The Diversity of Chemical Composition: The Impact of Stellar Abundances on the Evolution of Stars and Habitable Zones

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ABSTRACT: I have investigated how stars of different mass and composition evolve, and how stellar evolution impacts the location of the habitable zone (HZ) around a star. Current research into habitability of exoplanets focuses mostly on the concept of a "classical" HZ, the range of distances from a star over which liquid water could exist on a planet's surface. This is determined by the host star's luminosity and spectral characteristics; in order to gauge the habitability potential of a given system, both the evolutionary history and the detailed chemical characterization of the host star must be considered. With the ever-accelerating discovery of new exoplanets, it is imperative to develop a better understanding of what factors play a role in creating "habitable" conditions of a planet. I will discuss how stellar evolution is integral to how we define the HZ, and how this work will apply to the search for Earth-like planets in the future. I developed a catalog of stellar evolution models for Sun-like stars with variable compositions; masses range from 0.1-1.2 Msol (spectral types M4-F4) at scaled metallicities (Z) of 0.1-1.5 Zsol, and O/Fe, C/Fe, and Mg/Fe values of 0.44-2.28, 0.58-1.72, and 0.54-1.84, respectively. I use a spread in abundance values based on observations of variability in nearby stars. It is important to understand how specific elements, not just total Z, impacts stellar lifetime. Time-dependent HZ boundaries are calculated for each track. I have also created a grid of M-dwarfs, and I am currently working to estimate stellar activity vs. age for each model. This catalog is meant to characterize potential host stars of interest. I will discuss how to use existing observational data (i.e. the Hypatia Catalog) for a more robust comparison to my grid of theoretical models, and a new statistical analysis of the catalog to further refine the definition of "continuous" habitability. This work is an important step to assess whether a planet discovered in the HZ of its star has had sufficient time to develop a biosphere capable of producing detectable biosignatures. The catalog is designed for use by the astrobiology and exoplanet communities to characterize any real planetary systems of interest.