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Formation conditions of Titan

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Satellites are generally believed to form in circumplanetary disks (CPDs): a gas disk containing icy and rocky particles that accumulate to form massive moons over time. The discoveries by the Cassini-Huygens mission have led to a revision of the birth environment of the Saturnian system.

We aim to constrain the formation circumstances of Titan's building blocks by considering the moon's observed characteristics. We use radiation thermo-chemical CPD models and evaluate them on their capacity to reproduce a Titan-like satellite.

To form a moon with Titan's ice-to-rock ratio, we find that the dust-to-gas ratio in the CPD must be in the order of solar nebula values, $O(10^{-2})$. The ice availability upon accretion is otherwise incompatible with Titan's moment of inertia. Our models predict a large NH_3 inventory was available upon Titan's formation, □10-20wt.% of the total ice. This is consistent with the hypothesis that the observed N_2 in Titan is captured as NH_3 and converted by photolysis and shock heating, and is compatible with the possible presence of a conductive layer at 45±15 km as revealed by the Huygens probe.