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C/O Ratios in Exoplanetary Atmospheres

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Recent observations are allowing unprecedented constraints on the carbon-to-oxygen (C/O) ratios of giant exoplanetary atmospheres. Elemental abundance ratios, such as the C/O ratio, of planetary atmospheres provide important constraints on planetary interior compositions and formation conditions, and on the chemical and dynamical processes in the atmospheres. In addition, for super-Earths, the potential availability of water and oxygen, and hence the notion of 'habitability', is contingent on the C/O ratio. Typically, an oxygen-rich composition, motivated by the solar nebula C/O of 0.5, is assumed in models of exoplanetary formation, interiors, and atmospheres. However, recent observations of exoplanetary atmospheres are suggesting the possibility of C/O ratios of 1.0 or higher, motivating the new class of Carbon-rich Planets (CRPs). In this talk, we will present observational constraints on atmospheric C/O ratios for an ensemble of transiting exoplanets and discuss their implications on the various aspects of exoplanetary characterization described above. Motivated by these results, we propose a two-dimensional classification scheme for irradiated giant exoplanets in which the incident irradiation and the atmospheric C/O ratio are the two dimensions. We demonstrate that some of the extreme anomalies reported in the literature for hot Jupiter atmospheres can be explained based on this 2-D scheme. An overview of new theoretical avenues and observational efforts underway for chemical characterization of extrasolar planets, from hot Jupiters to super-Earths, will be presented.