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First Study of Photochemical Escape from Proxima Centauri b

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As the upper atmospheres of the 'habitable' exoplanets orbiting M-Dwarfs are affected by more extreme environments than what Solar System bodies experience, the observations of such exoplanets raise questions to the mass-loss mechanisms and the sustainability of their atmospheres. For the first time, we examine the loss of neutral atmosphere from Proxima Centauri b (PCb) via photochemical mechanisms and formation processes of resulting exoplanetary hot atomic coronae or exospheres.

The study is conducted by utilizing our integrated model framework, which couples our 3D Adaptive Mesh Particle Simulator (AMPS) for planetary exospheres and a 3D multi-species magnetohydrodynamic (MHD) model originally developed for Venus and Mars. The coupling of the two models is achieved in one-way, such that the AMPS code incorporates pre-simulated results by the MHD model as inputs for exosphere simulation. The MHD model describes the ionosphere of the planet self-consistently based on the neutral atmosphere adopted for PCb. All simulations in this study assume a Venus-like condition for the ionosphere and thermosphere of PCb, which is also based on an assumption of the absence of an intrinsic dipole magnetic field. As most of the relevant planetary parameters of PCb are unknown, this study provides one possible interpretation of the atmospheric loss process of PCb as well as other exoplanets similar to PCb, which reside in the Habitable Zones (HZs) of M-Dwarfs, to help our understanding of their habitability.