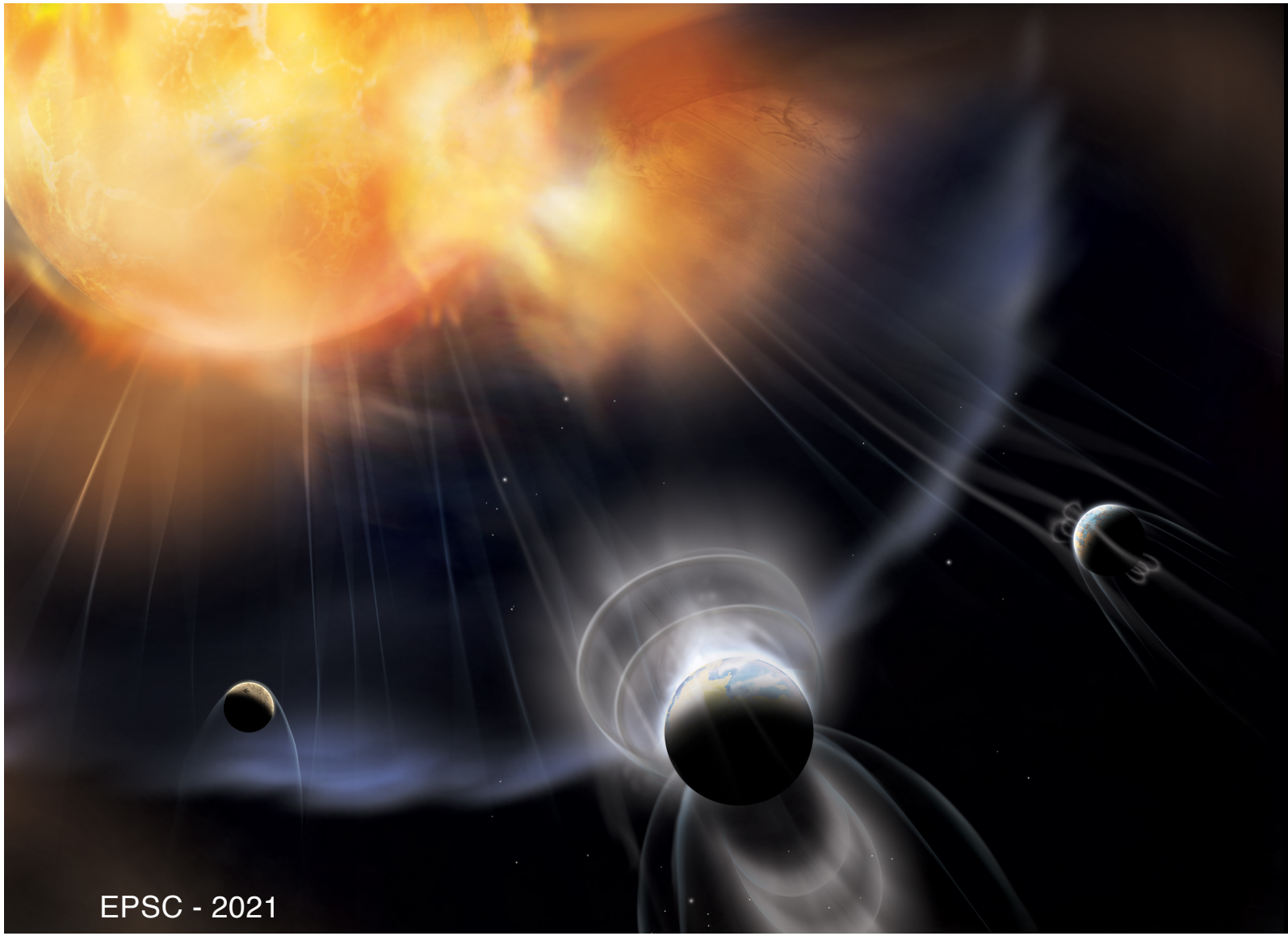
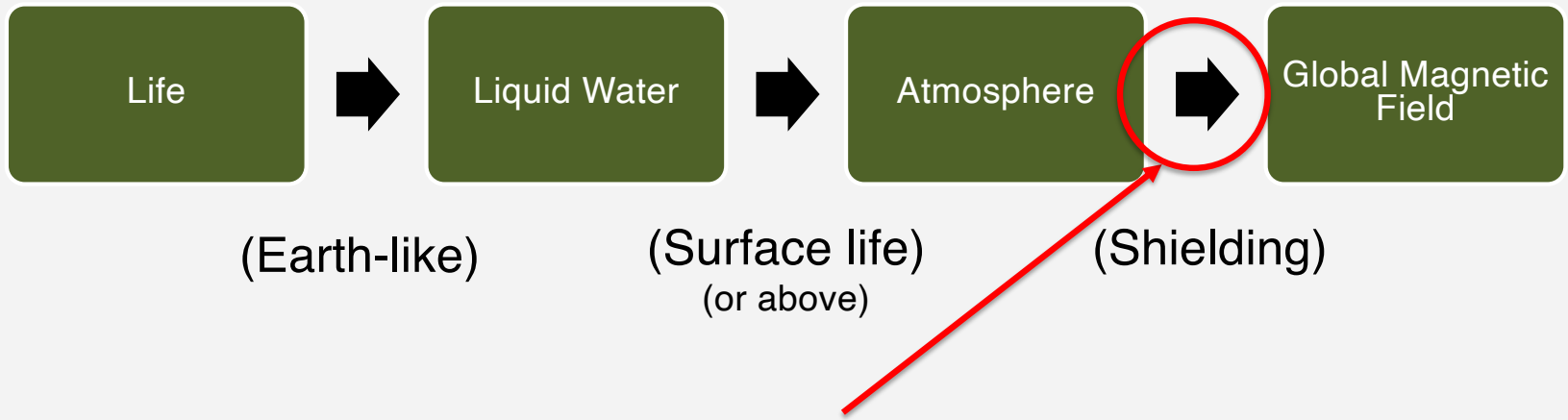


Do Habitable Worlds Require Magnetic Fields?

Dave Brain – U. Colorado
W. Peterson – U. Colorado
O. Cohen – UMass Lowell
T. Cravens – U. Kansas
K. France – U. Colorado
Y. Futaana - IRF
A. Glocer – NASA GSFC
M. Holmström - IRF
L. Kistler - UNH
Y. Ma - UCLA
L. Peticolas – Sonoma State U.
R. Ramstad – U. Colorado
K. Seki – U. Tokyo
R. Strangeway - UCLA
A. Vidotto – U. Leiden

EPSC - 2021

The chain of logic from magnetic fields to habitability involves several assumptions



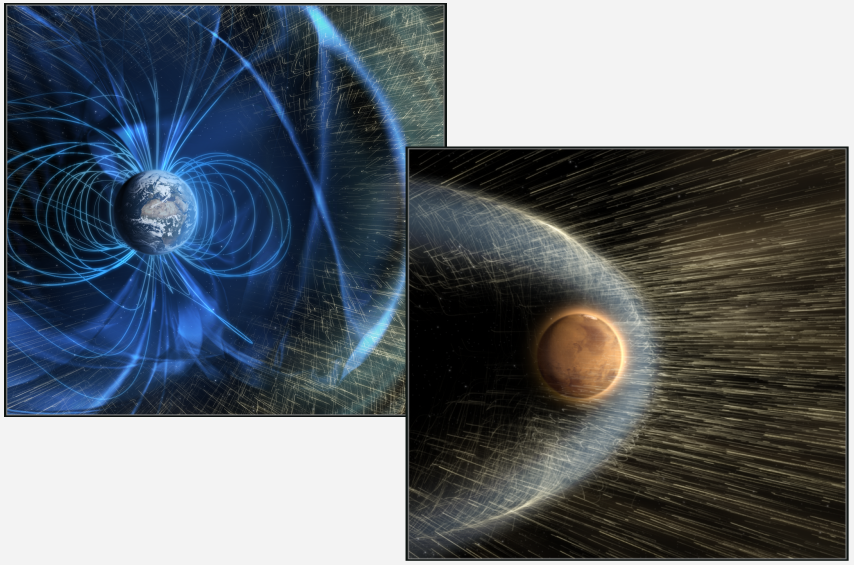
Confirming (or disproving) this link has implications for Earth, planetary, and exoplanetary topics

Atmospheric escape processes can reduce atmospheric pressure, making a planet uninhabitable

Do planetary magnetic fields influence atmospheric escape?

Do magnetic fields protect atmospheres? Arguments on both sides…

Yes!

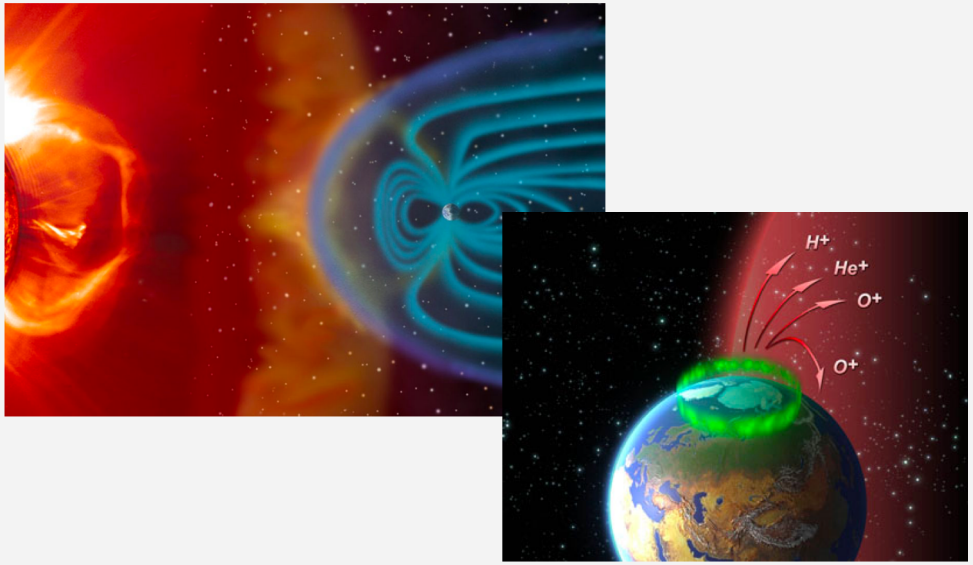


Magnetized planets deflect solar wind charged particles far from the atmosphere

- Solar wind doesn't encounter atmosphere
- Less energy for top of atmosphere

→ Atmosphere can't escape efficiently

No!



Magnetized planets capture solar wind energy

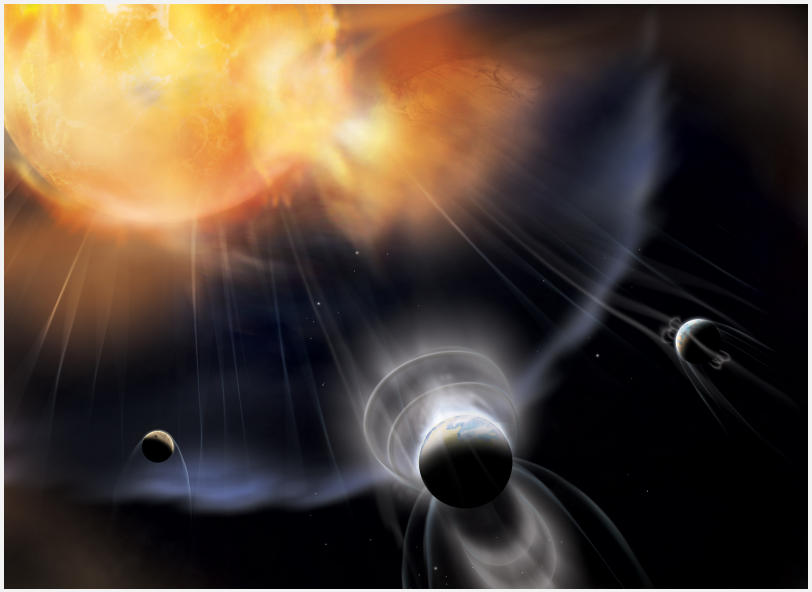
- A magnetic field gives a larger cross-section
- Energy transferred to the atmosphere along magnetic field (e.g. aurora!)
- Escape is efficient, but non-global

Solution: Multi-pronged Team Science approach

MACH

Magnetic fields,
Atmospheres,
and the
Connection to Habitability

https://mach-center.org



Observers, modelers, and theoreticians
who study atmospheric escape
at Earth, solar system planets, and
exoplanets
are working together

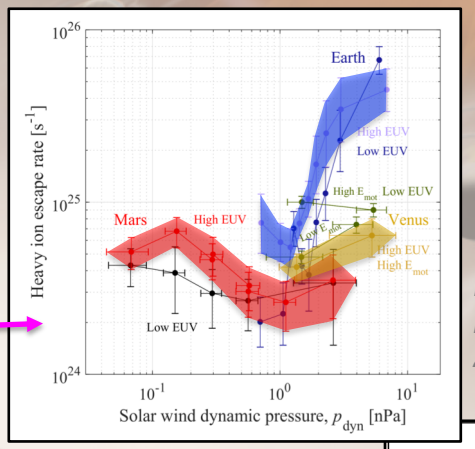
Approach: Six Interrelated Efforts

Construction of methodology for evaluating atmospheric escape

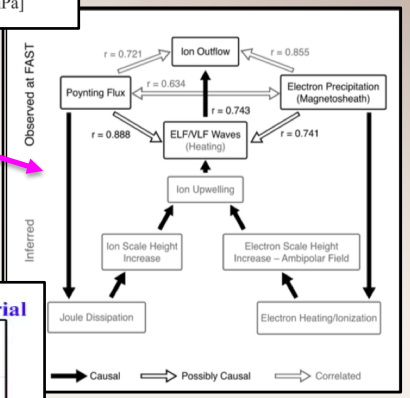
1. Empirical observational escape rate scaling laws
2. Physical understanding of escape and its drivers
3. Development and validation of models for escape
4. Application of models over multi-dimensional parameter space

Application of methodology

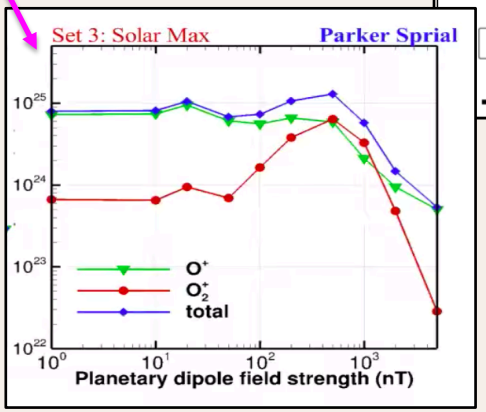
5. Develop a community interface to the framework
6. Application to exoplanets



Ramstad and Barabash, 2020



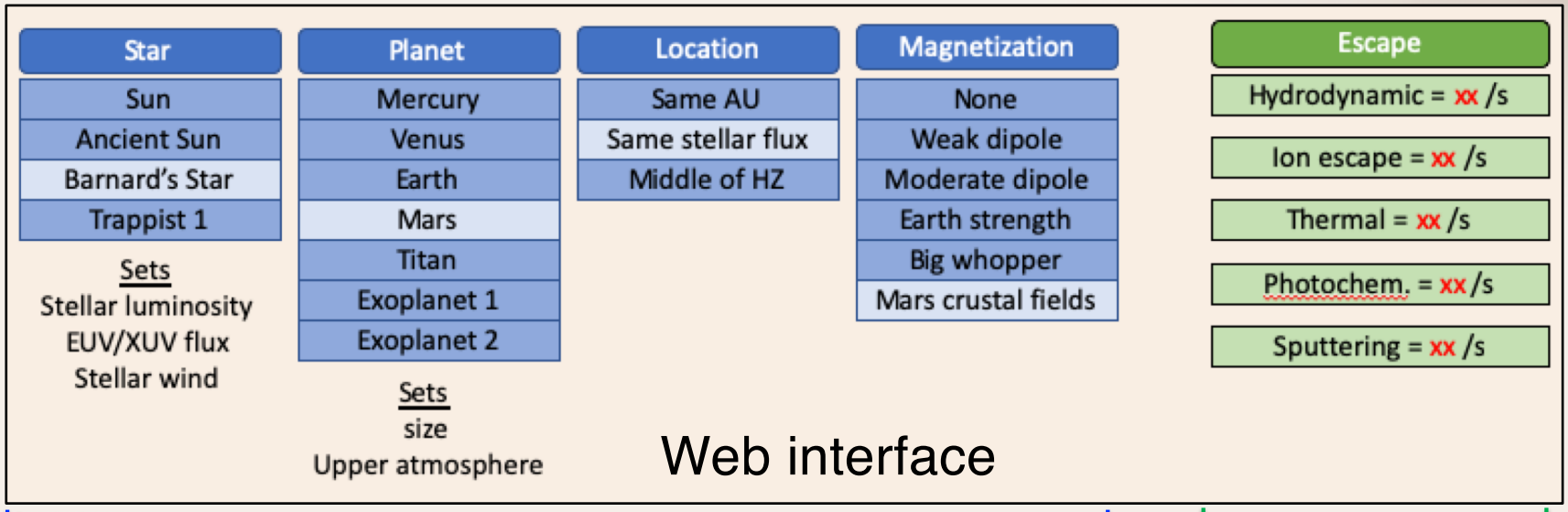
Strangeway et al., 2005



Ma et al., in prep

We'll provide escape rates to the community for a variety of planetary situations

MACH will construct a framework
that enables the evaluation of atmospheric loss
from an arbitrary rocky planet
given information about the planet and its host star



User input

MACH supplied escape rates