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Mechanisms for the Production of Fast HI from Dissociation of H_2 on Saturn

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Images of the Saturn system obtained by the Cassini UVIS at a pixel resolution of 0.1 $\times$ 0.1 Saturn radii (R_s) reveal atomic hydrogen in ballistic and escaping trajectories sourced at the top of the thermosphere, primarily in the southern sunlit hemisphere. The main feature in the image is a distinctive H Lyman-α plume structure with FWHM of 0.56 R_s at the exobase sub-solar limb at $\sim$ -13.5° latitude constituting the core of the distributed outward flow of atomic hydrogen from the sunlit hemisphere, with a counterpart on the anti-solar side peaking near the equator above the exobase limb. The structure of the image indicates that part of the out-flowing population is sub-orbital and re-enters the thermosphere in $\sim$ 5 hour time scale. A larger and more broadly distributed component fills the magnetosphere to beyond 45 R_s in the orbital plane and 20 R_s latitudinally above and below the plane in an asymmetric distribution in local time. Molecular hydrogen emission in extreme and far ultraviolet regions collected with the H Lyman-α into the image mosaic reveals a distinctive resonance property correlated with the atomic hydrogen plume and shows a strong deviation of H_2 $X\,^1\Sigma_g^+$ from local thermodynamic equilibrium in the main source region. The inferred approximate globally averaged energy deposition at the top of the thermosphere from the production of the hot atomic hydrogen accounts for the measured atmospheric temperature. Possible processes for the fast atomic hydrogen formation from dissociation of H_2 include the excitation of singlet-*ungerade* states and doubly excited states by photons and electrons, and the excitation of the singlet-*gerade* and triplet states by electrons, and chemical reactions involving the formation and dissociative recombination of H_3^+. Based on the available laboratory measurements and quantum mechanics calculations, the assessment of various mechanisms for $H_2 \rightarrow H$ production, especially those producing H atoms with sufficient energy to escape from Saturn, will be presented.