Geophysical Research Abstracts
Vol. 18, EGU2016-9657, 2016
EGU General Assembly 2016

Host Star C/O: Effects on Habitability

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We explore the effects of differences in C/O values for exoplanet host stars on the composition of planetesimals formed beyond the snow line in these systems. Since the value of C/O in a planet forming nebula has a strong effect on amount of oxygen available for water ice in an oxidizing nebula, exoplanet systems for host stars with C/O greater than the solar value may have planetesimals with very little or no water ice. The volatile ice content of planetesimals in these systems varies significantly with C/O, controlled primarily by the availability of O for H_2O ice condensation (Gaidos, Icarus 145, 637, 2000.). Systems with C/O less than the solar value (C/O = 0.55) should have very water ice rich planetesimals, while water ice mass fraction decreases very rapidly with increasing C/O until only ices of CO and CO_2 are left in significant proportions (Johnson et al., Astrophys. J. 757(2), 192, 2012). A number of surveys of stellar abundances, including C and O, are now available for planet host stars, solar type stars and stars supplying mass to the interstellar medium (e.g. AGB stars)(Bond et al., Astrophys. J. 715(2), 1050, 2010; Petigura and Marcy, Journal of Astrophysics 735, 2011; Wylie de-Boer and Cotrell, Astrophys. J. 692, 522, 2009). These studies report a range of C/O from about 0.3 to 1.4 with a peak in the distribution for values at or somewhat higher than the solar value. The reduction and analysis of the spectral data is complex and difficult due to low signal to noise and line blending and the accuracy of the highest reported C/O values in particular have been called into question (e.g. Fortney, Astrophys. J. 747, L27, 2012). However, as noted, water ice fractions decrease very rapidly for C/O values above solar. A study of expected planetesimal compositions for 457 stars in the Petigura and Marcy survey shows a large number of systems with only modestly super-solar C/O values from 0.6-0.7 which would be very water ice poor (<10% by mass) as well as many sub-solar C/O (0.3-0.4) systems which might have ice fractions of 40-60% (Pekmezci, Dottorato di Ricerca in Astronomia, Università Degli Studi di Roma "Tor Vergata", 2014). Thus we argue that host star C/O abundance is an important ingredient in assessing a key factor in habitability of exoplanet systems – the availability of abundant ice beyond the ice line. Efforts should continue to improve and further validate techniques for measuring this important metric.

TVJ acknowledges government support at JPL/Caltech, under a contract with NASA. JIL was supported by the JWST Project through NASA. O.M. acknowledges support from CNES.