

Predicting undiscovered species in Titan's stratosphere with chemical reaction network based on UMIST database

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Titan, the largest moon of Saturn, is the only satellite that has a dense atmosphere in the solar system. It is known that Titan's atmosphere contains a wide variety of chemical species which mainly generated from the dissociation of two main components, molecular nitrogen and methane. Fractional abundances of these species have been studied well by the Voyager and Cassini-Huygens probes. Also, ALMA now starts to detect global distribution of some species in the Titan's atmosphere. In this study, we applied chemical reaction network based on UMIST database, which has been used in the studies of interstellar medium, to calculate the chemical evolution of Titan's upper stratosphere around 200 km from the satellite surface, where most of the observation data of molecular abundances heretofore located. In this chemical network calculation, 375 species are included, which are three times more than previous studies (Wilson et al. 2004 & Loison et al. 2015). We note that the effects of turbulent diffusion and three-body reactions are not included in the calculation. By comparing results of calculations with the observational data, a physical parameter set with moderate FUV flux, effect of cosmic ray and self-shielding of molecular nitrogen and methane is recommended. As a result, 17 nitrogen compounds (e.g. NH₂CN CH₃C₅N HC₇N) are abundant and could be detectable in the future observations of ALMA.

Keywords: Titan's atmosphere, chemical reaction network, ALMA observations