Exploring Exoplanetary Through Visualization and Detection Signal Analysis

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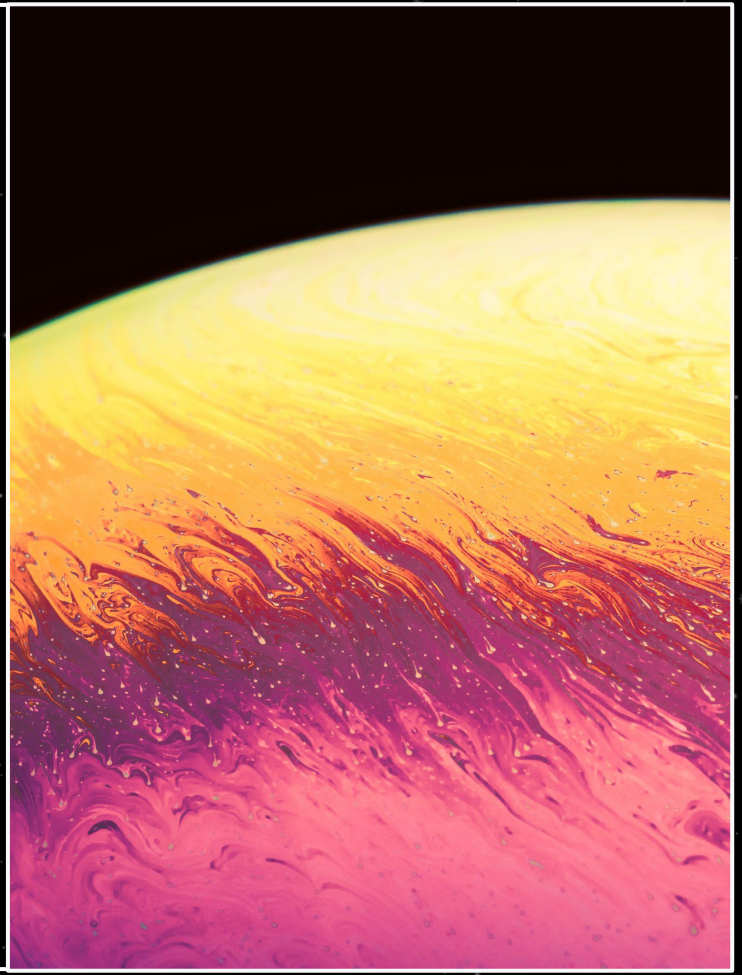
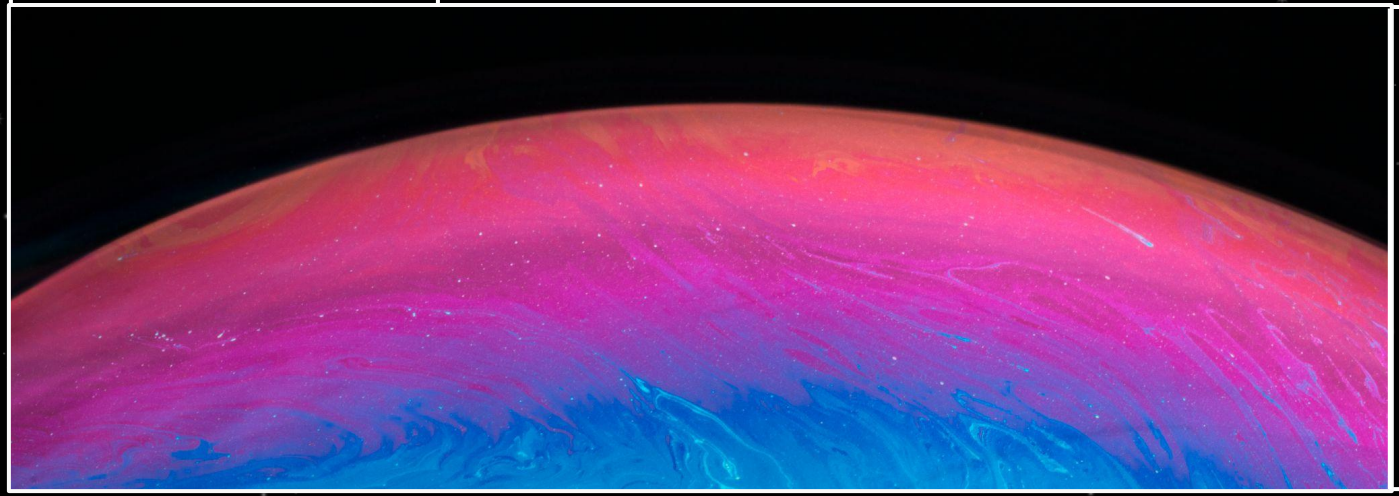
01 Abstract

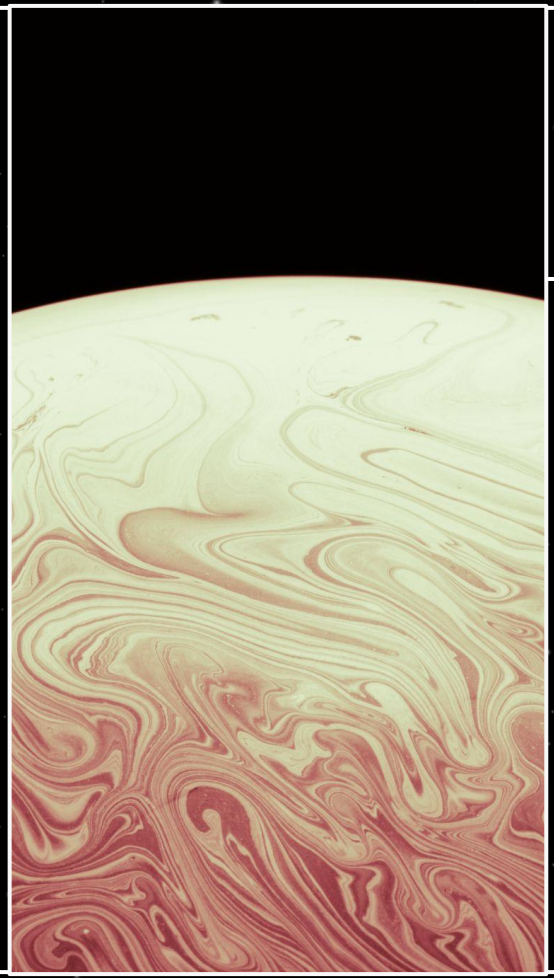
- This project uses NASA Exoplanet Archive to gather data
- Data visualized through 4 different plots
  - Mass vs. Orbital Period
  - Mass vs. Semi-major Axis
  - Radius vs. Orbital Period
  - Radius vs. Semi-major Axis
- Focused on Earth and Jupiter like planets around Sun like stars
- Findings show bias with different detection methods



02 Motivation



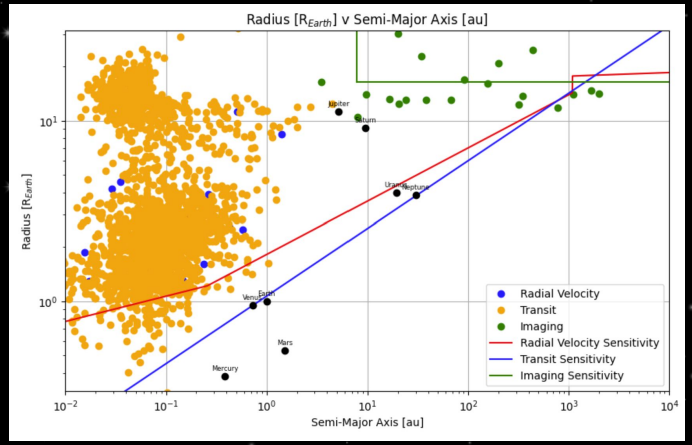
- Exoplanet discovery reveals insights into planetary formation and habitability.
- The project uses NASA Exoplanet Archive to analyze detection biases.
- The project evaluates the feasibility of detecting Earth-like or Jupiter-like planets around Sun-like stars.
- The project aims to enhance understanding of exoplanet distribution, detection biases, and the search for habitable worlds.

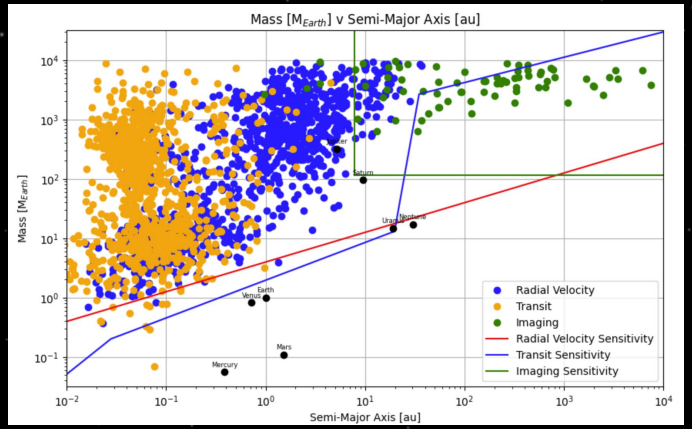


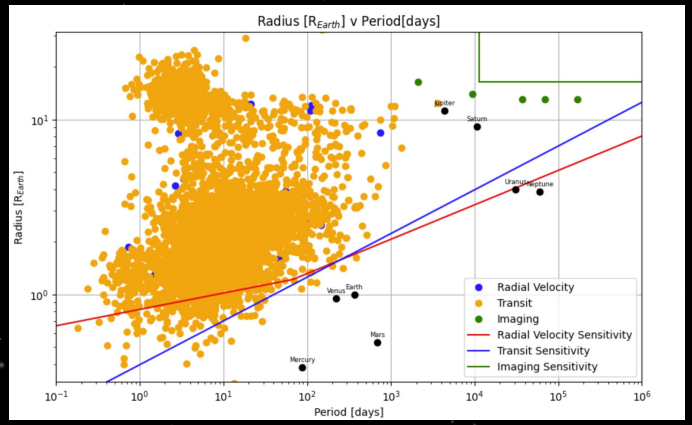
03
Methodology

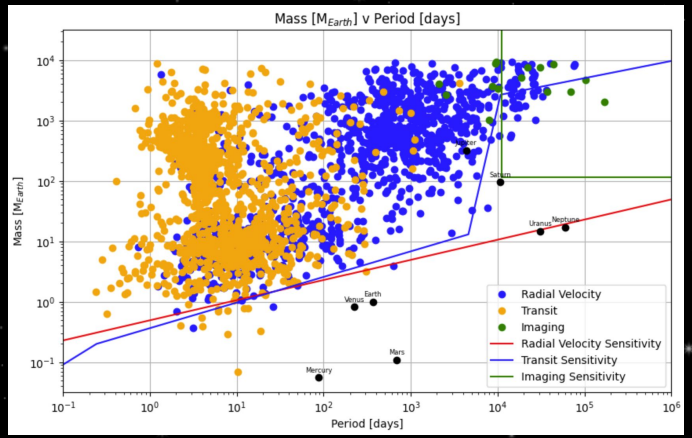
- **Data Processing:** Import and structure exoplanet data from NASA Exoplanet Archive.
- **Solar System Comparison:** Define key planet attributes and overlay them on plots.
- **Visualization:** Generate mass/orbit/radius plots, color-coded by detection method, highlighting biases and limitations.
- **Detection Sensitivity:** Analyze radial velocity, transit, astrometry, and microlensing methods, overlaying their effectiveness.
- **Detection Feasibility:** Calculate signals for Earth-like planets around Sun-like stars, comparing with detection limits.
- **Project Alignment:** Emphasizes detection biases, feasibility, and limitations of current methods.

04
Results

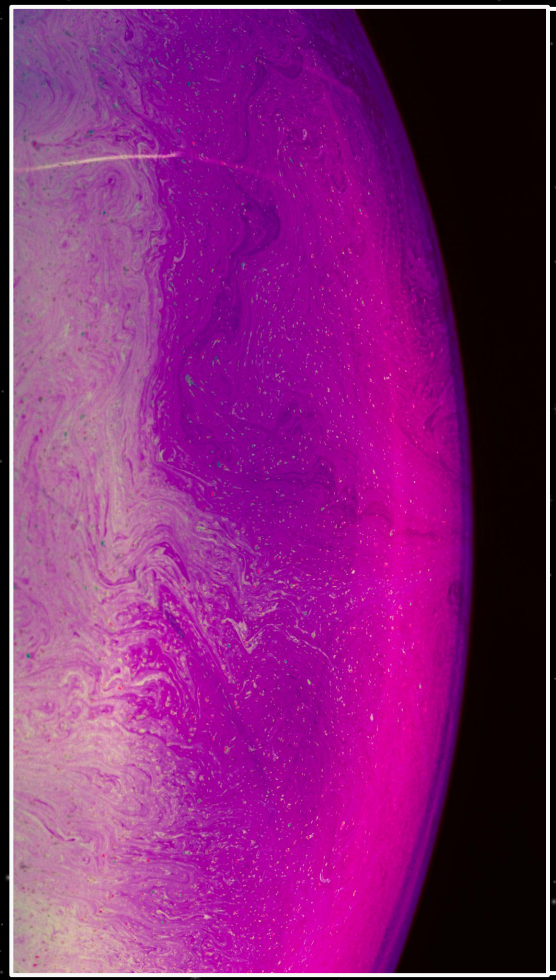

Radius [R_{Earth}] v Semi-Major Axis [au]
Radius [R_{Earth}]
Semi-Major Axis [au]
Jupiter
Saturn
Uranus
Neptune
Venus
Earth
Mars
Mercury
Radial Velocity
Transit
Imaging
Radial Velocity Sensitivity
Transit Sensitivity
Imaging Sensitivity


Mass [M_{Earth}] v Semi-Major Axis [au]
Mass [M_{Earth}]
Semi-Major Axis [au]
Jupiter
Saturn
Uranus
Neptune
Venus
Earth
Mars
Mercury
Radial Velocity
Transit
Imaging
Radial Velocity Sensitivity
Transit Sensitivity
Imaging Sensitivity


Radius [R_{Earth}] v Period[days]
Radius [R_{Earth}]
Period [days]
Jupiter
Saturn
Uranus
Neptune
Venus
Earth
Mars
Mercury
Radial Velocity
Transit
Imaging
Radial Velocity Sensitivity
Transit Sensitivity
Imaging Sensitivity


Mass [M_{Earth}] v Period [days]
Mass [M_{Earth}]
Period [days]
Jupiter
Saturn
Uranus
Neptune
Venus
Earth
Mars
Mercury
Radial Velocity
Transit
Imaging
Radial Velocity Sensitivity
Transit Sensitivity
Imaging Sensitivity

- **Temperate Earth-like Planet around a Sun-like Star:** The detection signals for both the Transit and Radial Velocity methods are below the current sensitivity limits, which suggests a low probability of detection with existing technologies.
- **Jupiter-like Planet around a Sun-like Star:** The signals exceed the thresholds of the Radial Velocity and Transit methods, which suggests a high probability of being detected.
- **Temperate Earth-like Planet around an M-type Star:** The Astrometry method shows some detectability, while the Transit Method remains below the desired threshold, which suggests some potential for detection, however these methods seem ineffective.



05 Conclusions

Our project was able to show the large biases in our current detection techniques. The detection calculations done provide proof of the challenges we face with our current . With the biases, the current methodologies used for detecting exoplanets are very important in understanding the distribution of exoplanetary systems. Future projects should focus on developing more sensitive instruments. This will help expand our understanding in how diverse planets are elsewhere in the universe.