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What Do Saturn and Titan Have in Common? (And, What They Don't)

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Although Saturn and Titan had some of the same original material available for their formation, their evolution took diverse, yet maintaining some similarities. The reducing atmosphere of Saturn dominates the chemistry of this planet. On the other hand, the nitrogen dominated atmosphere of Titan has little hydrogen. Both have methane in their atmospheres, but with a mole fraction that is ten times greater on Titan than Saturn. Despite the above differences, the C-H chemistry proceeds roughly along the same lines on Saturn and Titan, producing a set of complex CxHy molecules that are common to both. The reservoir of nitrogen on both Saturn and Titan is ammonia, except that a fraction of the original ammonia was photochemically converted to nitrogen during Titan's accretionary heating period. Such conversion must occur on Saturn also, but is reversed in the hot, hydrogen-rich deep interior of the planet. The same could be said about methane, whose hydrocarbon products are thermochemically recycled into methane in Saturn's interior. Methane is a key constituent of Titan's atmosphere also, because of its role in heating of the stratosphere and the troposphere of the satellite. Such heating also controls the pressure of nitrogen. Unlike Saturn, neither large quantities of free hydrogen nor high temperatures exist on Titan, thus preventing the hydrocarbon products from recycling methane. Instead, a hydrogeochemical process is likely responsible for recycling methane lost to chemistry on Titan. The NH3-CH4-H2 atmosphere of Saturn is not conducive to the formation of large quantities of nitriles (C-N-H molecules), contrary to Titan where they are relatively abundant and play an important role in maintaining haze layers in the upper atmosphere. In this talk, above similarities and differences will be discussed, with an eye on the models of the formation of Saturn and Titan and the origin of their atmospheres.