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Opportunity Title: Experimental Investigation of the Stability, Formation, and Exchanges in Clathrate Hydrates for Outer Solar System Applications
Opportunity Reference Code: 0100-NPP-MAR25-JPL-PlanetSci

Organization National Aeronautics and Space Administration (NASA)

Reference Code 0100-NPP-MAR25-JPL-PlanetSci

How to Apply All applications must be submitted in Zintellect

Please visit the NASA Postdoctoral Program website for application instructions and requirements: How to Apply | NASA Postdoctoral Program (orau.org)

A complete application to the NASA Postdoctoral Program includes:

1. Research proposal
2. Three letters of recommendation
3. Official doctoral transcript documents

Application Deadline 3/1/2025 6:00:59 PM Eastern Time Zone

Description **About the NASA Postdoctoral Program**

The NASA Postdoctoral Program (NPP) offers unique research opportunities to highly-talented scientists to engage in ongoing NASA research projects at a NASA Center, NASA Headquarters, or at a NASA-affiliated research institute. These one- to three-year fellowships are competitive and are designed to advance NASA's missions in space science, Earth science, aeronautics, space operations, exploration systems, and astrobiology.

Description:

Clathrate hydrates are crystalline arrangements of icy cages trapping gas molecules. Their stability and physical properties are intrinsically related to the interactions between the icy skeleton and the trapped gas, thus depend strongly on pressure, temperature, and gas composition conditions. These peculiar compounds form on Earth wherever the conditions are suitable for their formation. By analogy, clathrate hydrates are expected on Mars, icy satellites, and may have played a key role in trapping volatiles in the solar nebula. However, theoretical models to date critically lack constraints on the stability of clathrate hydrates at relevant conditions, on their kinetics of formation, and on exchanges that may occur in clathrate phase when the environment (e.g., gas partial pressures) change.

A cryogenic optical gas pressure system dedicated to studying the formation, stability, and chemical exchanges in clathrate hydrates is under development at JPL to conduct these measurements. This system will be used within a microscope coupled to a Raman system for phase identification. Other systems such as a cryogenic calorimeter and vacuum systems with FT-IR and mass spectrometer would be available for this project. The objective of this postdoctoral position is to contribute to carrying these new measurements and develop thermodynamic and kinetic models of the results. Among others, the results shall be used to provide new answers to two broad planetary science questions: 1) Did clathrate hydrates form in the solar nebula, based on their stability and kinetics of

formation? 2) What chemical reactions may occur in the clathrate phase under changing Titan conditions, how fast, and what are their geophysical and geochemical consequences?

Candidates with laboratory experience, and familiar with either of the experimental / analytical techniques to be used in this project are encouraged to apply.

Suggested references:

Choukroun M., Kieffer S., Lu X., Tobie G. (2012). Clathrate Hydrates: implication for exchange processes in the outer Solar System. In: « Science of Solar System Ices, 3rd Ed. » (S.M. Gudipati and J.C. Castillo-Rogez, Eds), Springer, New York, NJ.

Choukroun M., Sotin C. (2012). Is Titan's shape caused by its meteorology and carbon cycle? Geophys. Res. Lett., 39, L04201.

Turner N.J., Choukroun M., Castillo-Rogez J.C., Bryden G. (2012). A hot gap around Jupiter's orbit in the solar nebula. Astrophys J., 748 92 doi:10.1088/0004-637X/748/2/92.

Fortes A.D., Choukroun M. (2010). Phase behaviour of ices and hydrates. Space Sci. Rev., 153, 185-218, doi : 10.1007/s11214-010-9633-3.

Lunine J.I., Choukroun M., Stevenson D.J., Tobie G. (2009). The Origin and Evolution of Titan. In: Brown, R.H., Lebreton, J.-P., Waite, H. (Eds.), Titan from Cassini-Huygens, Ch. 3, pp. 35-59.

Choukroun M., Morizet Y., Grasset O. (2007). Raman study of methane clathrate hydrates under pressure: New evidence for metastability of structure II. J. Raman Spectrosc., 38, 440-451.

Location:
Jet Propulsion Laboratory
Pasadena, California

Field of Science: Planetary Science

Advisors:
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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;

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- 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

Questions about this opportunity? Please email npp@orau.org

Eligibility Requirements

- **Degree:** Doctoral Degree.