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Saturn satellite composition and C/O chemistry of the solar nebula

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The composition of material condensed from a solar composition nebula is highly dependent on the abundance of oxygen, the dominant solid forming element (silicates and water ice), and carbon, roughly half as abundant. The carbon chemistry of the nebula, specifically the partition of gaseous C between CO and CH_4, controls the relative amounts of rock and metal and water ice in the resulting condensates. The mean densities of satellites made from this material reflect the rock, metal and ice abundances, corrected for the effects of pressure and porosity. Recently proposed changes to the solar abundance values for carbon and oxygen have a large effect on the expected density solar composition condensates. We discuss the effects of these changes on the interpretation of new satellite density determinations from the Cassini mission. There are significant differences in the satellite densities, with the bulk of the small and medium sized icy satellite material having too low a density to be consistent with a solar abundance source unless a significant amount of carbon in the local Saturn nebula was incorporated as low-density hydrocarbon solids. Phoebe, an outer, irregular satellite, on the other hand has a much higher proportion of rock and metal in its make-up and is more consistent with an origin in a protoplanetary disk with CO as the major carbon species. A portion of this work was done at the Jet Propulsion Laboratory, Caltech, under a grant from NASA.