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Chemistry of the Outer Solar System: Composition, Clouds, and the Origin and Evolution

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Chemical processes provide important clues to solving big questions of the formation of planets and satellites and the origin of their atmospheres. In the outer planets, these processes determine the composition of the atmosphere, nature and structure of clouds, and act as tracers of mixing, internal processes, and atmospheric stability. In the hydrogen dominated atmospheres of the gas giants (Jupiter and Saturn), chemistry is initiated largely by the absorption of the solar UV radiation by methane and ammonia, whereas the colder temperatures of the icy giants prevent photolysis of ammonia. Nevertheless the presence of HCN on Neptune indicates that molecular nitrogen -- presumably primordial – plays a significant role in the chemistry of Neptune's atmosphere. The chemistry of methane or ammonia does little to explain the colors of the clouds of Jupiter and Saturn. Presumably the brown-orange-yellowish color is the result of a phosphorus or sulfur based chromophore. In this paper we will discuss these and other current issues of the chemical processes as related to the composition, clouds and the origin of atmospheres.