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Title: Saturn's formation at the Carbon Dioxide Iceline

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Abstract:
Giant planets of the solar system exhibit supersolar metallicities of volatile elements. It is believed that the heavy element content was acquired from the protoplanetary disk when the planets were formed. However, the source and nature of volatile compounds accreted by giant planets are still under debate. In this work, we use the metallicity and composition of the protosolar nebula (PSN) to infer the origin of the building blocks of Saturn based on currently available measurements of its atmospheric composition and bulk metallicity inferred from models. The metallicity profile is computed from a 1+1D state-of-the-art model that includes radial transport of volatile compounds and phase changes between pure ices and their corresponding vapors. Our model demonstrates that the bulk metallicity of Saturn is more accurately reproduced in the vicinity of the CO_2 iceline. Furthermore, our model calculates the composition of the PSN across varying heliocentric distances and time intervals. Leveraging this data, we offer a spectrum of elemental abundances anticipated within Saturn's atmosphere, including enrichments of noble gases that can be quantified via an *in situ* probe.