Using Transmission Spectra from JWST to Examine Biosignatures on Europa

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1 Introduction

Through recent developments in exoplanet detection, over 3000 planets have been discovered outside of the solar system with even more exoplanet candidates being studied further. With this, it has become possible to determine whether planets are rocky or contain water, so the question of habitability for life has become a big topic to research. The search for life outside of Earth has led scientists to develop different techniques to examine other worlds since many of them are too far away to physically explore. One technique often used is spectroscopy, which is used on exoplanetary atmospheres to determine the presence of different chemicals. This has helped astronomers determine the composition of many exoplanets, and with new instruments like the James Webb Space Telescope (JWST) and Europa Clipper, we will have an even more accurate way to observe spectra.

2 Proposal

One of the closest areas to Earth that has a strong possibility of life is one of Jupiter's moons, Europa. Europa is an ideal place to look for life because it is covered in ice and its believed to have oceans of liquid water underneath based on measurements by the Galileo probe. Europa has also been observed to have geysers on its surface that expel plumes of water as recently supported by images from Hubble. Since we are unable to see what is underneath the ice on the surface, we can use future missions to obtain transmission spectra from these plumes to look for biosignatures. To find these biosignatures, I propose we look at the biology of extremophiles that might be present within these geysers.

3 Purpose

Extremophiles on Earth are found in extreme environments where no other organisms can survive. Examples of extremophiles found on Earth include thermoacidophiles that survive in hot and acidic environments, psychrophiles that survive in cold environments, and lithoautotrophs that gain energy from minerals (Martin, A., / McMinn, A. 2018.) Extremophiles with similar characteristics have a high chance of being found in Europa's geysers because of its similar environments. The thermophiles can be studied here on Earth in Yellowstone's geysers as well. By looking at the byproducts of these extremophiles on Earth and examining the chemical makeup of geysers that contain life on Earth, we can then look for similar biosignatures and patterns on Europa's geysers. Byproducts created by extremophiles on Earth include NO3 from the nitrate reduction pathway, DMS, and isporene (Claudi, R. 2017). So these are what we should look for in Europa's plumes too. If we create models using what we understand about extremophiles and life in geysers here on Earth, we can compare these results to the spectra results we will get from future missions. However, although we do know that there are byproducts of extremophiles on Earth, we are still unsure about using this as a guaranteed sign of life because some of these chemicals can be found as the byproduct of inorganic processes too. Despite this, obtaining data would still be useful to organize our understanding of these geyser plumes.

4 Feasability

The feasibility of this plan depends on the access to missions such as the James Webb Space Telescope, ESA's Jupiter Icy Moon Explorer, and the Europa Clipper mission, so we will be receiving a lot of data soon that we will be able to analyze. The JWST plans on near-infrared spectrographs and id-infrared instruments to spectroscopically analyze the plumes' compositions. The fly by missions will hopefully be able to fly through the plumes to collect samples to analyze.

References

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