occurred within the last 200 Myr in order for them to survive impact gardening (Costello et al. 2019). A multi-institutional team of researchers, including the Jet Propulsion Laboratory, is currently developing a mission concept called the Cosmic Ray Lunar Sounder (CoRaLS) to search for similar extensive ice deposits on our Moon (Prechelt et al. 2022). It is hypothesized that the Moon's PSRs could have been like Mercury, the difference being that Mercury's ice was more recently emplaced (Costello et al. 2019). Observations that support this hypothesis are evidence of patchy surface water that covers roughly 10% of the total lunar PSR area from UV & IR spectra and statistical data on crater depths that suggest shallowing caused by buried ice. Searches for extensive ice deposits are limited to ambiguous radar data probing the first meter of the subsurface and a limit of 5 m depths from Arecibo radar data (Campbell et al. 2006).

Radio emission of UHECRs offer a probe for ice deposits within 20 m depths. When the UHECR impacts the regolith of an airless body, it forms a particle shower with an excess negative charge of ~20%. This results in the production of a coherent radio impulse transient (Askaryan radiation) within 5 m of the UHECRs path in the regolith. If an extensive ice deposit is present in the vicinity of the UHECR event, the radio emission will be reflected and it can be detected by an orbiter. The localized radio emission of cosmic ray showers minimizes surface roughness effects providing an advantage over traditional orbital radar sounders. The detector leverages over a decade of experience with NASA's ANITA sub-orbital mission.

We are searching for a postdoctoral scholar to participate in the development of CoRaLS and future probes of this type. The cross-disciplinary nature of this approach provides opportunities to contribute to the geophysical simulations, experiment simulations, and hardware development. A candidate with strong analytical skills, particularly for radio-detection techniques, and wide multi-disciplinary interests is highly desired.

NPP NASA Postdoctoral Program

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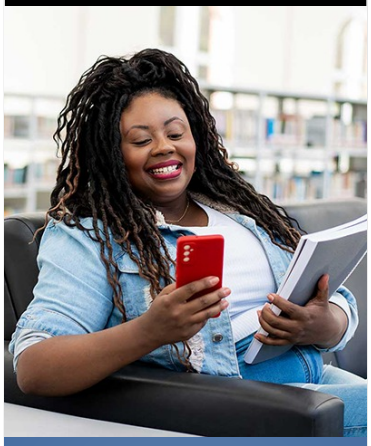

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In addition to close collaboration with the CoRaLS team, the postdoctoral candidate will be part of a group at JPL that is implementing the SunRISE space-based low-frequency radio interferometer as well as developing a variety of mission concepts for cosmic rays, radio astronomy, and passive sounding of planetary bodies using radio astronomical sources.

References:

Butler, B. J., Muhleman, D. O., and Slade, M. A., (1993) “Mercury: Full-Disk Radar Images and the Detection and Stability of Ice at the North Pole”, JGR 98, 15003.

Campbell, D. B., et al., (2006) “No evidence for thick deposits of ice at the lunar south pole” Nature 443, 835.

Costello, E. S., Ghent, R. R., Hirabayashi, M., Lucey, P. G., (2019) “Impact Gardening as a Constraint on the Age, Source, and Evolution of Ice on Mercury and the Moon”, JGR: Planets 125, e2019JE006172.

Paige, D. A., et al. (2013), “Thermal Stability of Volatiles in the North Polar Region of Mercury Show affiliations”, Science 339, 300.

Prechelt, R. L., Costello, E. S., Ghent, R. R.; Gorham, P. W.; Lucey, P. G., Romero-Wolf, A., Varner G. S. (2022), “Passive bistatic radar probes of the subsurface on airless bodies using high energy cosmic rays via the Askaryan effect”, arXiv:2212.07689

Field of Science: Technology Development

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Applications with citizens from Designated Countries will not be accepted at this time, unless they are Legal Permanent Residents of the United States. A complete list of Designated Countries can be found at: https://www.nasa.gov/oiir/export-control.

Eligibility is currently open to:

- U.S. Citizens;
- U.S. Lawful Permanent Residents (LPR);
- Foreign Nationals eligible for an Exchange Visitor J-1 visa status; and,
- Applicants for LPR, asylees, or refugees in the U.S. at the time of application with 1) a valid EAD card and 2) I-485 or I-589 forms in pending status

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Eligibility Requirements

- **Degree:** Doctoral Degree.