APS Undergraduate Research Opportunities Symposium

Part 2: 1-on-1 research internship opportunities

All documents, recordings and application form posted [here]

11 November 2025 | 5:00pm | Duane G1B20

John Keller, Nick Schneider & Zach Berta-Thompson
ASTR/PHYS Professional Development

1-on-1 Research Mentorship Positions: 20+ Opportunities!!

Common application for all opportunities. All majors welcome. Deadlines may vary.

- Some of the projects are already grant-funded
- Most projects can be carried out for Independent Study credit
- Most projects are eligible for UROP support this coming summer, if you write a successful proposal in February. SwRI projects aren’t included :-(
- Some additional projects will be supported by a $3000 APS Department “Undergrad Research Stipend” (APS majors only, priority to first-time researchers)

When you are interviewed for the positions, you can discuss which is the best path forward

Common Application for APS/PHYS UROS research positions

Use this common application to apply for positions as advertised at the Undergraduate Research Opportunities Symposium.

nick@colorado.edu Switch account

The name, email, and photo associated with your Google account will be recorded when you upload files and submit this form

* Indicates required question

Email *

- [ ] Record **nick@colorado.edu** as the email to be included with my response

Name *

Your answer

Email (if different than account linked above)

Your answer

Student ID # (9 digits) *

Apply at https://forms.gle/67eQFgXX4xWF9VKX6

Major(s) (include emphasis/track if applicable) *

Your answer

Please check all the positions you would like to be considered for: *

- [ ] John Keller (APS) - Studying Trojan Binarity through Stellar Occultations
- [ ] Dang Pham (APS) - Implementing gravitational structures in REBOUND
- [ ] Zach Berta-Thompson (CASA) - Slitless Spectroscopy of Exoplanets and Solar System Objects from SBO
- [ ] Olivia Cooper (CASA) - The evolution of dust properties in distant, massive galaxies with JWST + ALMA
- [ ] Stephen Majeski (JILA) - Modeling plasma micro-physics in galaxy clusters and around black holes
- [ ] Fran Bagenal (LASP) - Analysis of Data from Juno Mission in Jupiter's Magnetosphere
- [ ] Dave Brain (LASP) - MAVEN data analysis and/or Retention of Habitable Atmospheres
- [ ] Eryn Cangi (LASP) - Improving Mars and Venus atmospheric modeling with new chemistry and transport
- [ ] Chihoko Cullens (LASP) - Studying Atmospheric Coupling Process
- [ ] Yaxue Dong (LASP) - Studying Mars' pickup ion plume rotation based on multi-spacecraft observations
- [ ] Harish (LASP) - Unveiling the Composition of Asteroids through Near-Infrared Spectroscopy
- [ ] Kevin McGouldrick (LASP) - Improved Radiative Transfer to support studies of the

Click on presenter name to go to their slides
Slides may not appear in the same order as listed here

Speaker / Research Advisor	Organization	Research Project Title	Can you fund this position
Fran Bagenal	LASP	Analysis of Data from Juno Mission in Jupiter’s Magnetosphere	Yes
Eryn Cangi	LASP	Improving Mars and Venus atmospheric modeling with new chemistry and transport	No
Caroline Haslebacher	SWRI	Geologic age sequencing of linear surface features on Jupiter’s moon Europa	No
Olivier Mousis	SwRI	Europa’s Ocean Evolution and Habitability	No
Kevin McGouldrick	LASP	Improved Radiative Transfer to support studies of the Venus clouds	Yes
Harish	LASP	Unveiling the Composition of Asteroids through Near-Infrared Spectroscopy	No
Yaxue Dong	LASP	Studying Mars’ pickup ion plume rotation based on multi-spacecraft observations	No
Stephen Majeski	JILA	Modeling plasma micro-physics in galaxy clusters and around black holes	No
Zach Berta-Thompson	CASA	Spectrophotometry of Solar System Planets, Stars, and Exoplanets from SBO	No
Victoria Hartwick	SwRI	Diagnosing Dusty Exoplanet Climate & Spectral Signatures w/ Global Climate Models	No
Erika Barth	SwRI	Microphysical Properties of Haze Particles in Jupiter’s Atmosphere	No
Olivia Cooper	CASA	The evolution of dust properties in distant, massive galaxies with JWST + ALMA	No
Dang Pham	APS	Implementing gravitational structures in REBOUND simulations	No
Amanda Alexander	SwRI	Quantifying impact-induced damage in iron meteorites	No
Criscuoli & Kuridze	NSO	The Sun at the highest spatial scales	??
Adam Kowalski	NSO	Exploring the Magnetically Active Galaxy with Sloan Digital Sky Survey V	No
Gianna Cauzzi	NSO	The Large Scale Solar Chromosphere	
Kevin Reardon	NSO	The History and Instruments of Sacramento Peak Observatory	
Dave Brain	APS	MAVEN data analysis and/or Retention of Habitable Atmospheres	Yes
Chihoko Cullens	LASP	Studying Atmospheric Coupling Process	Yes
John Keller	APS	Studying Trojan Binarity through Stellar Occultations	Yes
			No

Juno Mission in Jupiter's Vast Magnetosphere

Topic:

- Structure and dynamics of Jupiter's plasma sheet
- Analysis of 80 orbits of Juno measurements of sulfur and oxygen spewed from Io's volcanos

Skills To Start:

- Basic Python, Matlab or similar

Skills to be learned:

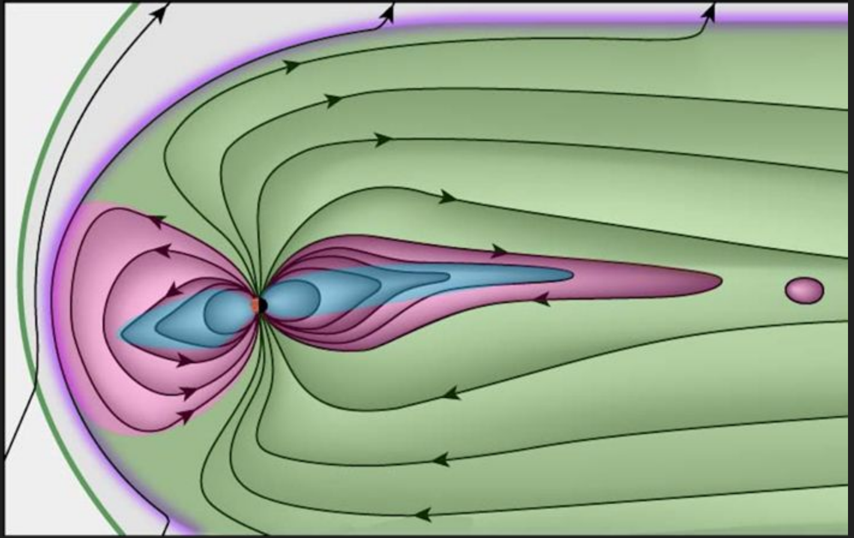
- Data analysis – picking out peak densities
- Coding to plot data
- What's a magnetosphere? What's Io up to?

Research Group:

- LASP Magnetospheres of Outer Planets
- 4 researchers & students

Timeline/Pay:

- 1 position – apply for UROP?
- Accepting applications now to Jan 10th
- Spring 2026 and/or Summer



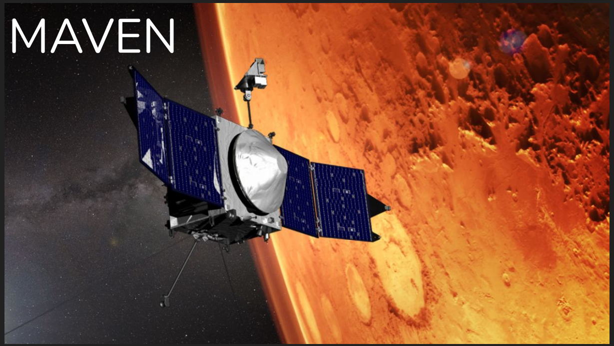
Improving Mars and Venus atmospheric modeling with new chemistry and transport

Advisor - Eryn Cangi - eryn.cangi@lasp.colorado.edu

I'm on travel, plz click: https://youtu.be/Q53zcNOMVh0

Study the chemistry and loss to space of the Mars and Venus atmospheres! We are looking for someone to help upgrade our photochemical model by:

1. updating the chemistry and diffusion schemes;
2. analyzing changes with new modeling and/or comparison with space mission data; and
3. identifying important but unmeasured chemistry reactions and making recommendations for lab measurements

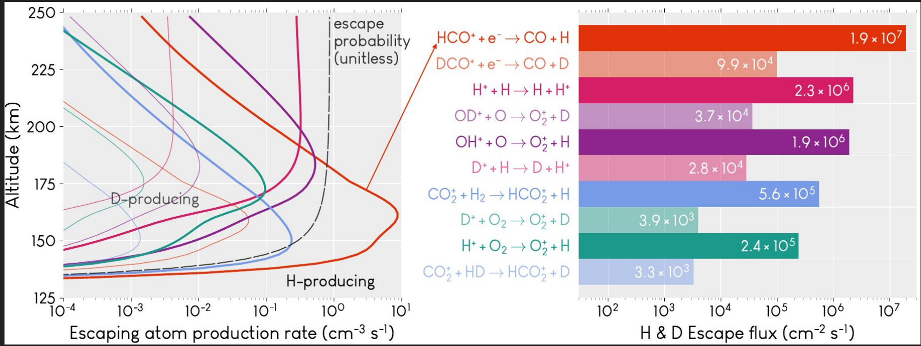


Requirements:

- ★ Scientific programming (*e.g.* PHYS/ASTR 2600 or similar)
- ★ General chemistry

Helpful, not required:

- ★ Coursework in atmospheres (any)
- ★ Experience with Julia language



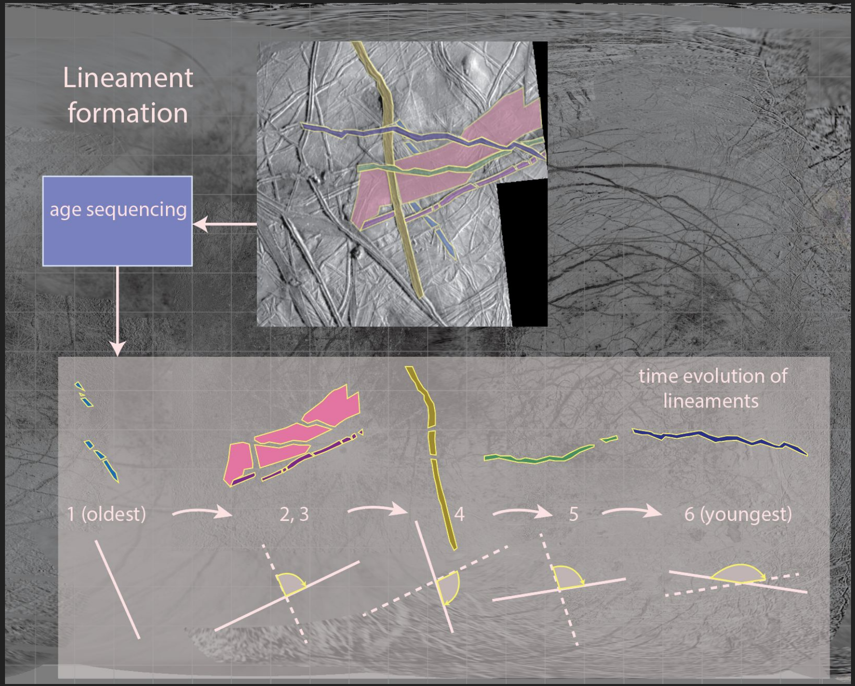
Help us improve results like this! (Venus atmospheric escape)

Please submit CV and 1-page cover letter by November 26th, 2025

Geologic age sequencing of linear surface features on Jupiter's moon Europa

Advisor: Caroline Haslebacher (caroline.haslebacher@contractor.swri.org)
SwRI in Downtown Boulder, Group of Alyssa Rhoden

- Linear surface features (lineaments) on Europa's icy surface likely emerge out of fractures in the ice shell.
- Producing an age sequence of lineaments can give insights into lineament formation and evolution.
- You are going to
  - Provide an age sequence of a selected region (mapping is provided)
  - Assess approximative relative age parameter
  - Perform statistical analyses of lineament characteristics with respect to relative age



What you should bring:

- Statistics and data analysis skills
- Interest in geological processes
- Interest in learning geographic information systems (GIS)
- Programming knowledge (e.g. Python or R)

Europa's Ocean Evolution and Habitability

Advisor: Olivier Mousis, SwRI (olivier.mousis@swri.org)
https://sites.google.com/view/olivier-mousis/homepage

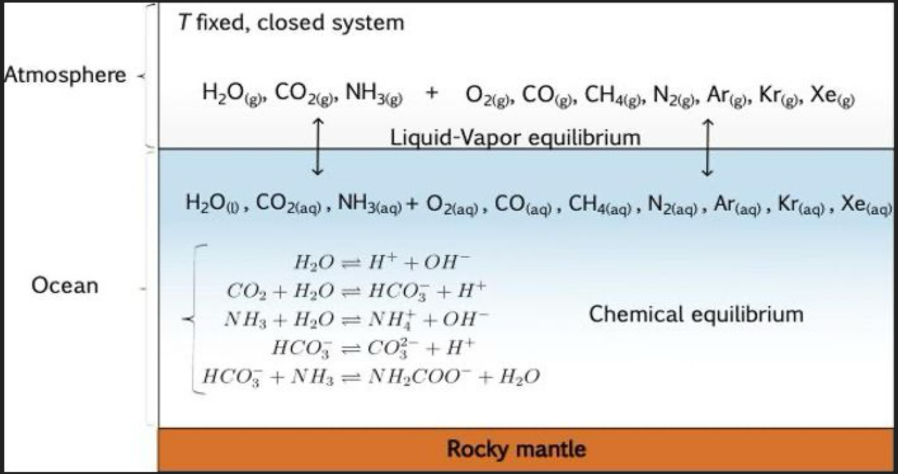
Objective: Enhance an in-house model of Europa's ocean to simulate its **chemical evolution** and predict its **present-day composition**, supporting **Europa Clipper** data interpretation.

Current Model: Computes **thermodynamic and chemical equilibrium** between Europa's early ocean and dense primordial atmosphere. Tracks **CO_2–NH_3 speciation** and includes **volatile exchange** during the early open phase post-accretion.

Planned Developments: Extend the model to capture Europa's long-term ocean evolution: (1) transition from open to closed ocean beneath the ice shell; (2) inclusion of a **clathrate module** with self-consistent thermodynamics of formation/destabilization; (3) assessment of **volatile trapping**, **redox balance**, and **habitability**.

Expected Outcomes: Deliver a **predictive framework** for interpreting Europa Clipper's surface, exosphere, and plume data, and a **community model** for Europa's volatile cycling and **habitability evolution**.

Background: interest in planetary chemistry/physics, Python



Model of early ocean–atmosphere equilibrium and H_2O–CO_2–NH_3 speciation (Amsler Moulanier et al. 2025).

Please submit CV and 1-page cover letter by November 26th, 2025

Advisor - Kevin McGouldrick (LASP)
kevin.mcgouldrick@lasp.colorado.edu

You'll help upgrade our Venus Aerosol and Radiative Transfer model by implementing an improved method of calculating atmospheric absorption and scattering called "correlated K coefficients." The goal is to produce a model that more accurately describes the role of solar heating in the Venus atmosphere and clouds.

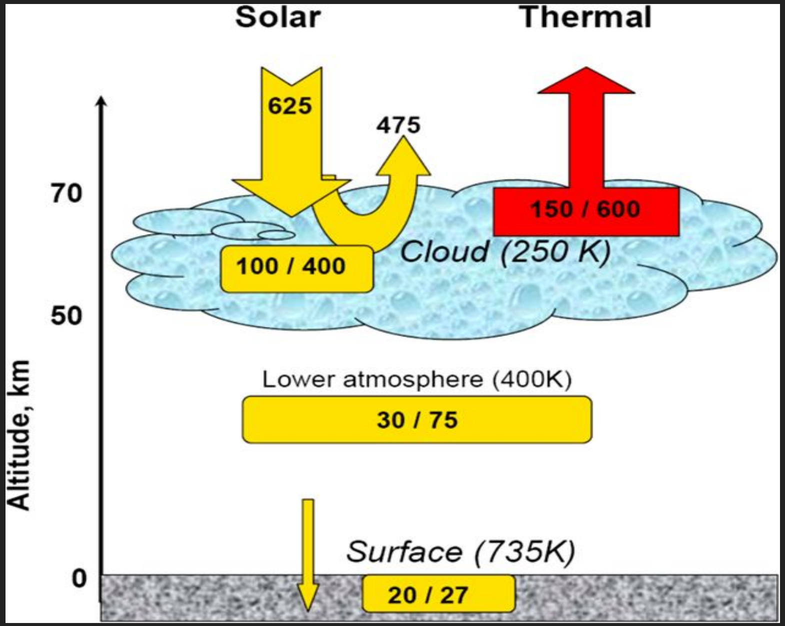
Requirements:

- ★ Some scientific programming (e.g. PHYS/ASTR 2600)
- ★ Integral Calculus (Calc 2)

Helpful, not required:

- ★ Coursework in atmospheres (planets/Earth)
- ★ Thermodynamics

Energy Balance in the Venus Atmosphere



Limaye et al. , 2018, SSR 214:102.

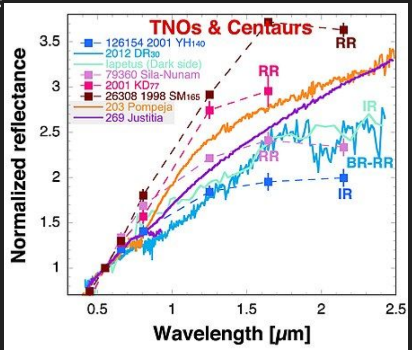
Unveiling the Composition of EMA Target Asteroids through Near-Infrared Spectroscopy

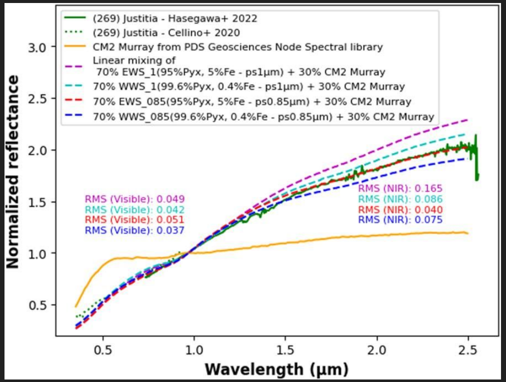
Advisor: Harish, LASP (harish@lasp.colorado.edu)

About the project:
The Emirates mission to the asteroid belt (EMA) will visit 7 main belt asteroids. By studying their NIR spectra, we can uncover clues about their composition, formation, and evolution.

Your Tasks:

- ❏ Process and analyse Earth based NIR spectral data of asteroids
- ❏ Interpret the composition of target asteroids
- ❏ Relate compositional trend to asteroid evolution and solar system history.





Desirable:

- ❏ Interest in spectroscopy or planetary geology
- ❏ Basic knowledge of IDL or Python

Studying Mars' pickup ion plume rotation based on multi-spacecraft observations

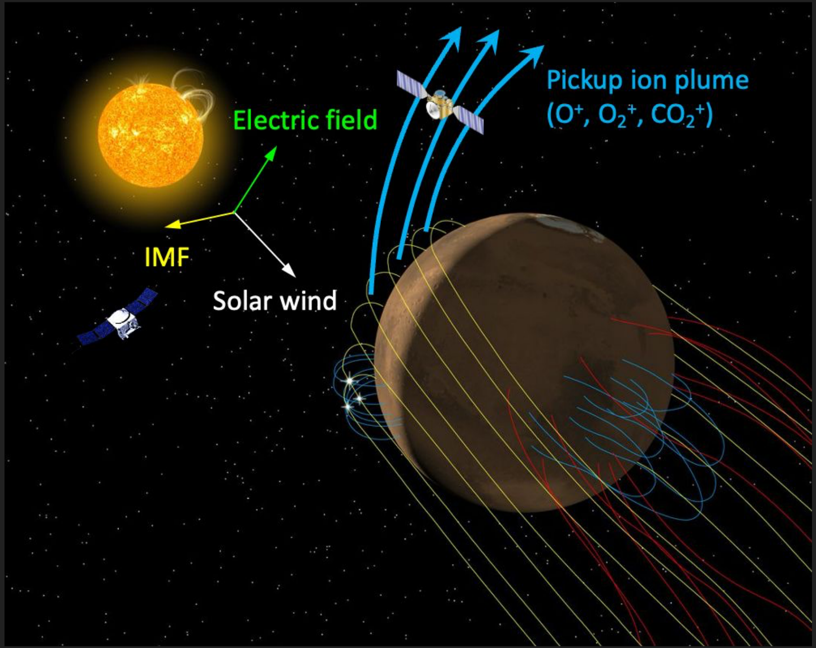
Advisor: Yaxue Dong, LASP (yaxue.dong@lasp.colorado.edu)

Please click here for the recorded presentation: https://www.youtube.com/watch?v=27oAQIa_EpU

Background: The pickup ion plume of Mars is an important ion escape channel of Mars. Its direction is mostly controlled by the upstream interplanetary magnetic field (IMF). Understanding its variability is important for the studies of Mars' plasma environment and atmospheric loss.

Goals: Use data from NASA Mars Atmosphere and Volatile Evolution (MAVEN) and ESA Mars Express (MEX) missions to investigate the time scale of the pickup ion plume responding to IMF rotations and the effects in atmospheric loss.

Tasks: **1)** Identify IMF rotations with MAVEN magnetic field data. **2)** Analyze ion data from MAVEN and MEX shortly before and after the IMF rotations to examine the changes in plume directions, ion fluxes, and other properties.



Requirements: Interests in physics and planetary science. Basic electromagnetics and vector operations. Coding experiences in IDL, MatLab, or Python

Please submit CV and 1-page cover letter by November 26th, 2025

Modeling plasma micro-physics in galaxy clusters and around black holes

Advisor: Stephen Majeski, JILA (stephen.majeski@colorado.edu)

Small-scale (tiny!) instabilities change the large-scale material properties of numerous astro-plasmas. With >10 decades of scale separation, simulating this physics requires a carefully designed *closure*.

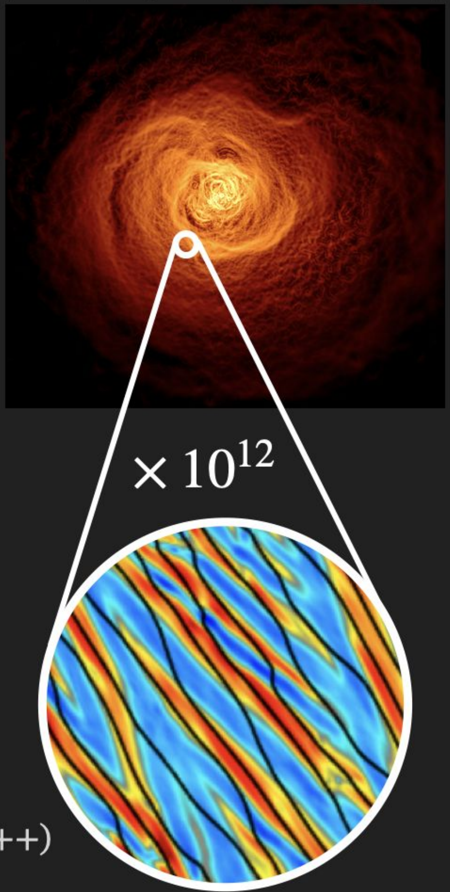
Problem: Existing numerical closures are either inaccurate and stable **or** accurate and unstable.

Your tasks:

1. Learn about these instabilities! Why do they show up? What exactly do they change?
2. Find a way to numerically implement an (already-determined) analytical closure for them.
3. Code and test in the Athena++ and/or AthenaK MHD codes.
4. (bonus) Investigate the Kelvin-Helmholtz instability in galaxy clusters.

Background: Interest in plasma physics, fluids, coding experience (will work with C++)

(NASA/CXC/GSFC/S.A.Walker, et al.)



Observing Wide-Field, Low-Resolution, Spectrophotometry of Solar System Planets, Stars, and Exoplanets from SBO

Advisor: **Prof. Zach Berta-Thompson**

Goals:

- Measure Solar System planet albedos as function of wavelength + phase.
- Measure the effect of rotating starspots on stellar spectra and exoplanet radii.
- Measure the chromatic statistics of twinkling starlight.
- Understand the noise limits.

Activities:

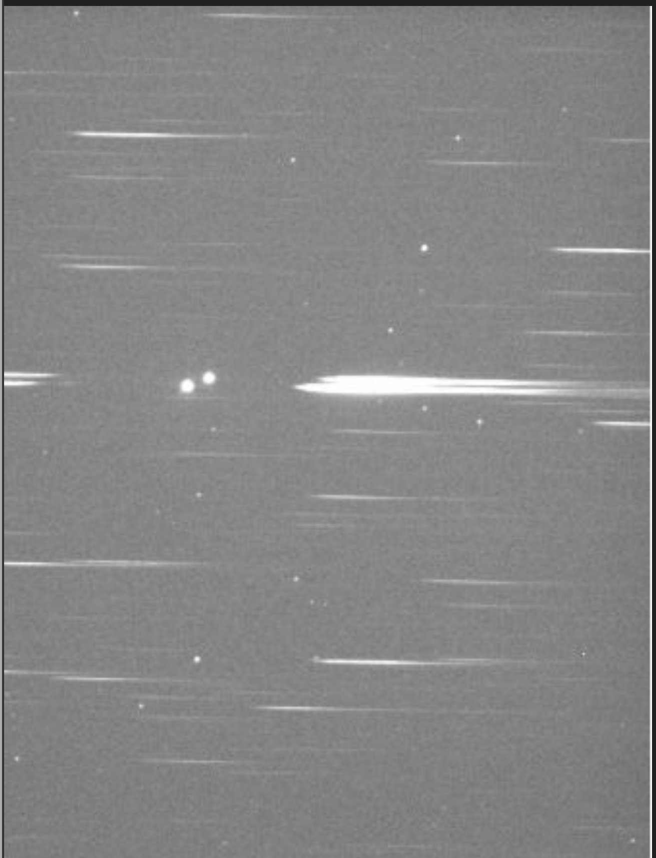
- Observe time-series spectra from SBO.
- Test, revise, and document protocols.
- Write analysis + visualization code.

Helpful skills:

- Curiosity. Attention to detail.
- Teamwork. Patience. Kindness.
- Statistics. Python coding. Literacy.

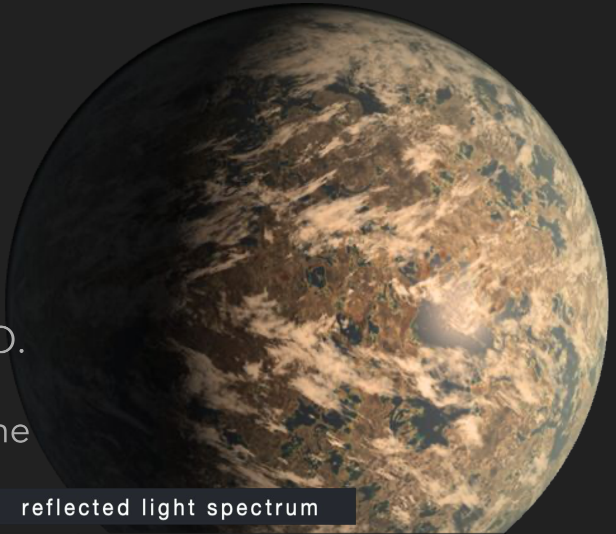
Expectations:

- Team meetings + late nights at SBO.
- Variable commitment, from observing a few nights up to UROP, independent study, honors thesis projects.



Diagnosing Dusty Exoplanet Climate & Spectral Signatures Using Global Climate Models

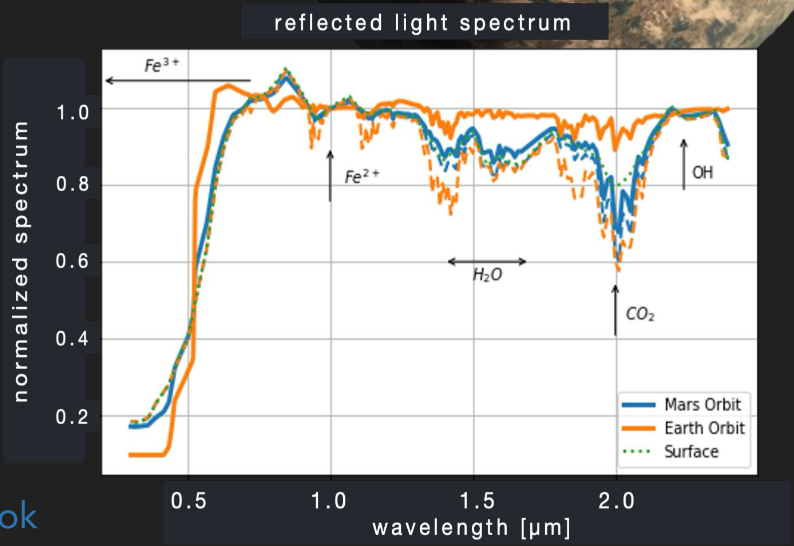
Advisor: Victoria Hartwick, SwRI (victoria.hartwick@swri.org)



Dry dust dominated worlds may represent a large fraction of the first terrestrial exoplanets we systematically characterize using JWST and HWO. Theoretical modeling work in advance of these observations can help us better understand the most likely climate and habitability and constrain the spectral signatures of these climate types

Your Tasks:

- Use the PICASO software package to generate theoretical reflected light and transmission spectra of Trappist-1e, Proxima Centauri b and TOI-700d with and without dust and water clouds
- Compare spectra to clear sky versions to identify and quantify differences, focusing on unique or diagnostic features



Useful but not required skills: python, jupyter notebook

Microphysical Properties of Haze Particles in Jupiter's Atmosphere

Advisor: Erika Barth, SwRI (erika.barth@swri.org)

Despite multiple spacecraft flybys and a dedicated orbiter mission, we still do not know the basic properties of Jupiter's atmospheric particles. The hazes and cloud particles play a key role in the radiative heat budget of the planet, and their variability can provide useful information about the chemistry and dynamics occurring in the stratosphere and troposphere.

You will:

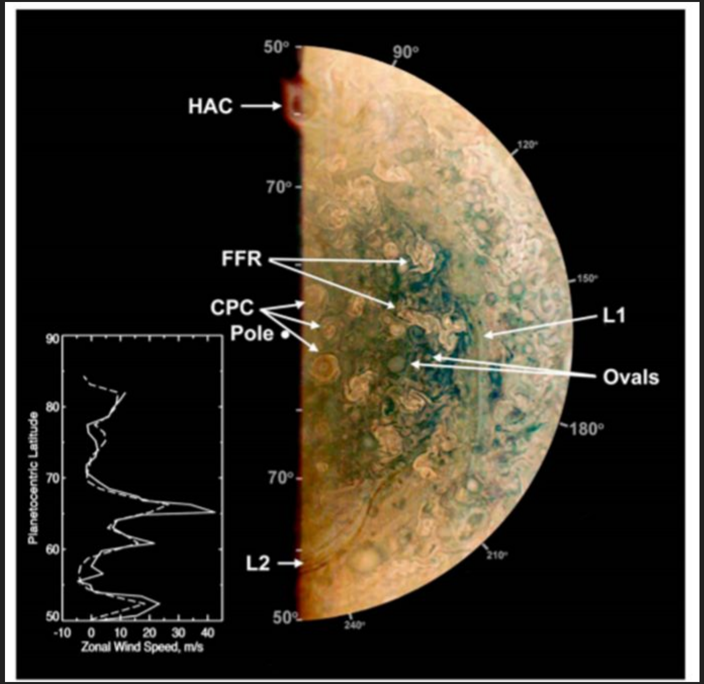
Learn about what chemical species are present in Jupiter's atmosphere

Run a microphysics model to simulate the particles these species create

Compare the effects of composition, abundance, size, and shape on the generated particle profiles

Helpful background:

Interest in planetary atmospheres; working with Python; coding experience not necessary, but could allow for more interaction with the model



Composite image of Jupiter's north polar region from JunoCam, with labeled features: high-altitude cloud (HAC), folded filamentary regions (FFR), circumpolar cyclones (CPC), ovals, and linear features (L1 and L2); Orton et al. (2017).

The evolution of dust properties in distant, massive galaxies with JWST + ALMA

Advisor: Dr. Olivia Cooper
Email: olivia.cooper@colorado.edu // website: 0cooper.github.io

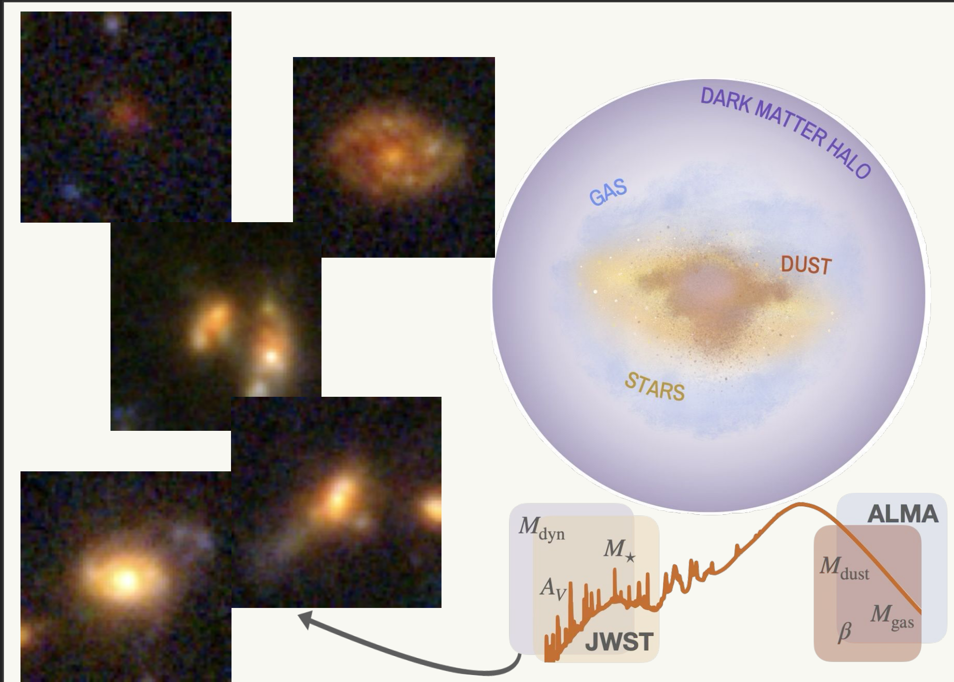
Star formation within massive galaxies drives much of cosmic assembly across time. To understand the formation and evolution of massive galaxies, we must trace the fuel, product, and byproducts of star formation: molecular gas, stars, and dust. How did these galaxies form and grow so early, ultimately seeding the Universe we see today? In this project, we will trace cosmic assembly from the lens of **massive dusty star-forming galaxies using JWST and ALMA**.

Activities:

- Analyze joint JWST and ALMA data for a sample of ~100 distant massive galaxies
- Measure their physical properties (e.g. dust and stellar mass, dust emissivity index)
- Characterize trends in physical properties over redshift (do dust properties evolve, and how?)
- Create science plots and present results in oral/written form

Expectations:

- Interest in extragalactic science and multiwavelength observational astronomy
- Interest in data analysis and scientific programming (minimal to no coding experience required!)



Implementing gravitational structures in REBOUND simulations

Advisor: Dang Pham

Email: **Dang.Pham@colorado.edu** // Website: **dangpham.ca**

Tasks: You'll help implementing gravitational structures (rings, disks, and shells) into the REBOUND N-body code.

Why: These gravitational structures describe the effects of debris disks, clouds, and long-term effects of planets. Thus, they will greatly aid N-body users in many problems, such as simulating the dynamics of Kuiper Belt and Oort cloud asteroids/comets. They can also speed up "secular" simulations.

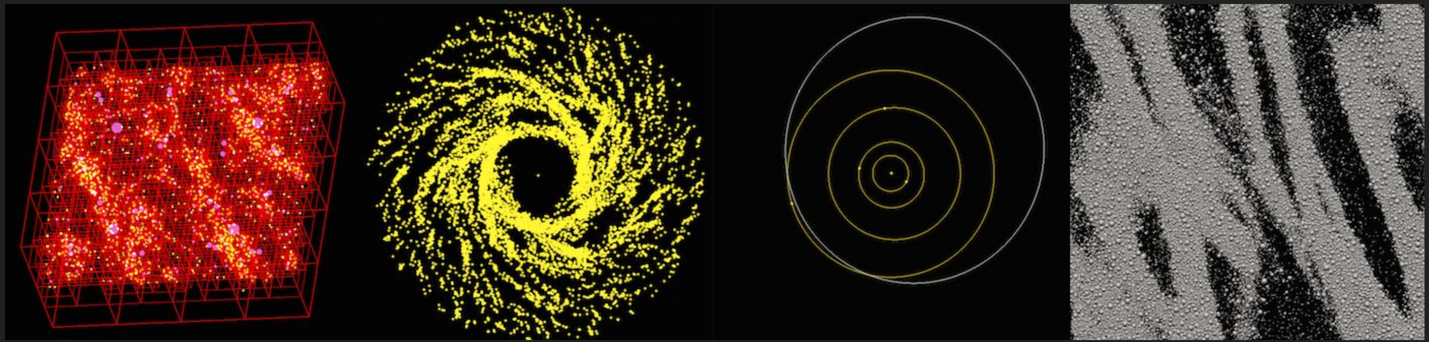
This project will have wide-ranging impacts on users of the popular code REBOUND.

Requirements:

- ➔ Some programming experience (and willing to learn more!)
- ➔ Completed first year physics and integral calculus
- ➔ Have seen at least one differential equation

Useful, not required:

- (Ordinary) differential equations
- Have attempted to compile something in C/C++



Quantifying impact-induced damage in iron meteorites

The consequences and geologic evolution of metal-rich surfaces (like Asteroid 16 Psyche, target of the NASA Psyche mission) as a result of impacts are not well understood. We are working to develop a comparative database of impact craters and impact-generated geologic features on such worlds through laboratory experiments and numerical simulations of iron meteorites.

Project 1 description:

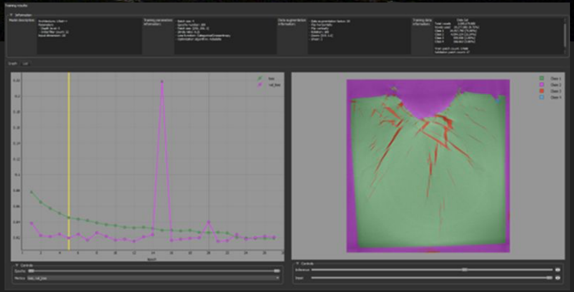
- Deep-learning assisted mapping of iron meteorites before and after hypervelocity impact experiments via Dragonfly software
- Orientation analysis with Blob3D and Quant3D software

Project 2 description:

- Set up and analysis of numerical models using iSALE-2D to simulate impacts on metal worlds for a variety of material parameters determined from laboratory measurements and empirical fitting

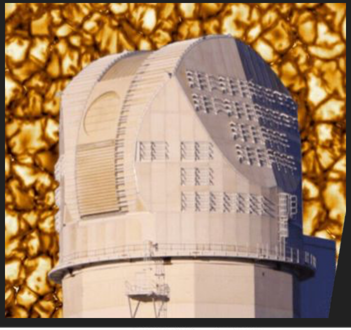
Requirements/expectations:

- Interest in planetary processes, specifically impacts
- 1 hour weekly progress/mentorship meeting at SwRI in downtown Boulder
- Experience with python is helpful but not required
- Experience with machine learning techniques is helpful but not required

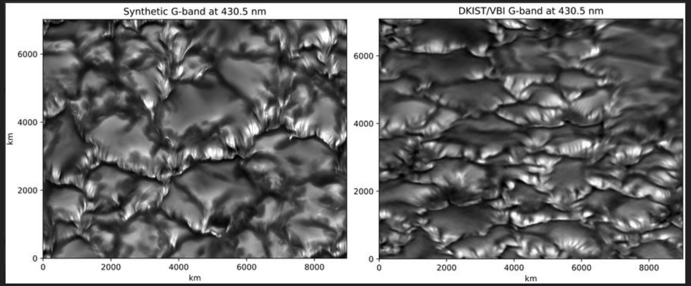


Contact: Amanda Alexander (amanda.alexander@swri.org)

The Sun at the highest spatial scales



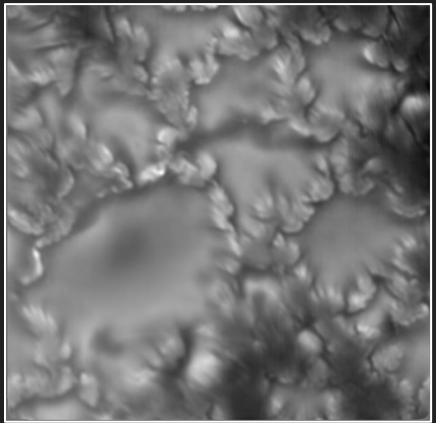
Advisors: Serena Criscuoli (scriscuo@nso.edu)
David Kuridze (dkuridze@nso.edu)

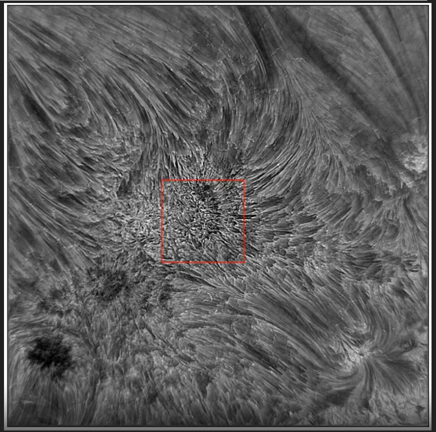


Description: analyze fine structuring and dynamics of magnetic features using unprecedented spatial resolution data acquired during a dedicated campaign at the DKIST. Comparison with lower resolution observations and models.

Looking for: one or two students. Python or other programming language experience is highly recommended.

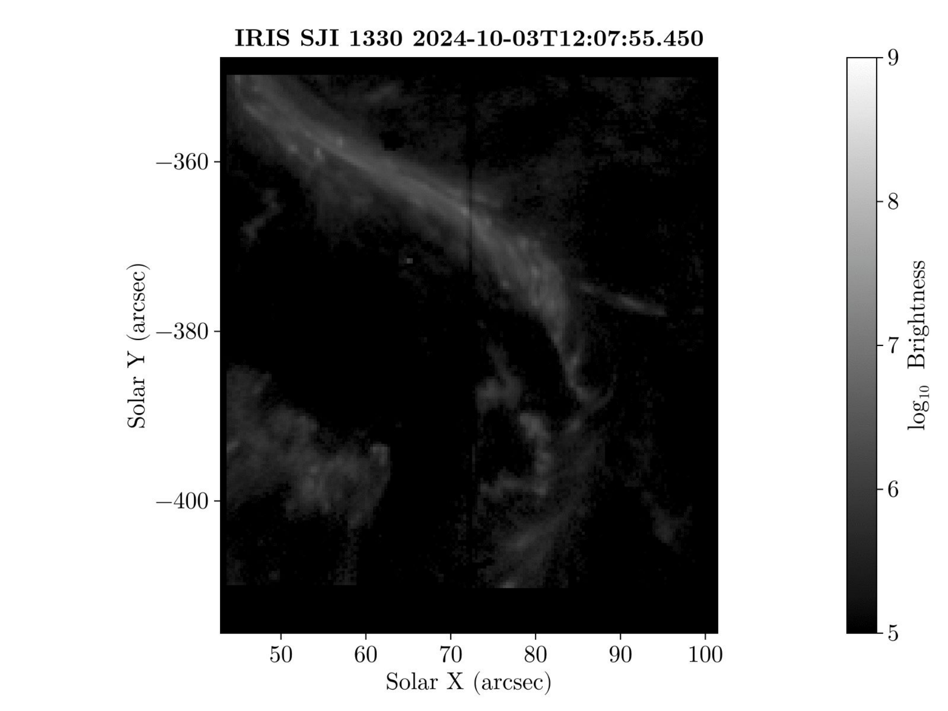
Application Deadline: December 15.
Support: funds may be available.
Start: ~ February.
Duration: ~1 semester.





Exploring the magnetically active Galaxy with SDSS V

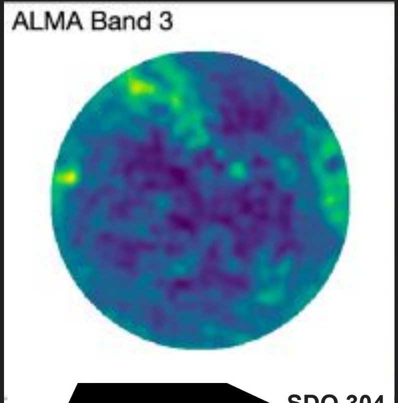
Prof Adam Kowalski (adam.f.kowalski@colorado.edu)

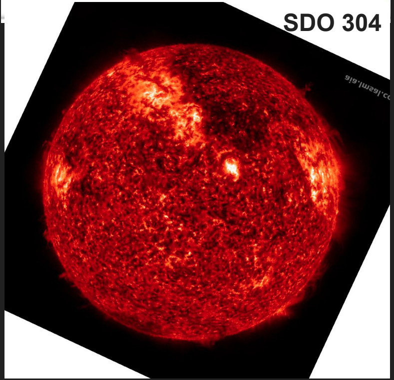


The Large Scale Solar Chromosphere

Advisor: Gianna Cauzzi (gcauzzi@nso.edu; National Solar Observatory)

- Full disk observations of the Sun give us a snapshot of solar activity and structures.
- Images in different wavelengths give us different diagnostics of the solar atmosphere (e.g. GONG, SDO).
- In some wavelengths we get full-disk images every minute or better. 🎉
- But we get some of these full disk images only sporadically (e.g. ALMA). 😿
- *Can we find some proxies in the regular full-disk images that we can use to fill in the gaps of the sporadic images?*
- *Can we use these proxies or other information to understand stellar activity?*





Project description: Retrieve solar full-disk data from repositories; Perform coalignment of images; Examine relationships between values in different images; Learn about spectral diagnostics; Determine combinations of parameters to infer best-fit proxies.

Requirements: Interest in solar images and data analysis; some programming experience.

Historical Astronomy: Sacramento Peak Observatory

Advisor: Kevin Reardon (kreardon@nso.edu; National Solar Observatory)




Sac Peak (with CU roots) had multiple solar telescopes and instruments, that took a lot of film data (1950-1990), much of which is now languishing in a film vault.

You will help compile information on the instruments from published papers, scan in records and reports, digitize example films, analyze some of the old data, and learn the ancient arts.

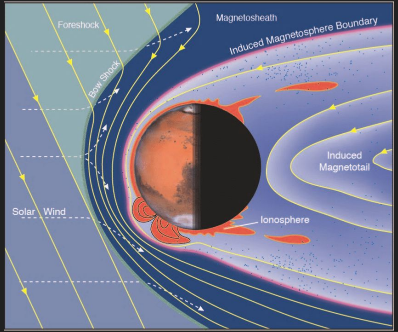
Potential for interdisciplinary research with History or Anthropology Departments

MAVEN Data Analysis and/or Retention of Habitable Atmospheres

Dave Brain

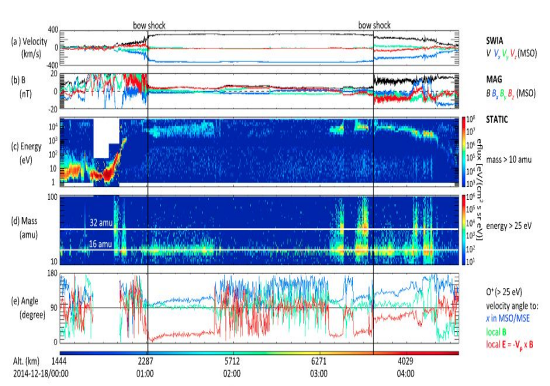
You: No previous research experience, but comfortable with coding

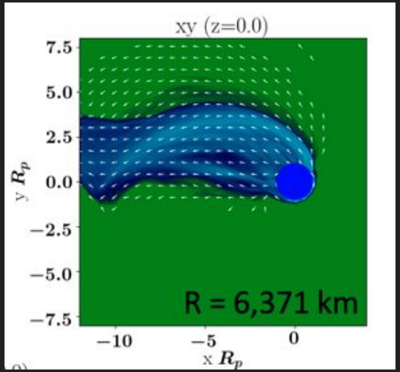
Us: Brain Research Group at LASP



Topic: Negotiable (there are ~10 ideas!), but related to topics such as the physics of Mars's magnetosphere to Martian climate evolution to atmospheric escape from exoplanets

Task: Could be spacecraft data analysis (magnetic fields, charged particles, etc.) or computer simulations





Apply: Email me a CV (w/current GPA) and 2 paragraph cover letter (what will you bring, what will you take?) by Jan 12. 1-2 paid positions start in May. Happy to discuss independent study or other ways of starting earlier if desired.

Studying Atmospheric Coupling Process between the Troposphere to the Thermosphere

RECON 2.0 -
Research and Education Collaborative Occultation Network

NASA SSO Award:

Solar system origins through Jupiter Trojan shapes

Shape and binarity for 100 Trojans