Proposal to Gather Atmospheric Data from Distant Planets

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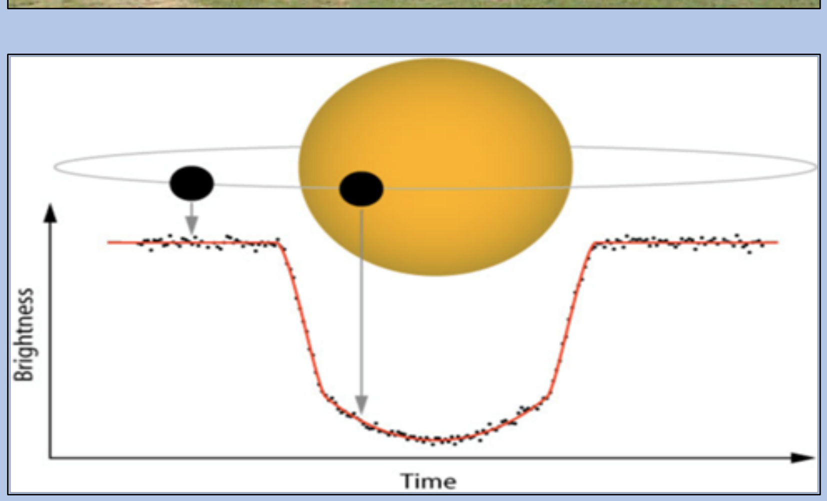
What Is An Exoplanet?

Exoplanets are just planets orbiting other stars. How do we know planets in other parts of the galaxy exist? See the bottom image below!



Top image: A model of **James Webb Space Telescope (JWST)**, the newest exoplanet telescope that will be launched in 2021.

Bottom Image: A model of how we detect exoplanets. When an exoplanet passes in front of a star, or transits, it blocks some of its light, causing a periodic dip in the star's light. On the reverse side, we get infrared light from the planet. From these changes in the star's light curve and other methods, we infer the existence of a planet. We can confirm this through atmospheric retrievals.

Choosing Target Planets

Right now, we know of thousands of planets. If current estimates are true, there should be billions in our galaxy. So where should we start in choosing a target planet?

Several factors go into choosing targets to research. For a proposal such as this, we want to select planets that aren't relatively easy to observe. These already have a great amount of good data. But we also need a planet with enough data to show an improvement. This puts us in terms of a **Hot Neptune** (Neptune-sized planet with cloud-top temperatures near and above 980°F).

The other interesting thing about Neptune-like planets is that they contain large amounts of *water and methane* compared to Jovians. These are very prevalent in life as we know it and would be good to learn how to track!

Research Question

How can we produce atmospheric data on planets in other solar systems, and how can we do it better than it has been done already? With this type of information, what can we hope to learn?

Research Context

Why would we want to research the atmospheres of distant *exoplanets?*

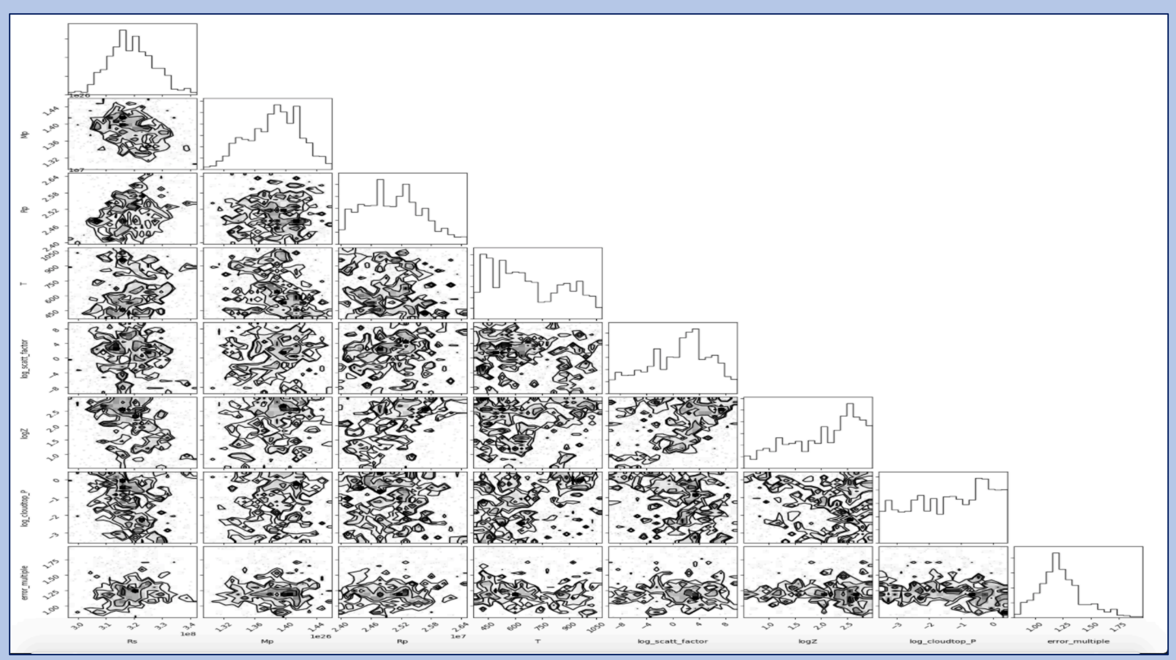
Knowing the composition of exoplanet atmospheres, we can better study stellar system formation and how different types of planets can amass matter and shape the evolution of their stellar system.

Furthermore, if we apply these techniques to terrestrial (rocky) worlds, we can potentially look for chemical signs of life in these worlds. In order to continue with this research, *JWST* is a new space-based telescope launching to perform better research. We will submit a proposal for observation time on this telescope by July 1st.

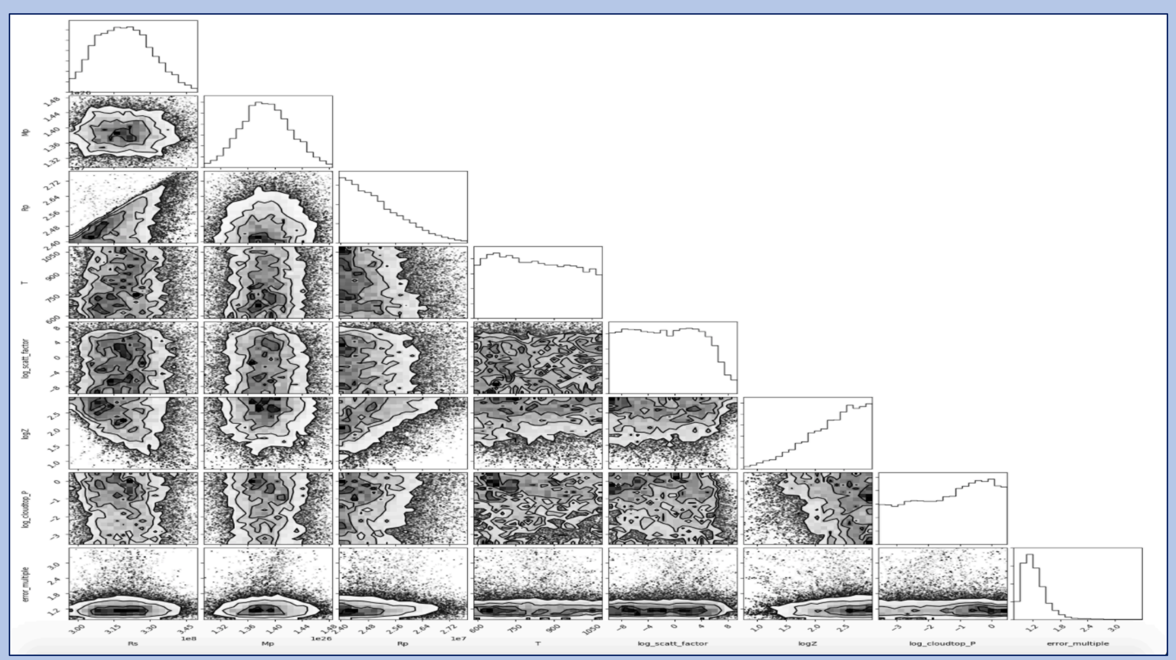
Methodology

To ensure the best possible proposal, we have divided our research this year into a few steps:

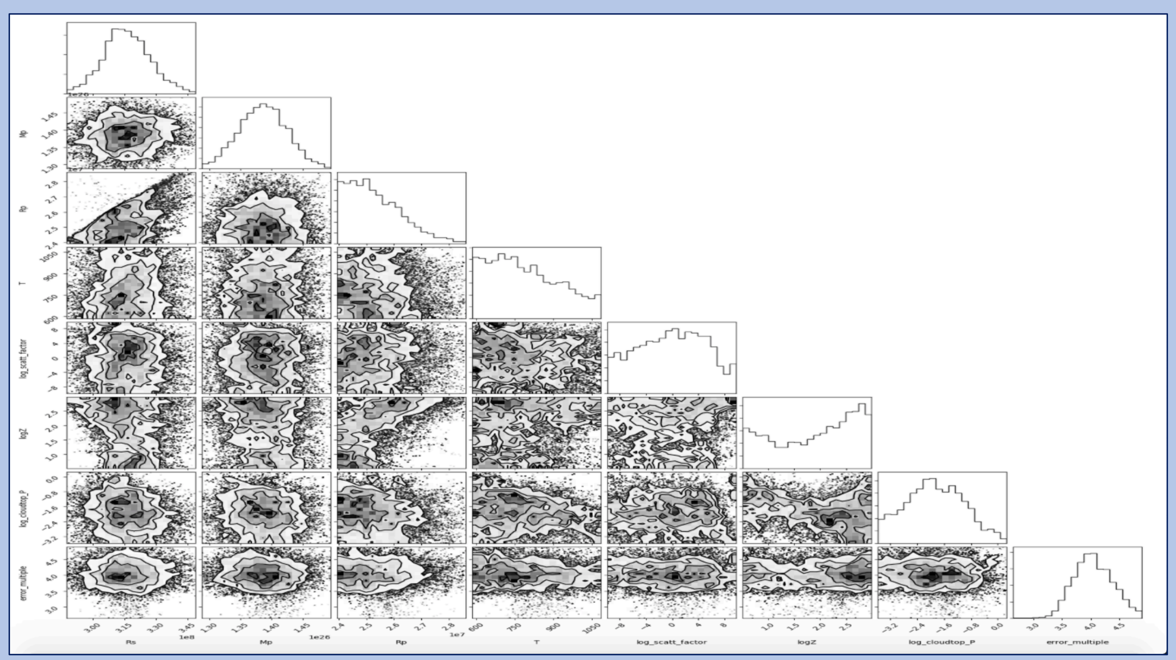
1. Big Picture: we want to show clear scientific interest in our target planets and that simulations of JWST data give superior results to existing data
2. If we already know key information about a planet and its host star, and if observations have already been made, we can:
3. Run already existing programs with these data and retrieve what atmospheric contribution would give us the data we found.
4. Now, JWST has released a program to simulate data from their soon-to-be launched telescope. We simulate data.
5. Add this data to our already-running program and demonstrate how more-refined our retrieval is
6. Submit the proposal!



Corner plot of the data showing little convergence and multi-values.



Corner plot of actual data showing mostly good convergence and comparatively higher resolution. Notice some corners don't converge to a single value, though.



Corner plot of simulated data and actual data. Convergence is better than previous two plots even if resolution isn't as great as data alone. These plots show some of the enhancements JWST could make.

Limitations

As is always the case with research, things aren't perfect. One of the biggest limitations we had was finding data for target exoplanets. There isn't too much research on any one planet, so our options were limited. This is why we're proposing for more research.

References

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