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On the effective recombination coefficient in Saturn's ionosphere

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The present study combines RPWS/LP and INMS data from Cassini's orbit 292, which reached an altitude of 1685 km at the lowest point, to constrain the effective recombination coefficient α_{300} from measured densities and electron temperatures at a reference electron temperature of 300 K. Assuming photochemical equilibrium at these low altitudes and linking established methods to calculate the electron production rate and the dissociative recombination rate results in a formula to calculate an upper limit for α_{300} . This is then compared against rate constants of individual recombination reactions as measured in the laboratory.

We derive upper limits for α_{300} of $\leq 2.5 \times 10^{-7} \text{ cm}^3 \text{ s}^{-1}$, which suggest that Saturn's ionospheric positive ions are dominated by species with low recombination rate coefficients. An ionosphere dominated by water group ions or complex hydrocarbons, as previously suggested, is incompatible with this result, as these species have recombination rate constants $> 5 \times 10^{-7} \text{ cm}^3 \text{ s}^{-1}$ at an electron temperature of 300 K. The results do not give constraints on the nature of the negative ions.