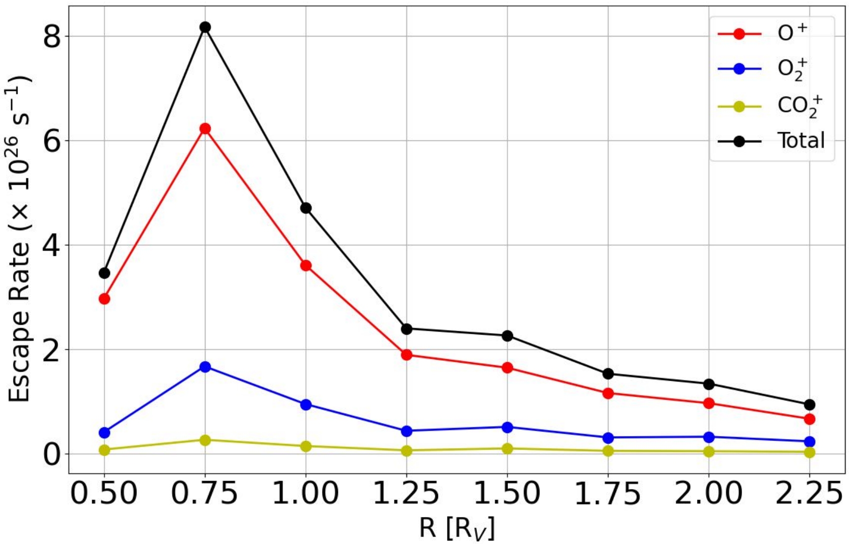
Role of Planetary Radius on Atmospheric Escape of Rocky Exoplanets

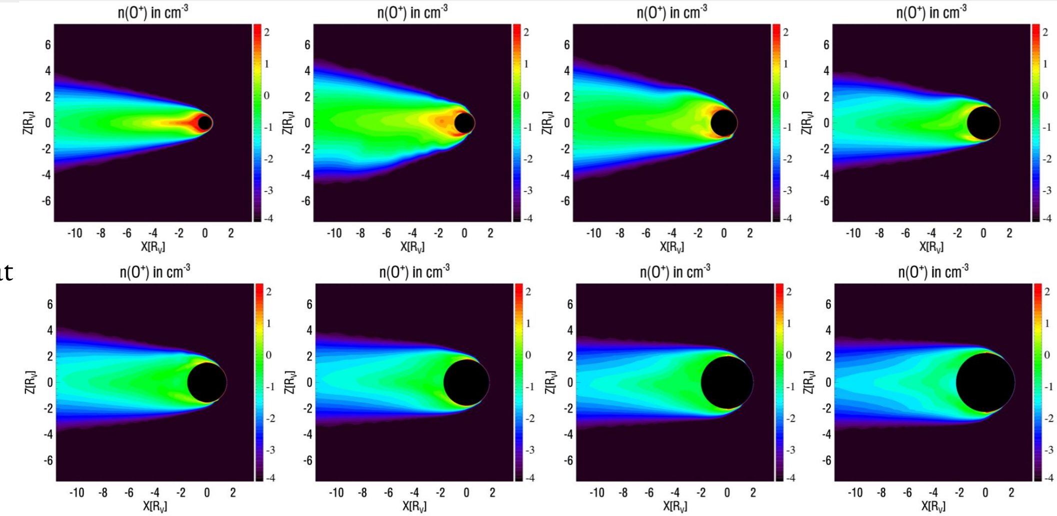
Laura Chin[1], Chuanfei Dong[1], and Manasvi Lingam[2,3]

[1] Department of Astronomy, Boston University, Boston, MA 02215, USA [2] Department of Aerospace, Physics and Space Sciences, Florida Institute of Technology, Melbourne, FL 32901, USA [3] Department of Physics, The University of Texas at Austin, Austin, TX 78712, USA

- Observational and numerical findings indicate that close-in rocky exoplanets **may not possess a thick atmosphere**.
- Using the BATS-R-US MS-MHD code, we investigate stellar wind-mediated, non-thermal atmospheric ion erosion as a mechanism for atmospheric loss for unmagnetized rocky worlds.
- Under the young sun conditions (analogous to M-dwarf), we discover a **non-monotonic trend** in which the escape rate peaks at a planet ~70% the size of Earth.



Atmospheric ion escape rate as a function of planetary radius *R* in units of Venus radii R_V



Logarithmic scale contour plots of the escaping O+ ion density (units of cm^{-3}) in the meridional plane for eight modeled exoplanets ranging from $0.5R_V$–$2.25R_V$.

We propose the local maximum arises from **competing trends** with planetary radius:

(1) Rising trend:
planetary **cross-sectional area** increases with radius → more stellar wind-planet interaction → higher atmospheric ion loss rates

(2) Declining trend:
planetary **surface gravity** increases with radius → higher **escape velocity** → lower atmospheric ion loss rates

Chin et al. (2024), ApJL | Highlighted on AAS Nova | Laura Chin — lrchin@bu.edu