Opportunity Title: The inner workings of galaxy formation and feedback processes over cosmic time
Opportunity Reference Code: 0221-NPP-NOV23-JPL-Astrophys

Organization National Aeronautics and Space Administration (NASA)

Reference Code 0221-NPP-NOV23-JPL-Astrophys

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

Description The story of galaxy formation is not yet well-understood, but gravitational lensing offers us some shortcuts. With this Fellowship project, we will work with existing observations including from *Hubble* and *Keck* Observatories, and plan for the *Webb* and *Roman* Observatories, publishing our insights and results along the way.

Galaxies form on a scaffolding of dark matter structures that evolve over time, and their structure, dynamics, and chemical composition evolve through a combination of active and star formation processes as well. The star formation and mass growth history of galaxies is well-measured in the aggregate (Madau & Dickinson 2014, ARA&A, 52, 415), but there are many evolutionary paths that individual systems may follow. One especially critical tranformation to understand is the change from blue star-forming galaxies to red quiescent galaxies (Faber et al 2007, ApJ, 665, 265). Studies of galaxies at the cusp of such a transformation, including mapping chemical signatures across the structures of individual galaxies, can explicitly address and rule out or improve competing models (e.g. Maiolino & Mannucci 2019, A&AR, 27, 187). Such spatially extended chemical and stellar composition maps can serve as a key to guide full hydrodynamic numerical simulations of galaxy formation, and also guide what future observations with the *James Webb* and *Nancy Grace Roman* Observatories should pursue.

Strong gravitational lens systems offer an extended and magnified view of the cosmologically-distant universe, including profoundly high-resolution views of distant galaxies (Newman et al 2018, ApJ, 862, 125). Through multi-wavelength imaging, spectroscopy, or both, the chemical and stellar properties can be mapped in exquisite detail (Conroy et al 2014, ApJ, 780, 33; Bunker & Moustakas 2000, ApJ, 531, 95).

By using existing datasets on strong gravitationally lensed systems (Steinhardt et al 2020, 247, 64; Postman et al 2012, ApJS, 199, 25; etc), we will design and develop efficient analysis tools and models to investigate the spatially resolved stellar populations of aged distant galaxies, to test models of specific star formation and assembly scenarios. In the very near future, through *Roman*, *Rubin*, and *Euclid*, substantially more than 100,000 galaxy-galaxy lenses, and enormous numbers of galaxy cluster-scale gravitational lenses will be discovered. So in addition to the rich veins of observations available today, the modeling and analysis framework and tools developed will be directly applicable to the data to come. The Fellow working at JPL will experience a vibrant and collaborative environment, with many opportunities for collaborations both within and beyond NASA.

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Location:
Jet Propulsion Laboratory
Pasadena, California

Field of Science: Astrophysics

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;
- 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

Eligibility Requirements

- **Degree:** Doctoral Degree.