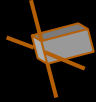




Space Weather of Other Stars Below 15 MHz with the MegaWave Radio Surveyor



Ivey Davis (they/them)

Space weather is a critical element of habitability

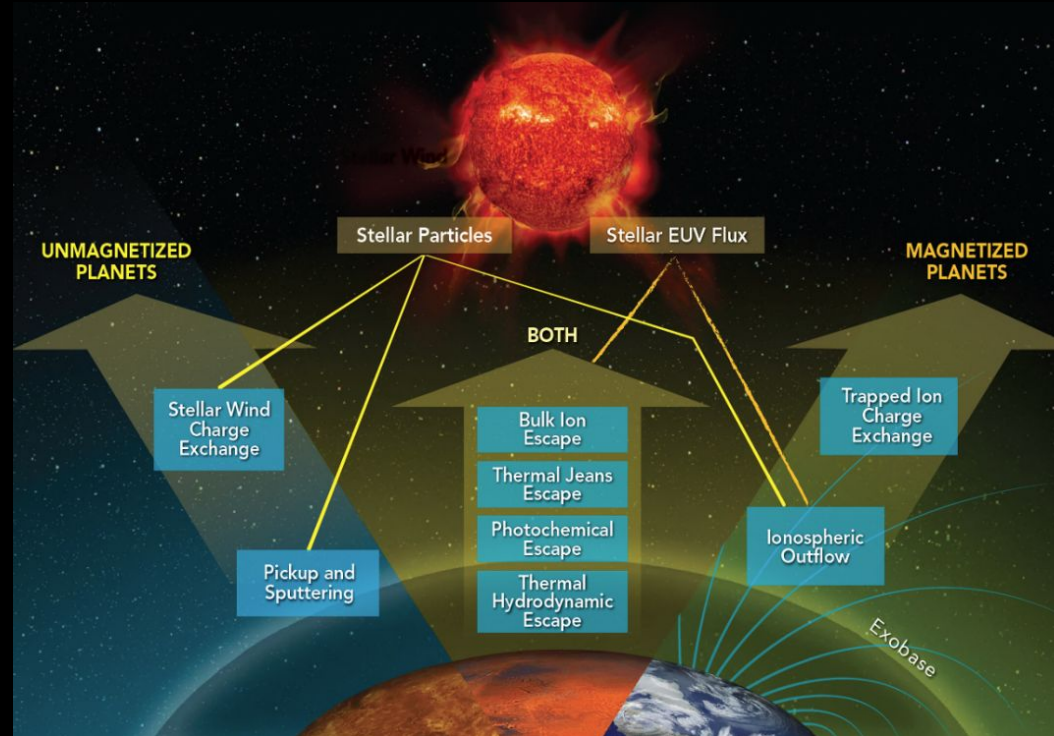
Drives surface and atmospheric chemistry (and loss)

Martian atmosphere (Jakosky+ 2015)

Miyake events (Miyake+ 2012)

Evolves as stars age

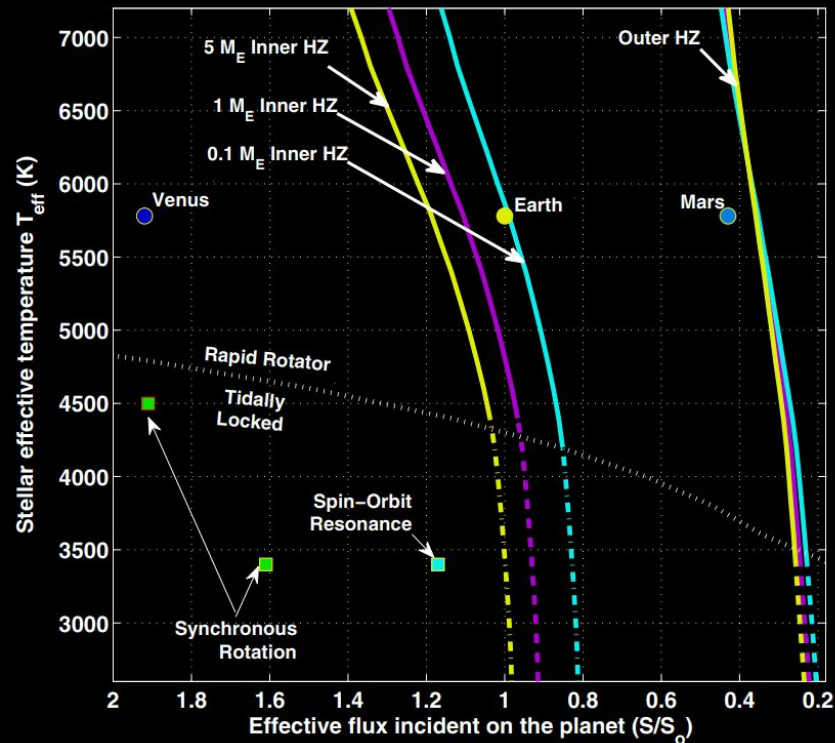
FYSP (Airapetian+ 2016)



EM radiation dominates our understanding of exo-SpWx

It is much easier to measure an
exo-solar photon than an exo-solar
massive particle

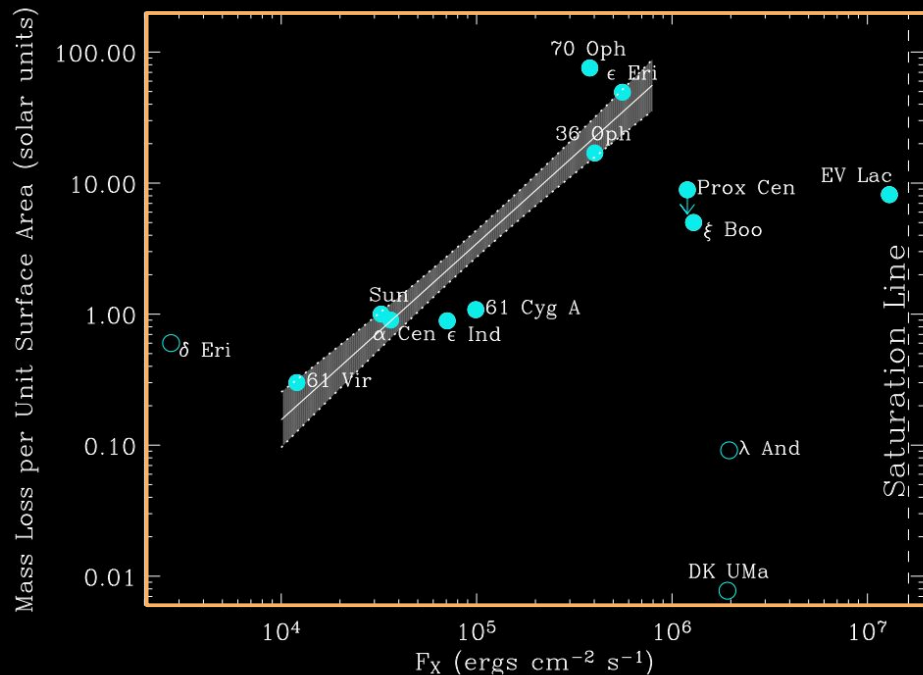
- ★ Habitable zone
- ★ Flare contribution



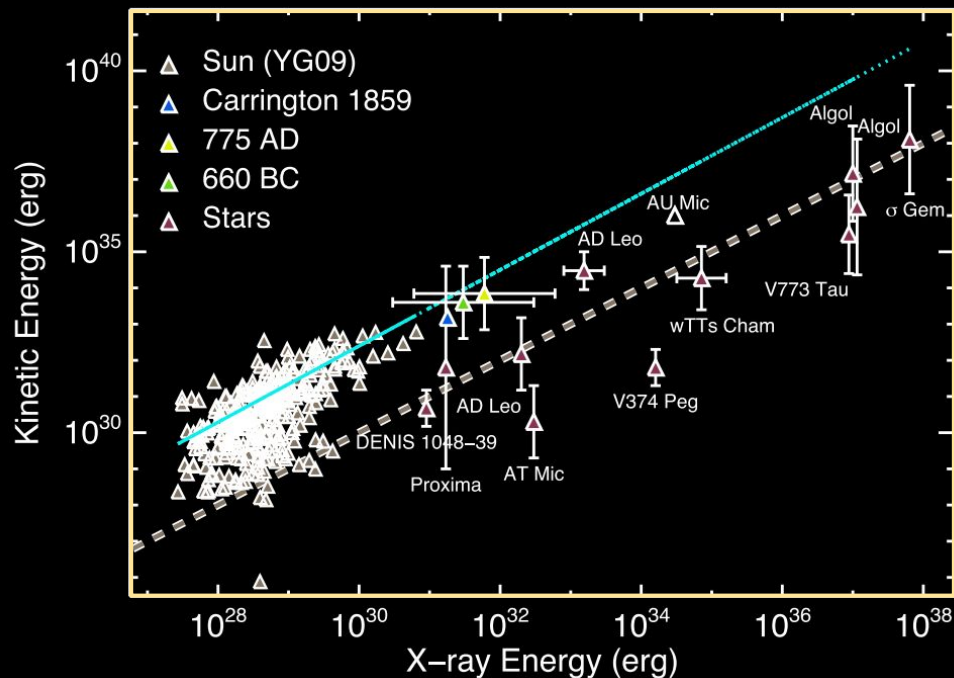
Particle environments are difficult to constrain

Wind constraints from astrospheres (100s AU):

- ★ **Ly- α** (Wood+ 2005, Wood 2018)
- ★ **X-ray** (Kislyakova+ 2024)



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Moschou+ 2019

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CME candidates from chromosphere/low corona ($<1 R_*$)

- ★ **H-alpha doppler spectra** (Namekata+ 2022, 2024, 2025)
- ★ **X-ray, EUV dimmings** (Loyd+ 2022, Strickert 2024)

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Problems:

Small number statistics

Wind measurements rely on solar assumptions

CME candidates indicate motion, not escape

No IPM measurements

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What are the properties and histories of stellar particle environments?

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What are the properties and histories of stellar particle environments?

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Magnetic field evolution

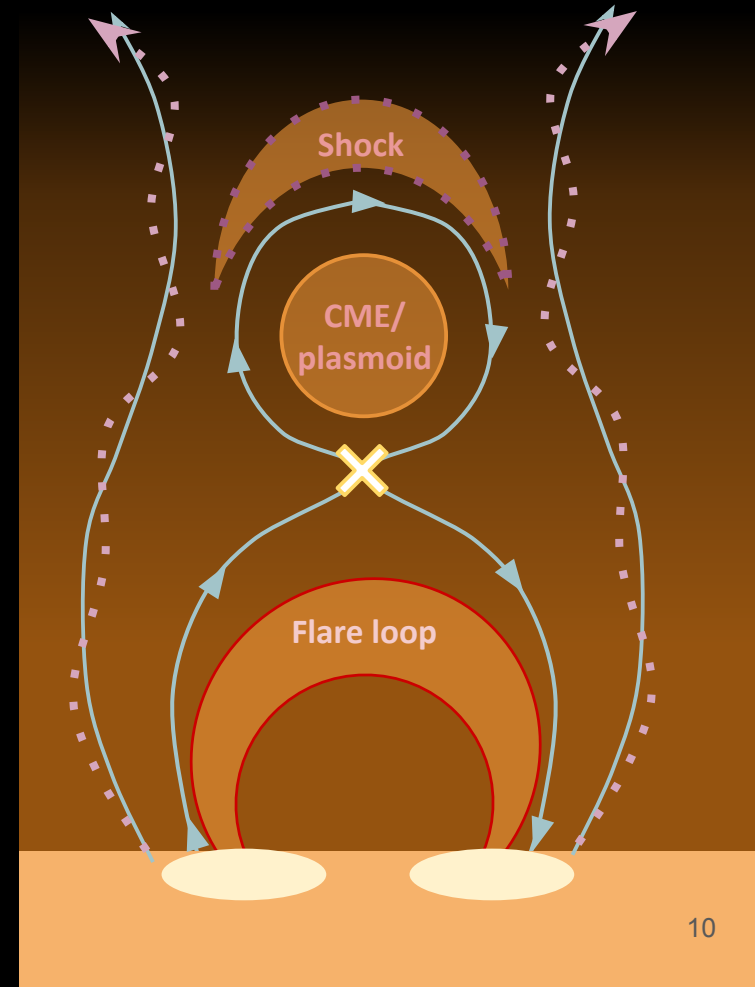
Exoplanet chemistry

Angular momentum

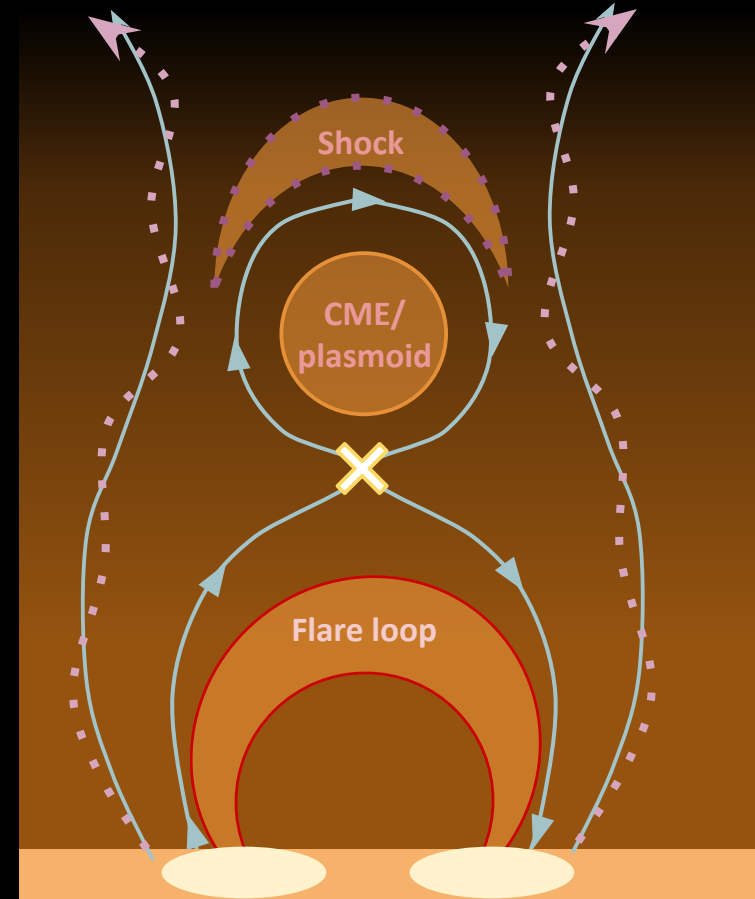
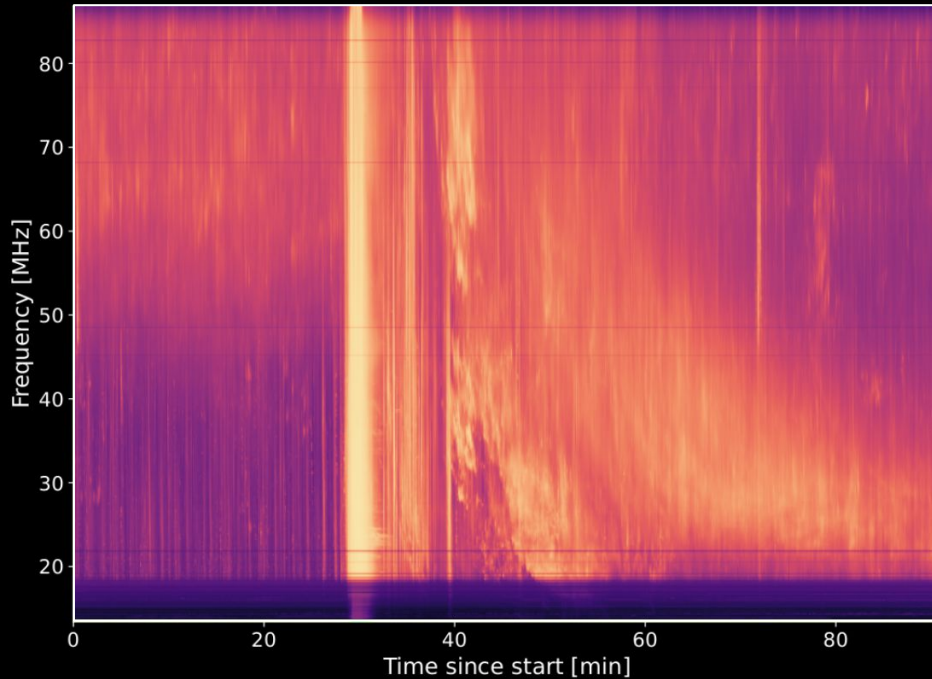
Plasma emission gives information on ambient *and* transient particles

Plasma emission frequency:

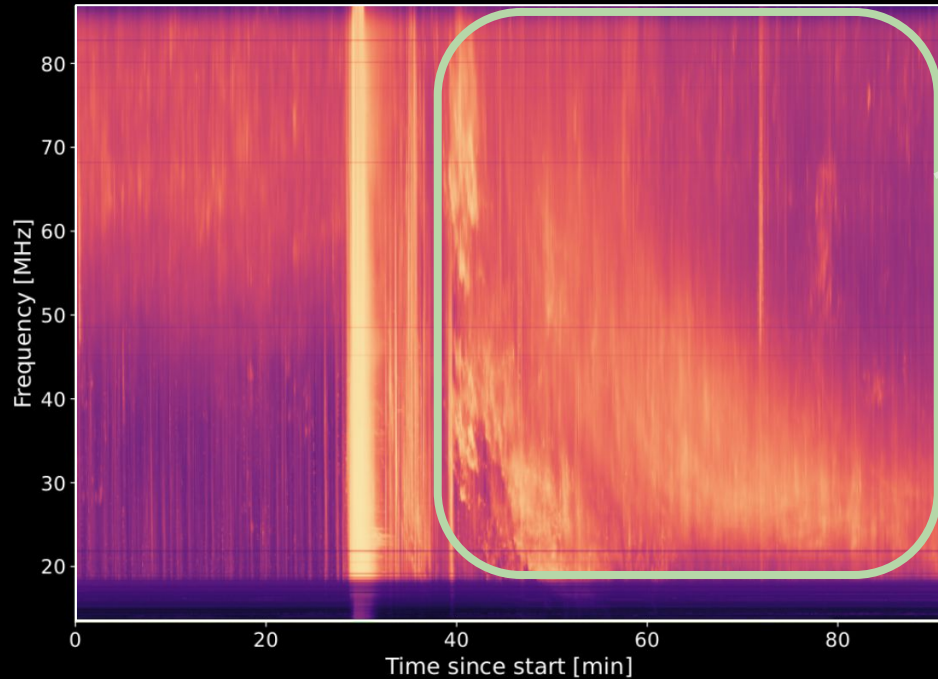
$$\nu_p = 9.8 \text{ kHz } \sqrt{n_{e^-}}$$



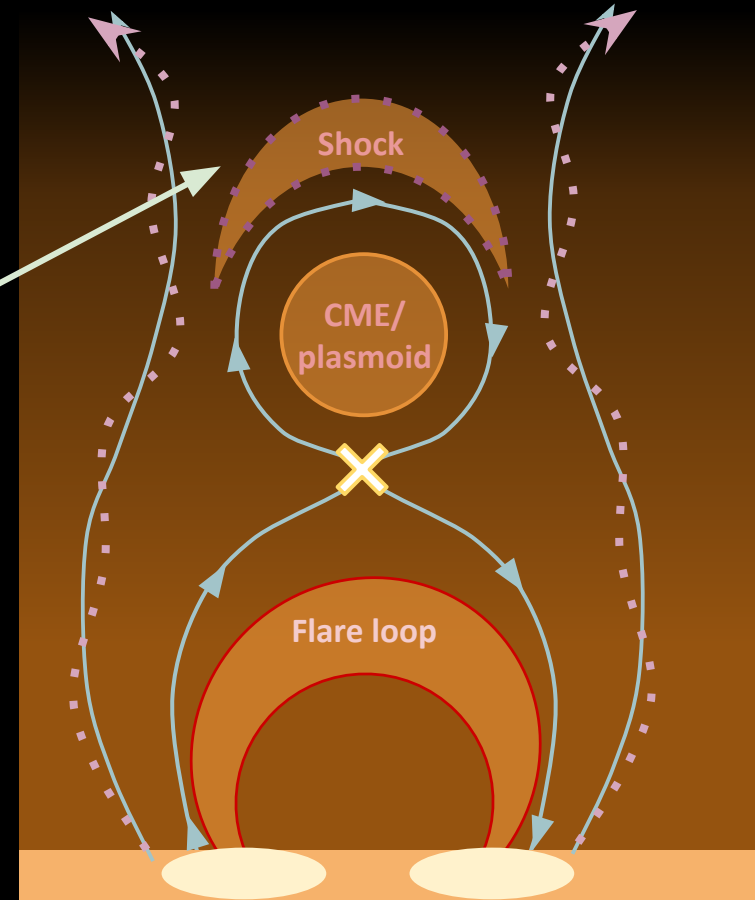
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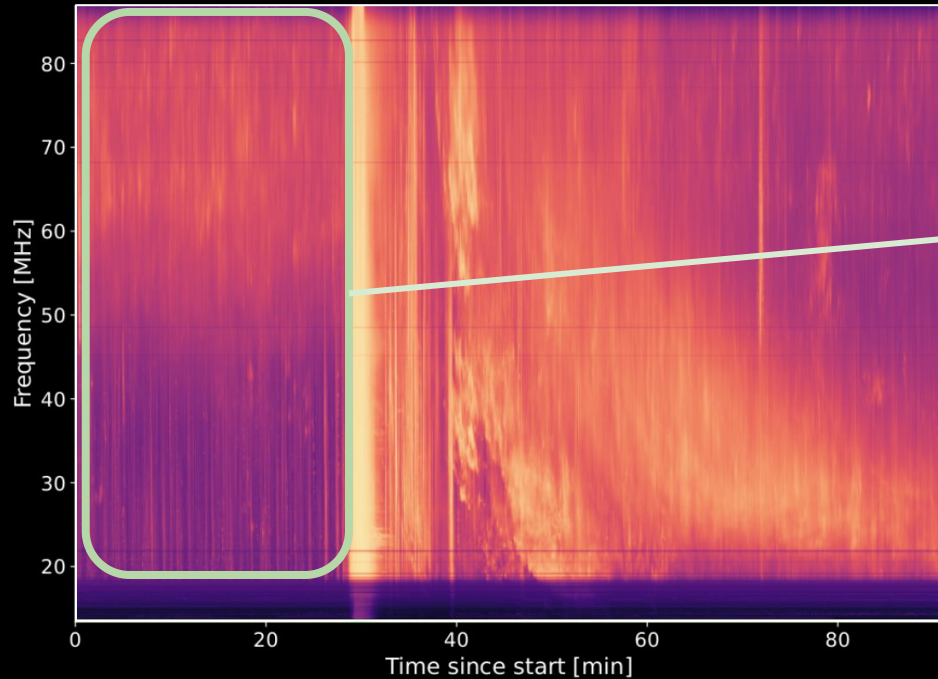
Plasma emission gives information on ambient *and* transient particles



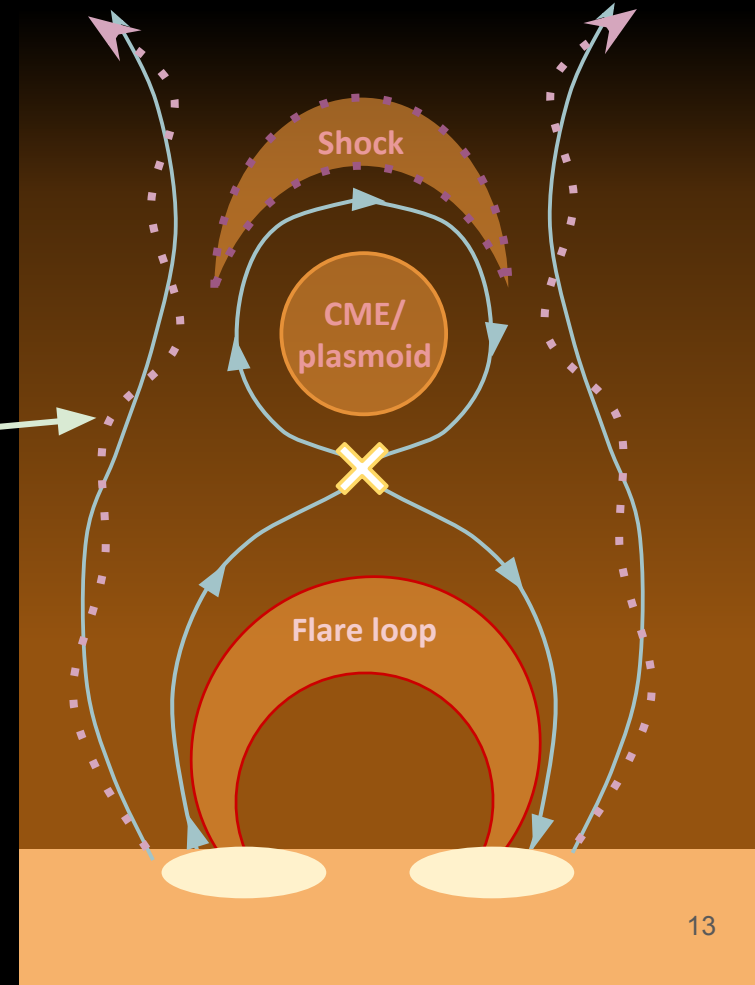
Type II
burst



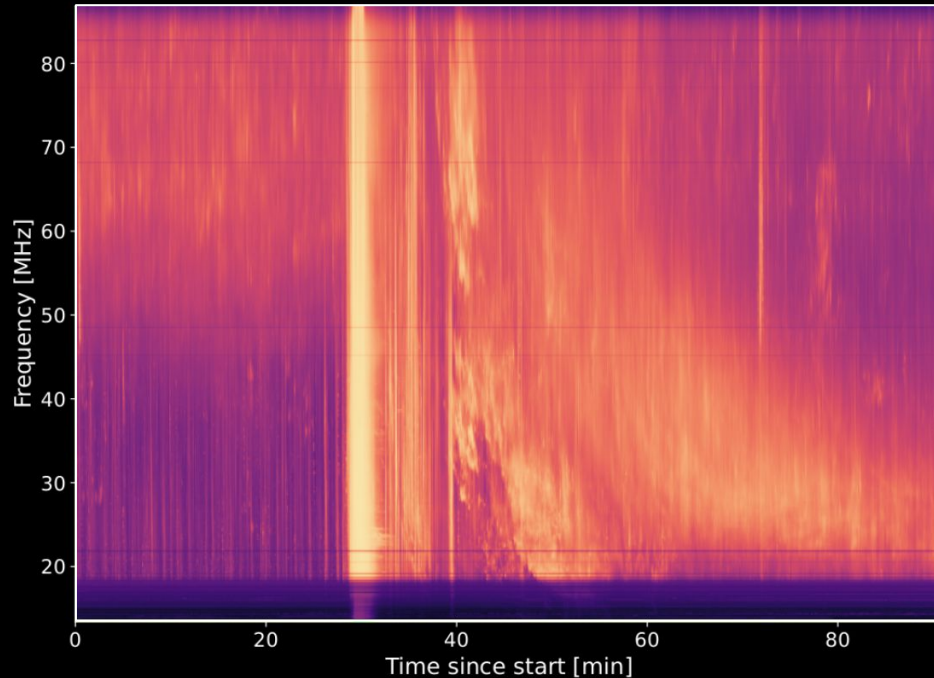
Plasma emission gives information on ambient *and* transient particles



Type III
burst



Plasma emission gives information on ambient *and* transient particles



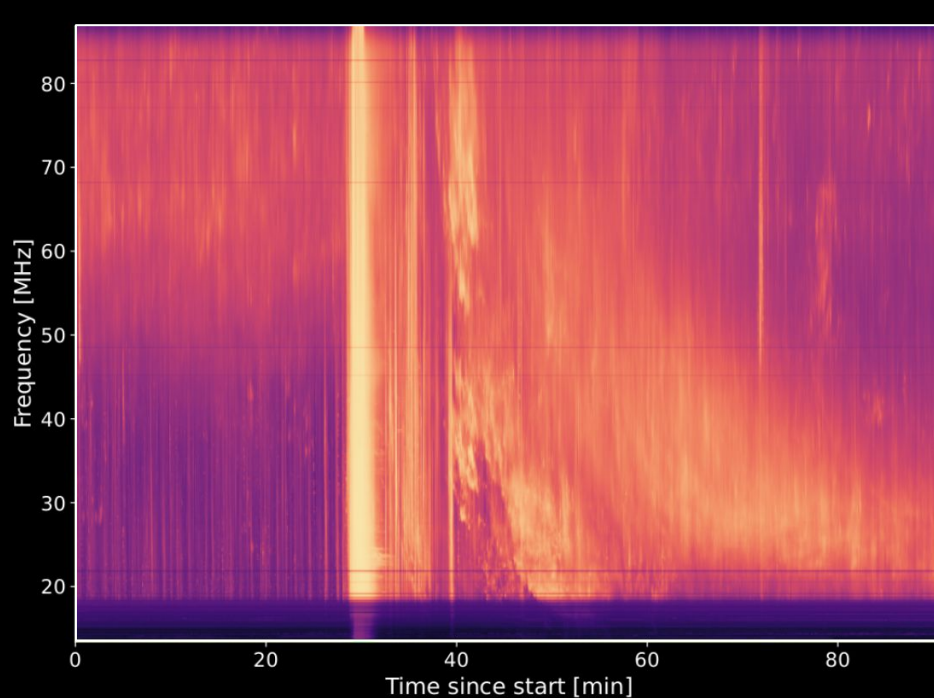
Perks

Frequency explicitly tied to density of *ambient* material

Drift rate provides information on bulk velocity

Type II's direct indicator of shocks

Plasma emission gives information on ambient *and* transient particles



Perks

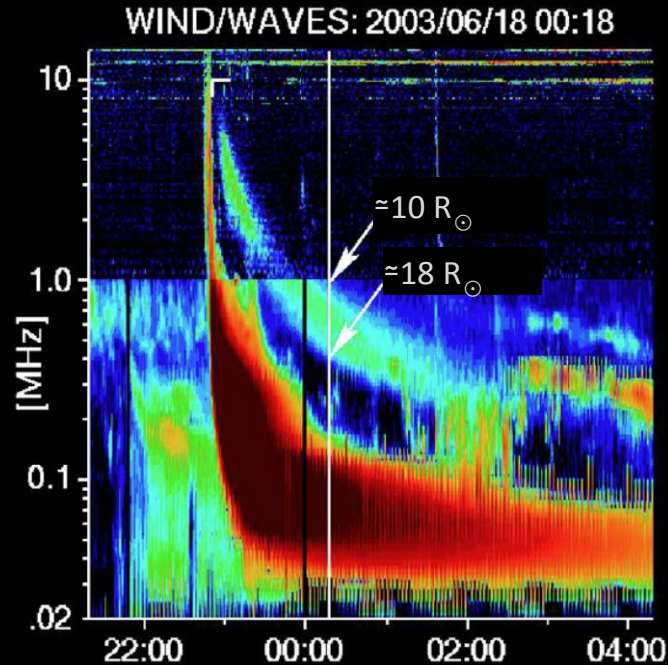
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Sensitive to $d \lesssim 5R_{\odot}$

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Perks

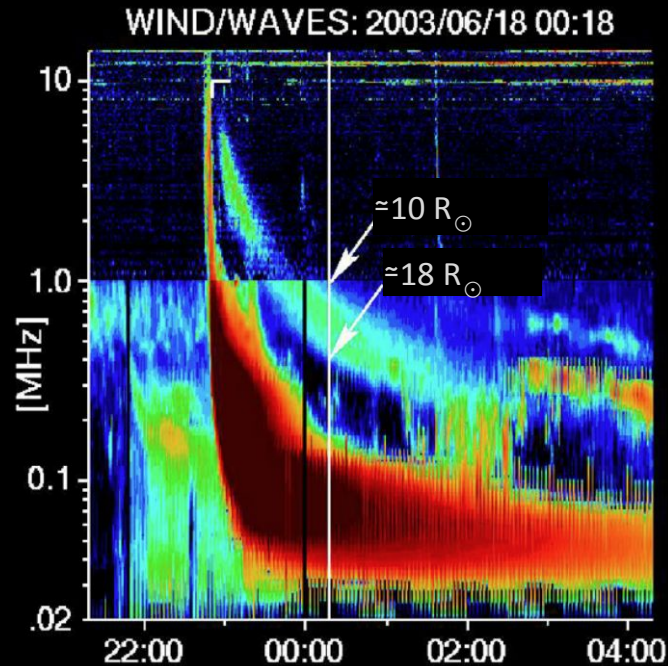
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Adapted from S. Pohjolainen 2024

Plasma emission gives information on ambient *and* transient particles



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Only accessible from space

Adapted from S. Pohjolainen 2024

<10 MHz corresponds to different distances on different stars

Sun-like stars:

$$d \gtrsim 10R_*$$

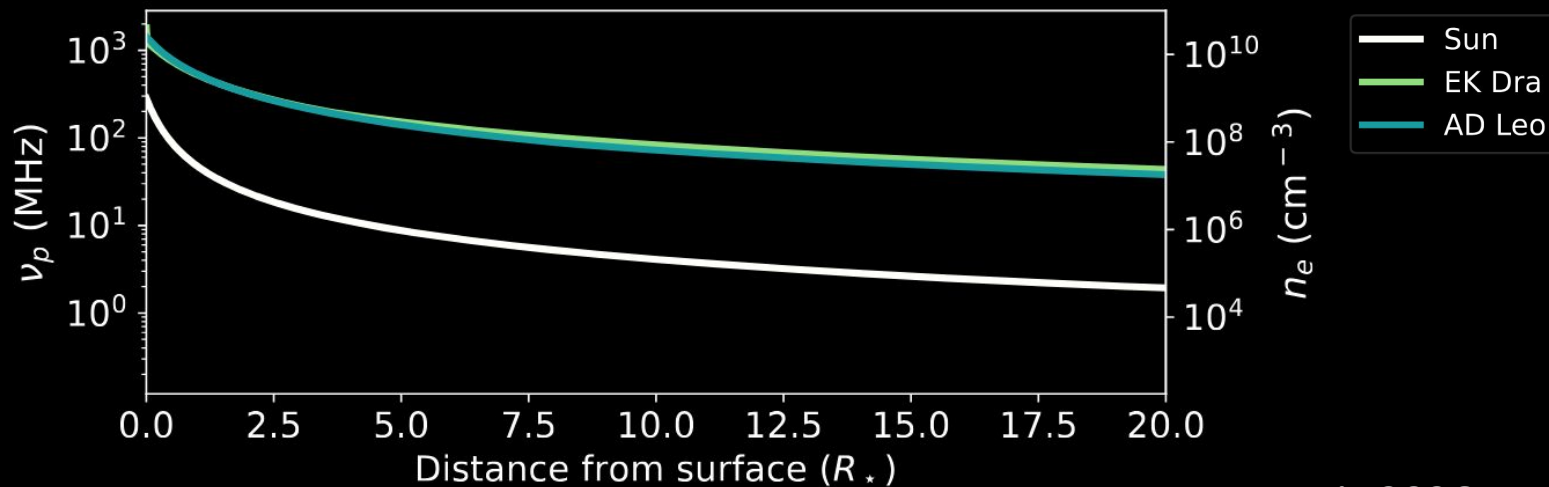
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*Probe of open-field
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regime*

**Unambiguous
indicator of mass
escape to IPM**

**Density profile and
mass-loss rate in IPM**

Observing needs

Science goals:

Population studies

Unpredictable events

$\ll 10$ MHz

~ 1 Jy sensitivity at $\sim$ min time scale

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Survey (1000s of stars)

Monitor (long-term, high cadence)

Space-based

Interferometer

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**MegaWave Radio Surveyor presentation by Joe Lazio
during radio breakout session tomorrow afternoon**



Major Questions

What are the
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IPM and winds?

Temperature, density, speed,
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What are the
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CMEs and electron
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Occurrence rate, mass, speed,
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**What was the
environment of the
young Earth?**

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Thank you!

Phillipe Zarka
Parke Loyd
Rachel Osten
Stuart Bale
Joseph Callingham
Susan Lepri
Melodie Kao
James Mason
Sebastian Pineda
Jackie Villadsen

Peter Driscoll
Ravit Helled
Andrea Isella
Mary Knapp
Leslie Rogers
Evgenya Shkolnik
Joseph Lazio
Gregg Hallinan
Jake Turner



arXiv: 2608.26322