UNDERSTANDING THE CHEMICAL VARIATIONS MEASURED IN HOST STARS. N. R. Hinkel,[1] M. D. Pagano[1], P.A. Young[1], and Steven J. Desch[1] [1]School of Earth and Space Exploration, Arizona State University, PO Box 876004, Tempe, AZ 85287 (natalie.hinkel@gmail.com)

Introduction: The formation of stars and their planets are closely related: planets are made up of dust and material from within the stellar nebula. Because they share a common birthplace, it follows that the composition of the planet(s) are correlated to the star. To date, the only confirmed chemical connection between a host star and an orbiting planet involves high stellar iron content ([Fe/H]) and the presence of a giant, gaseous planet.

There are a wide variety of elements that have a direct and profound impact on the evolution of a planet. For example, the presence of short-lived radionuclides, such as ^{26}Al and ^{60}Fe, affect the temperature of the planet and surface water content. Long-lived radionuclides, like ^{40}K and $^{235,\,238}$U, slowly heat terrestrial mantles, encouraging biogeochemical cycles. And elements such as C, N, S, P, and Fe are the basis for life on Earth. If we are to understand the chemical composition of nearby exoplanets, specifically as we try to decipher what makes a planet habitable, then we must first understand the chemical composition of the host star and how it effects the formation and evolution of the planet(s).

Composition of the Host Star: There are currently a wide variety of techniques used to measure element abundances within stars. Some of them utilize spectral fitting while others measure the equivalent widths (EW) of spectral features and determine the abundance through the curve-of-growth method. Different groups measure different lines when analyzing the same elements, in addition to the variety of stellar atmospheric models that are available. There are many more deviations in the methods used to determine stellar abundances, however, the main result has been the introduction of systematic and stochastic discrepancies between datasets, as was noted in Hinkel et al. (2014).

To better understand the implications of multiple techniques on the abundance measurements, we led a collaboration with multiple groups (ASU, Bordeaux, Carnegie, and Porto) who analyzed the same high-resolution (R ~ 50,000) spectra using their own techniques and variations thereupon [2, 3]. We conducted a four-pronged investigation, where each group analyzed the spectra using 1) their own autonomous technique, 2) the same standardized parameters, 3) the same line-list, and finally 4) using both standardized parameters and line-list. We will discuss new results that have arisen as we've prepared for publication. Overall, because of the interdependencies inherent in many of the techniques, we find that the most viable solution may be to share and distribute EW determinations on a line-by-line basis, in addition to relying on benchmark stars for consistency.

Planet-Star Connection: While the variations in abundance measurements between groups is certainly cause for concern, we have taken steps to homogenize abundance datasets found in literature by compiling the Hypatia Catalog [1]. Hypatia contains abundances for +3000 stars within 150pc covering ~50 different elements and element species. The statistical significance from Hypatia allows for an unbiased and comprehensive understanding of star composition.

Of the total stars within Hypatia, ~220 of them are exoplanet host stars. In addition to the planet-iron correlation, we will discuss the trends seen for other elements that have specific bio-essential implications. We will also look at the variations seen in the host compositions when the planets are either terrestrial, giant, or a combination of the two (in multi-planet systems). It is by understanding the compositional differences between stars that host planets and those that do not, that we may better understand planet formation and the building blocks for habitable planets.

Conclusion: The connection between planetary structure and element abundances within the host star is important, yet not well understood. Therefore, it is important to explore the relationship between the planet and star with respect to bioessential elements, different types of planets, and a variety of system geometries. We believe that by better understanding both the abundance measuring techniques and the composition of the bodies in planetary systems, we may begin to answer fundamental questions regarding the formation and evolution of planetary systems.

References:

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