Know Thy Ultracool Dwarf, Know Thy Magnetized Planet

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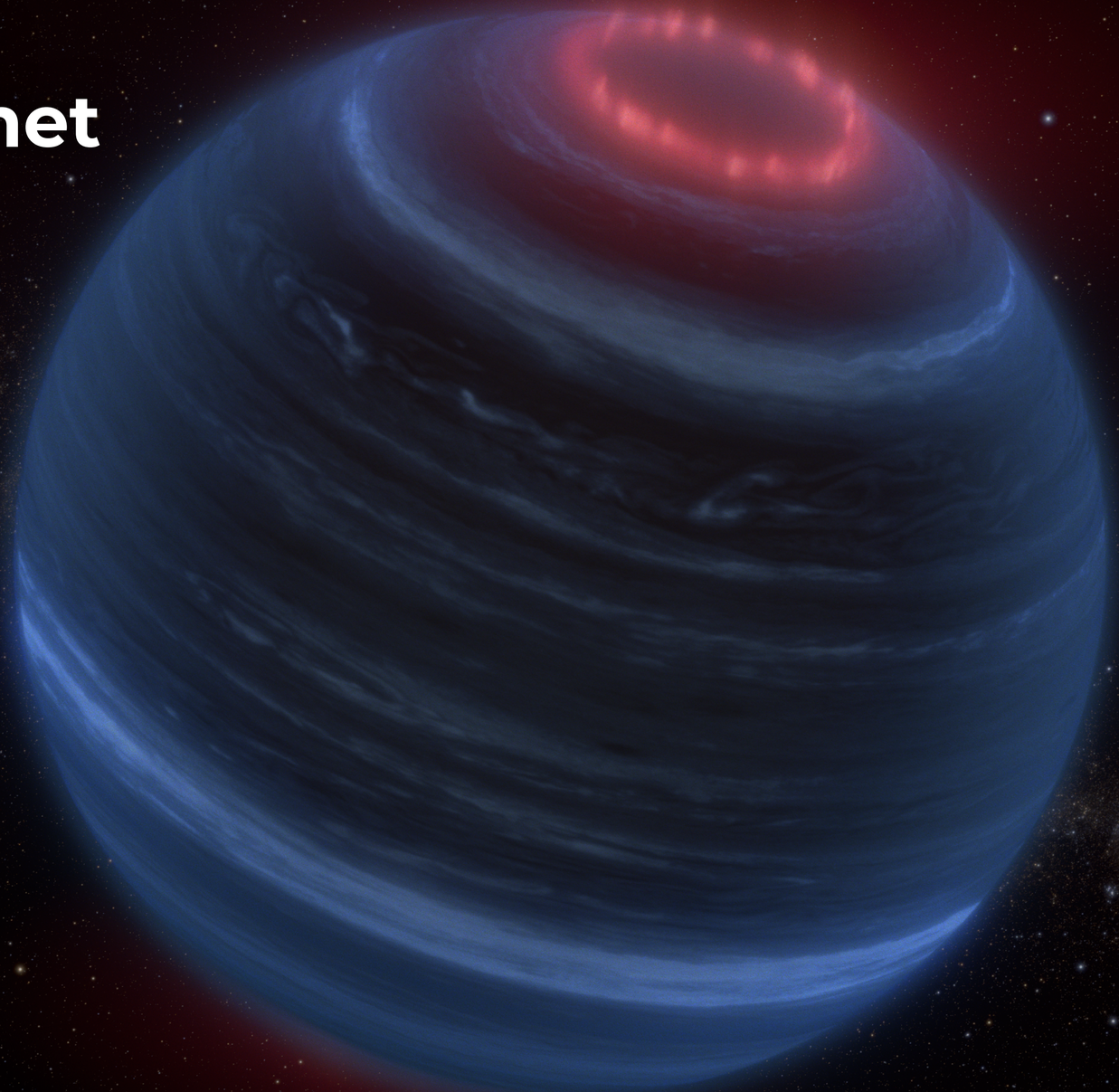
ASTRON/University of Amsterdam

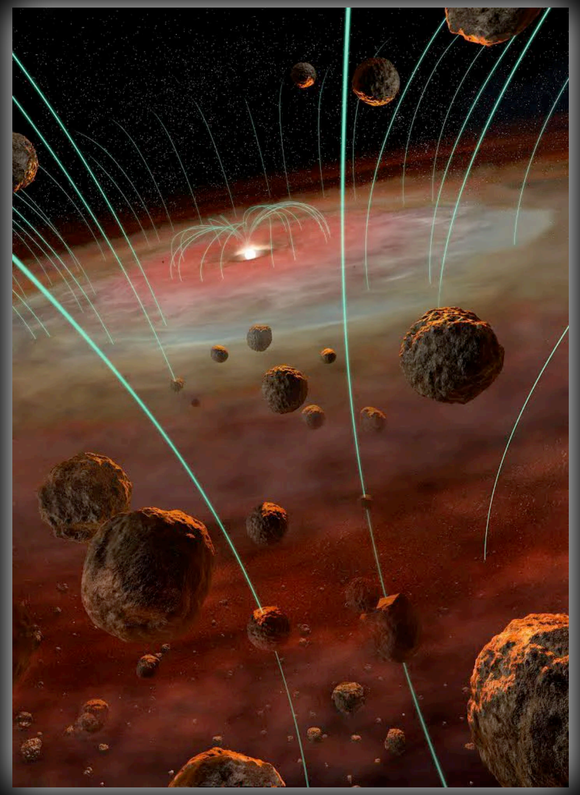


ASTRON

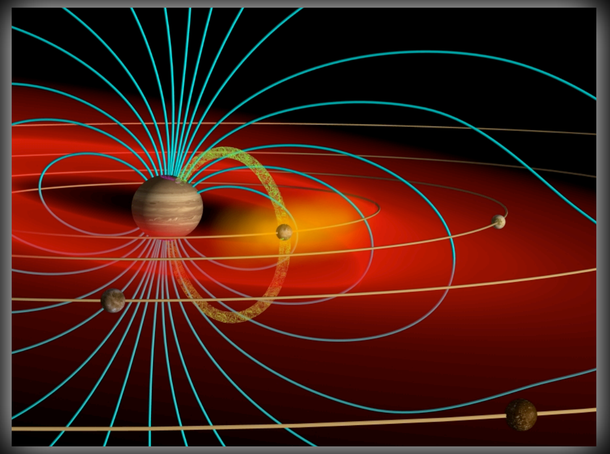
NWO

Image: Leah Hustak

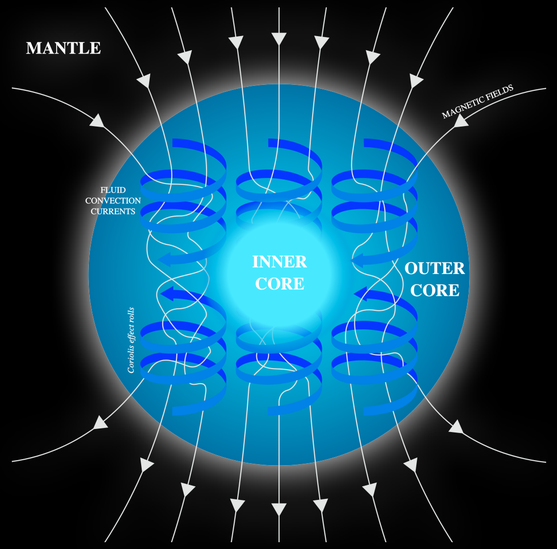
Who cares about magnetic fields? (me)



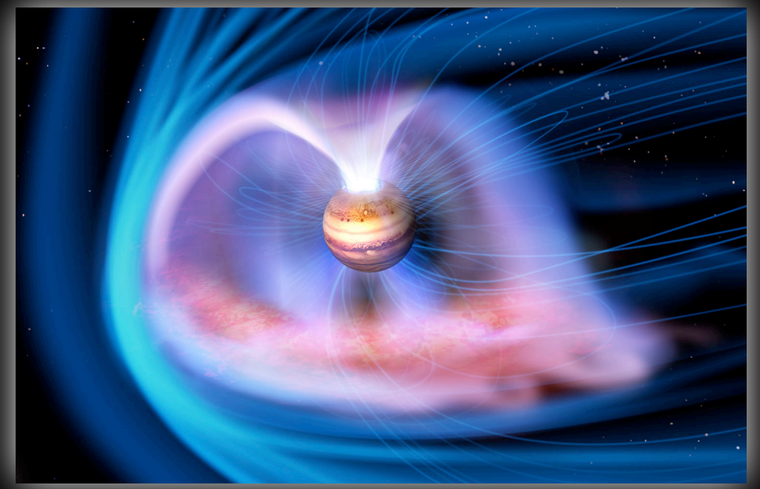
formation



exoplanet/exomoon detection



interior structure



atmospheres and habitability

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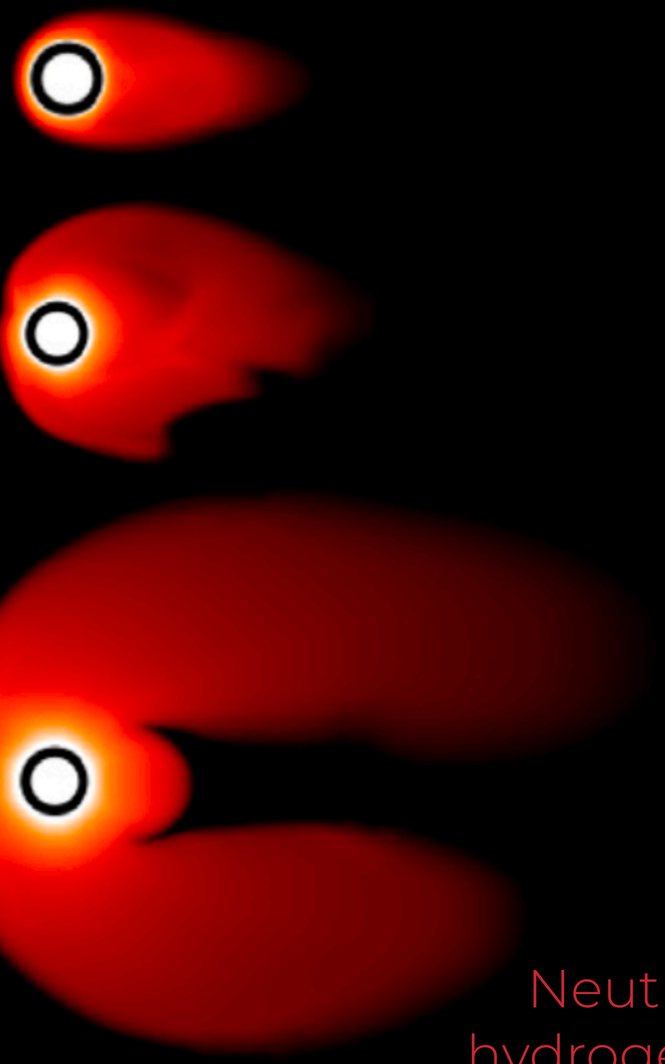
Magnetic fields shape atmospheric escape

No magnetic field

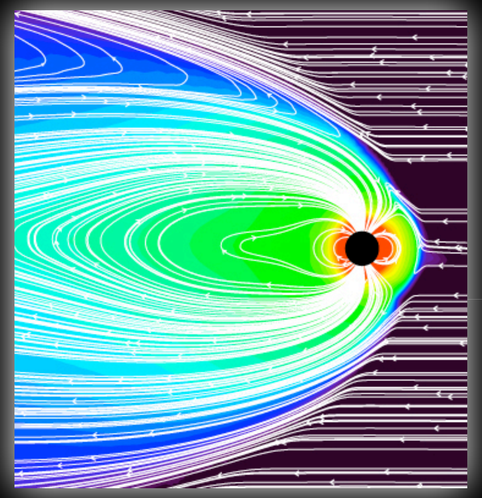
1 G

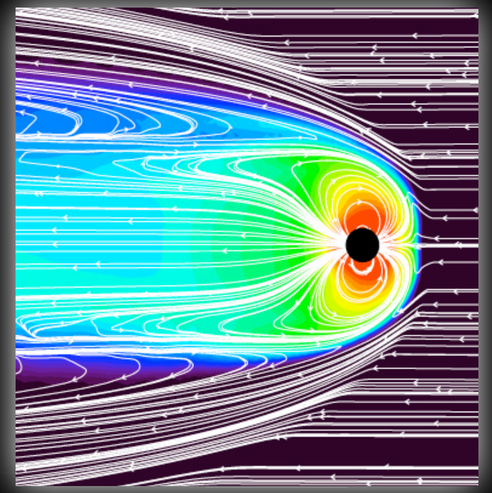
10 G

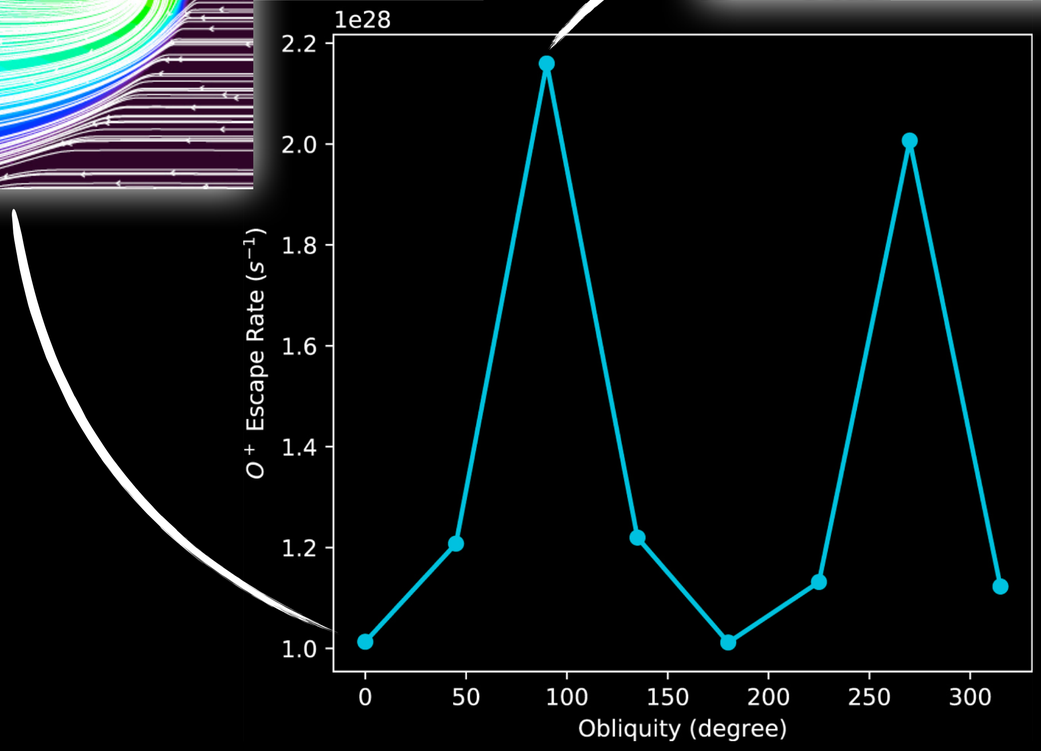


Neutral hydrogen

(Carolan+ 2021)







(Dong+ 2019)

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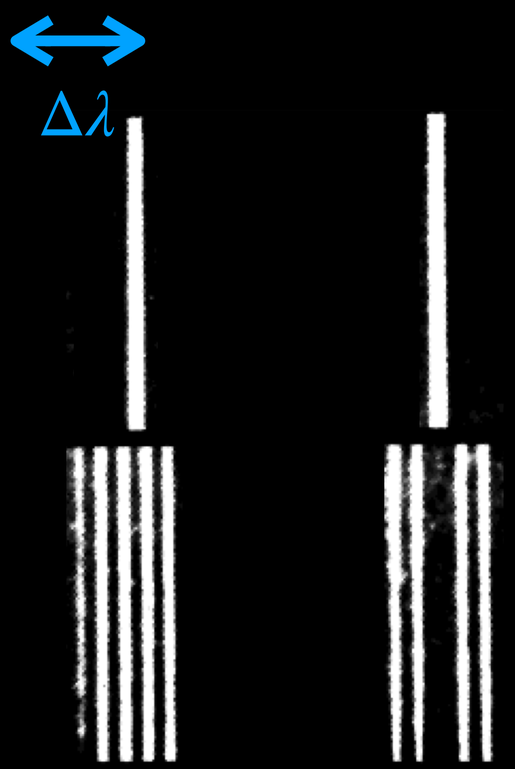
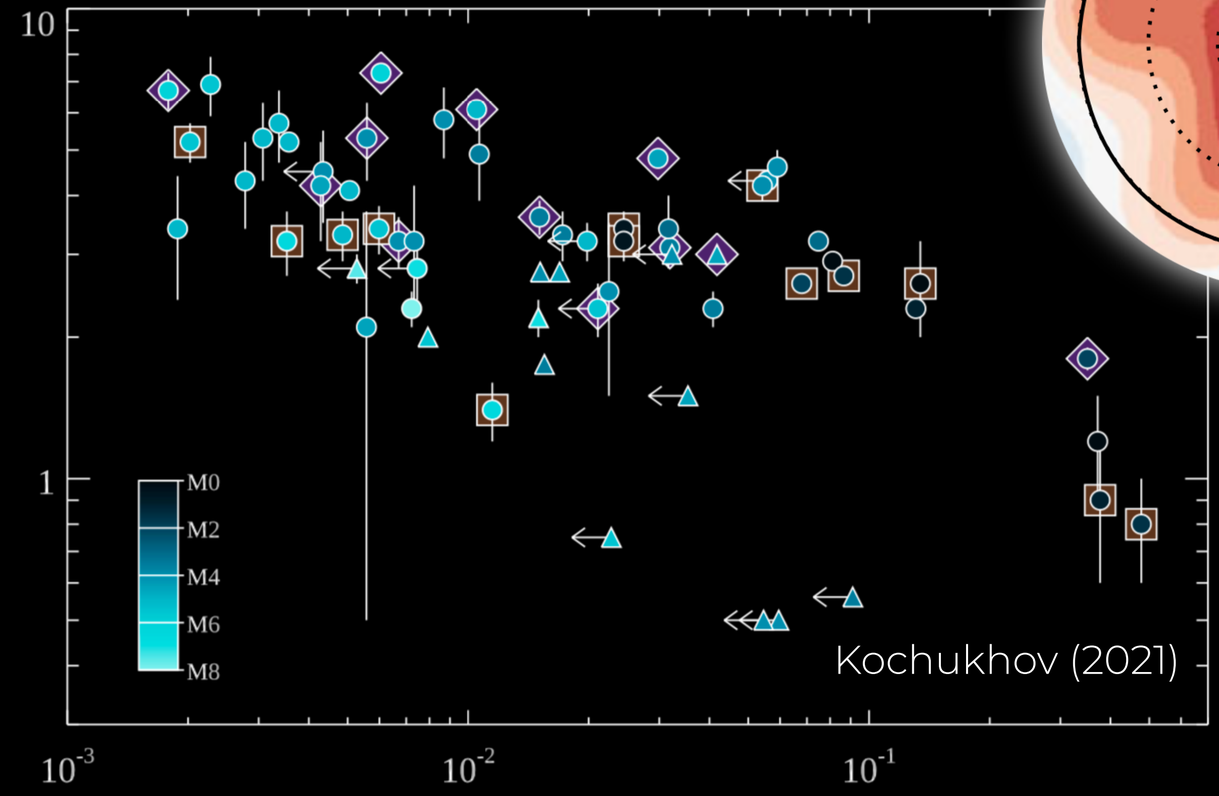
Measuring magnetic fields in extrasolar systems

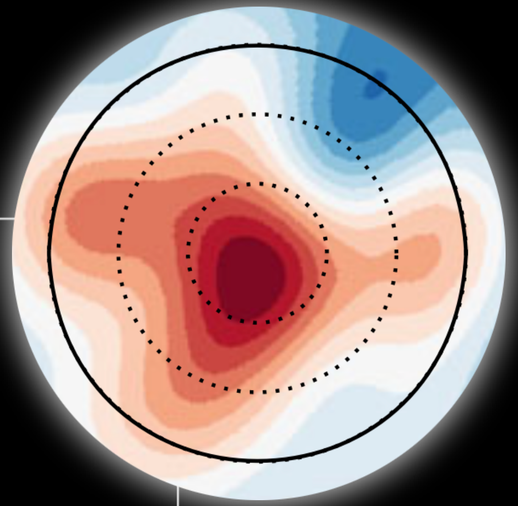


The Zeeman effect
($\Delta\lambda \propto B$)

Magnetic field strength (kiloGauss)



Rossby number ~ rotation period



Stellar
surface map

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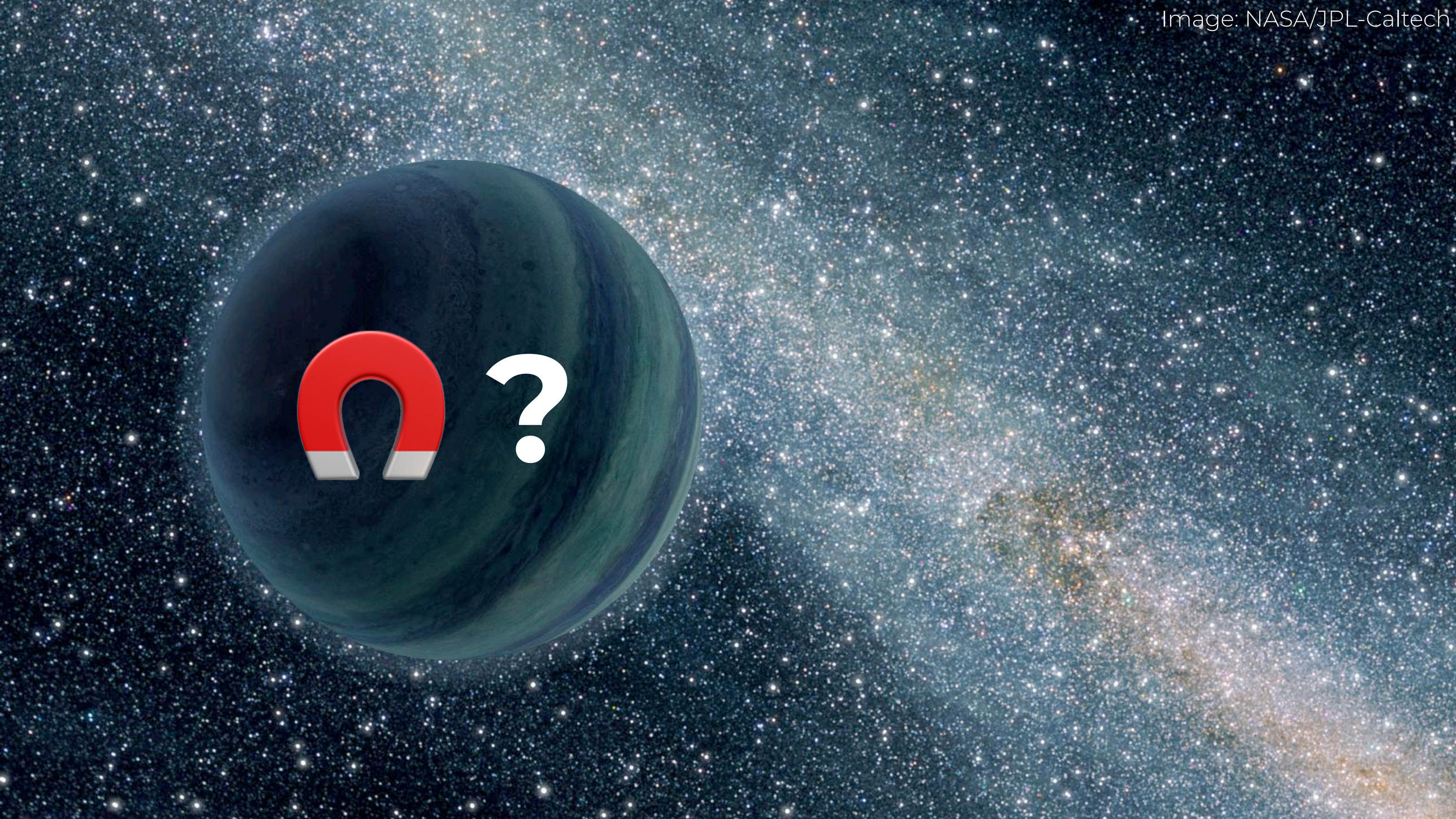
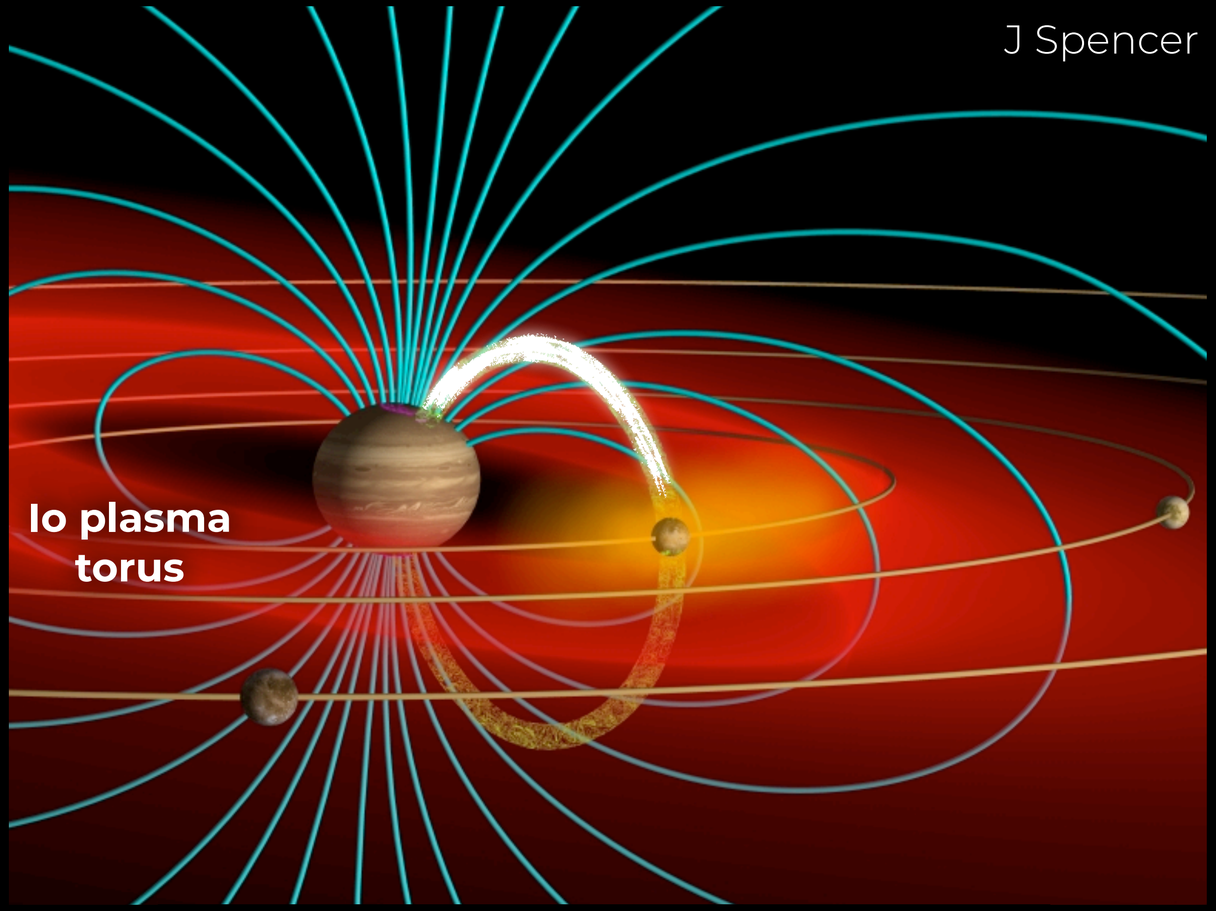
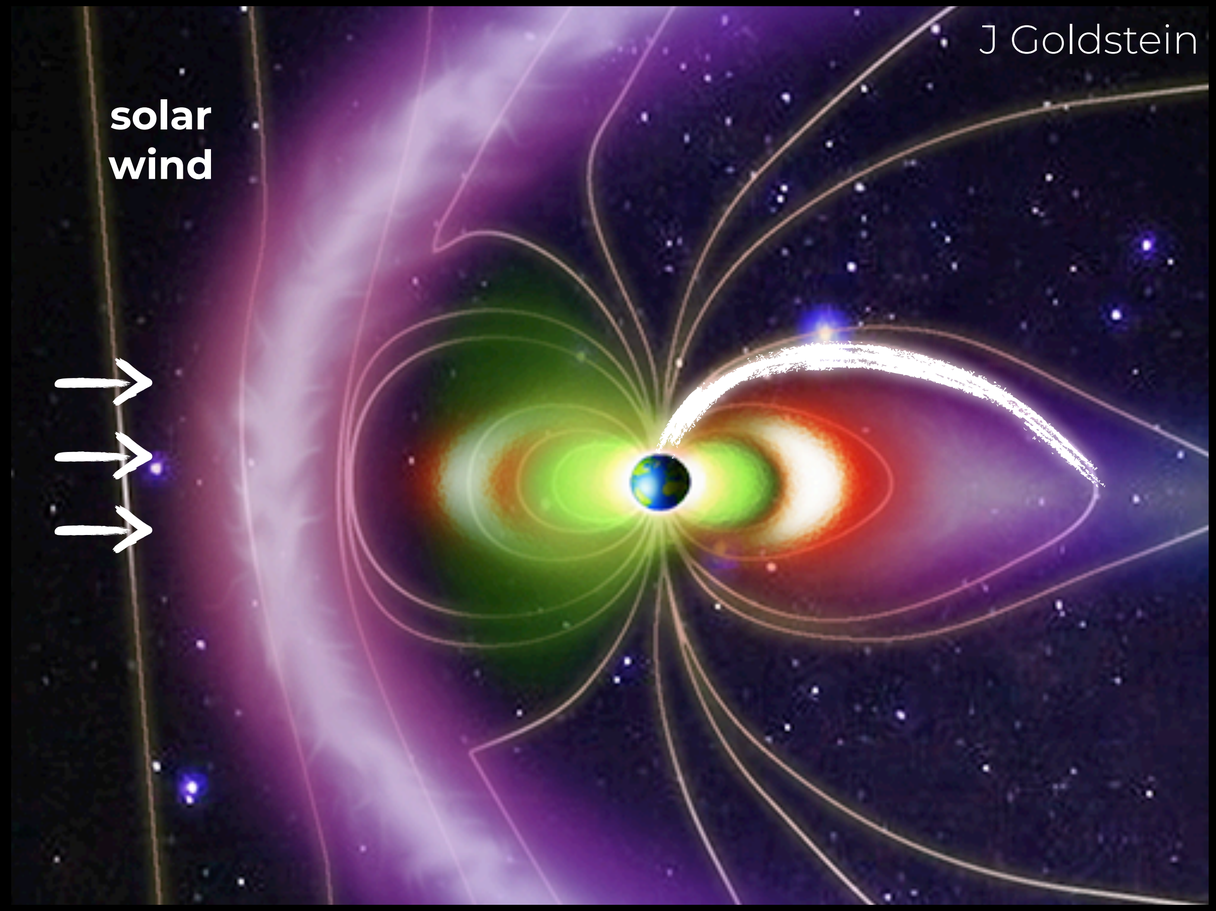


Image: NASA/JPL-Caltech

Auroral radio emission on the magnetised planets



1 – Outgassing moon interaction



2 – Host star wind interaction

Characterising magnetic fields via auroral emission

Radio frequency

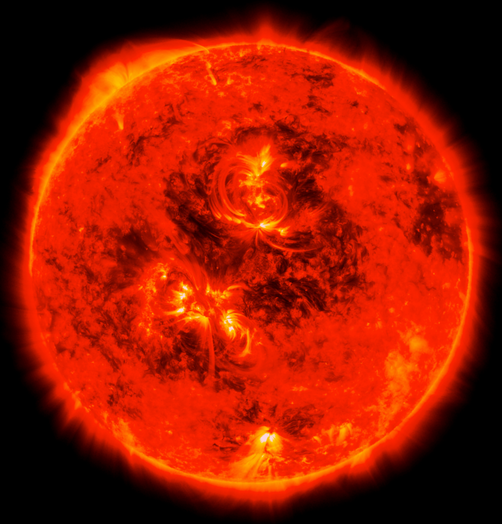
$\propto$

field strength

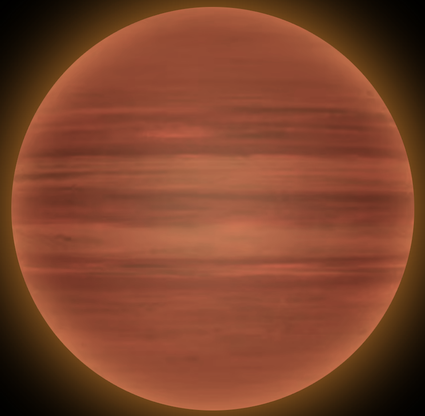
magnetic field line

accelerated electrons

An ultracool bridge to exoplanets

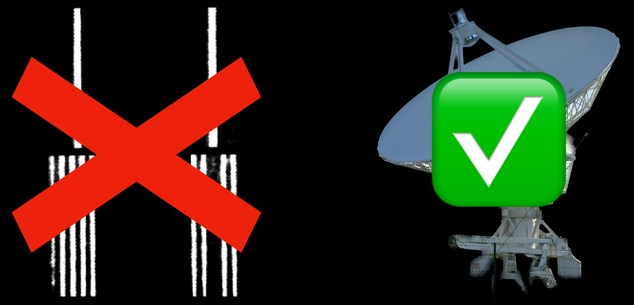


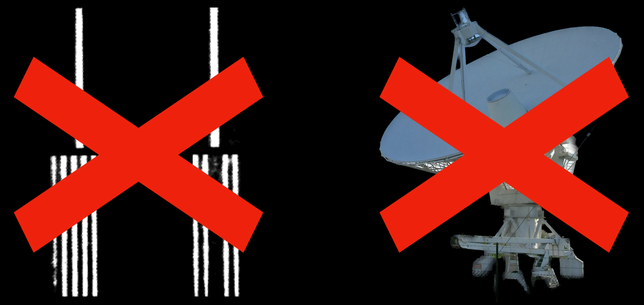
late M dwarf ($\lesssim$ M7)



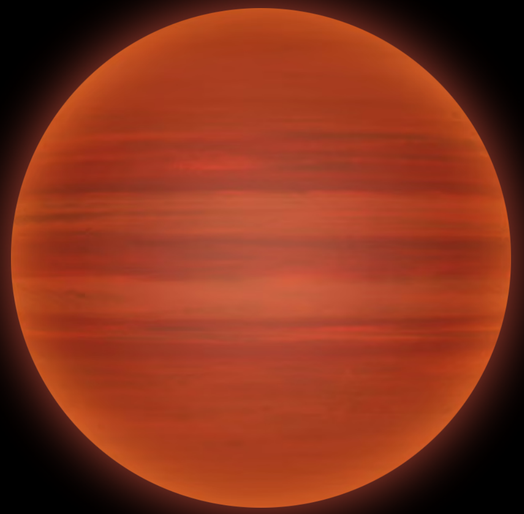
ultracool dwarf

exoplanet





Puzzling periodic pulses



T8 dwarf
WISE J062309.94-045624.6 (J0623)

$T_{\rm eff} \sim 700$ K

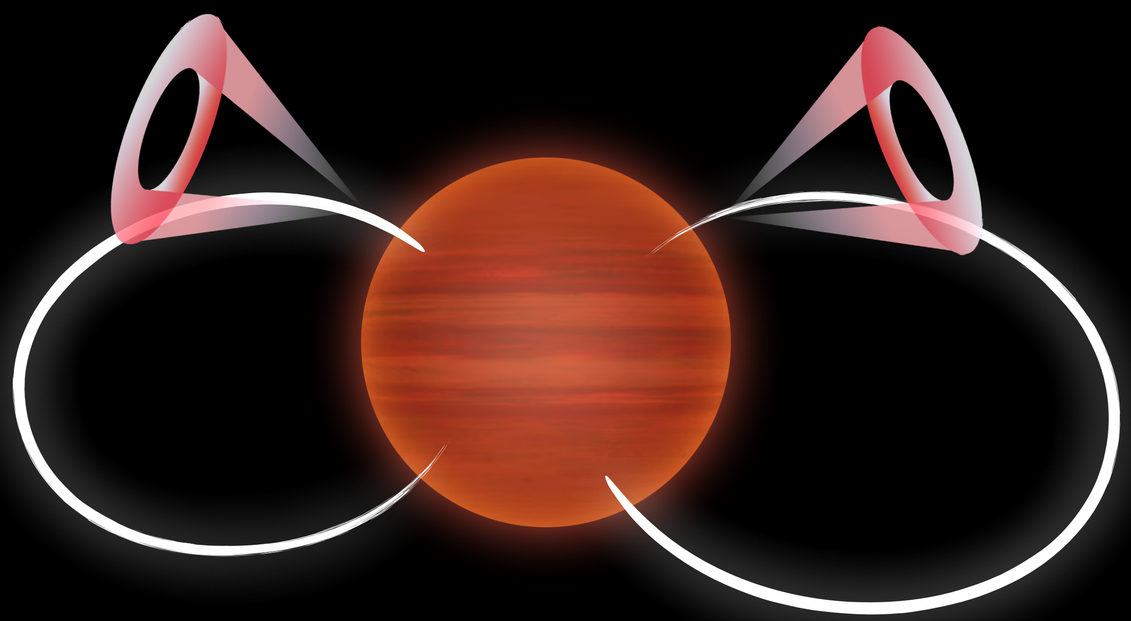
Radio brightness

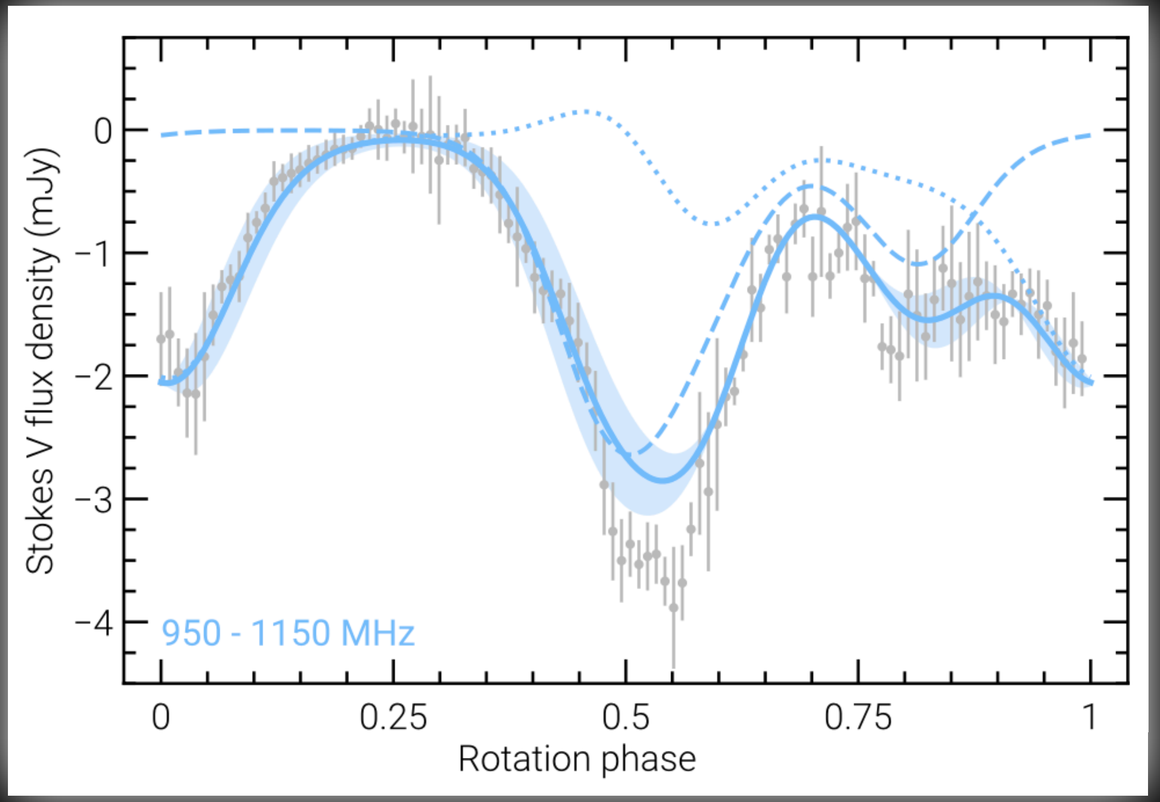
data from Rose+ (2023)

~6 hours

Magnetic retrieval framework

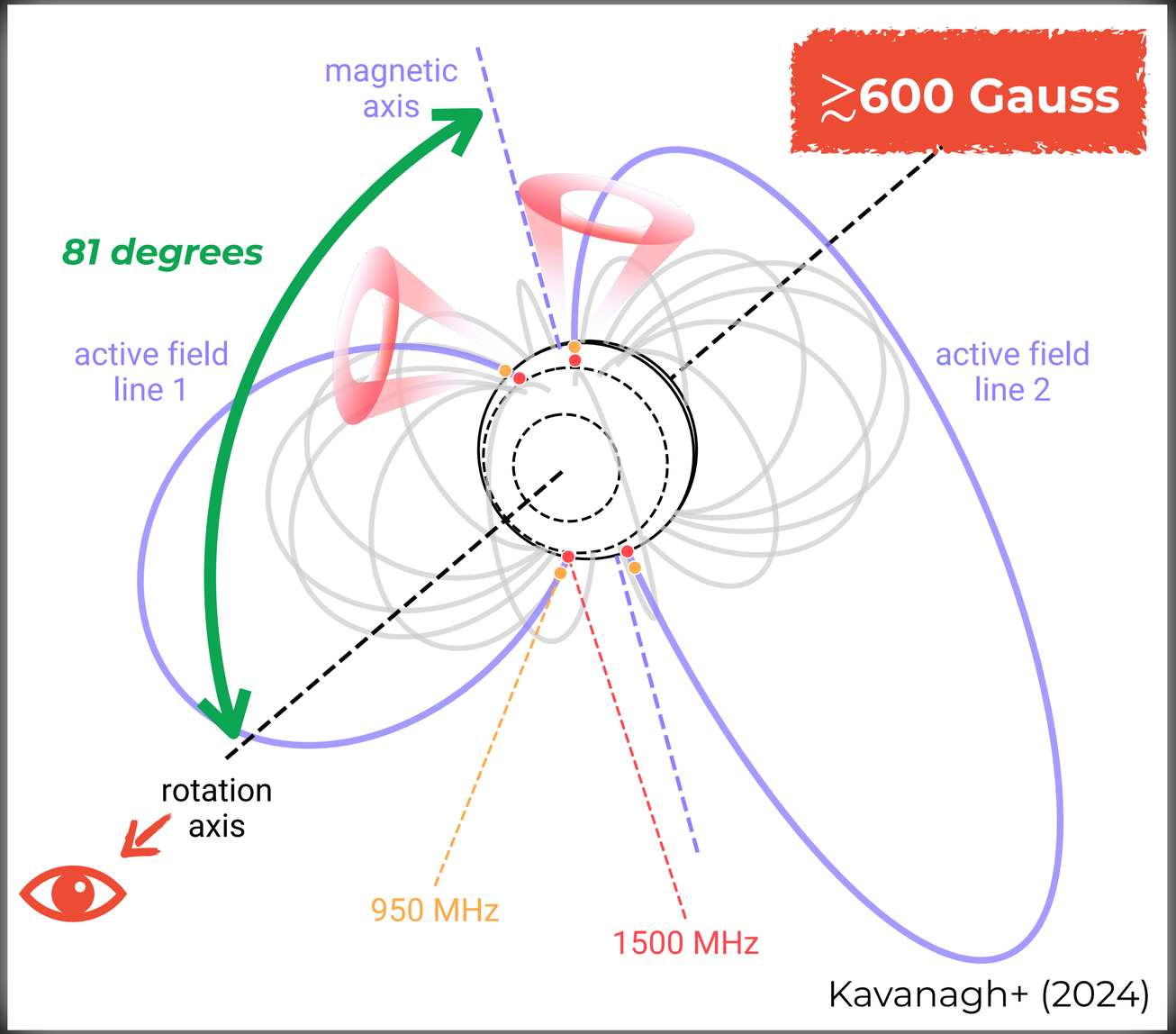
'Active field line' approach:



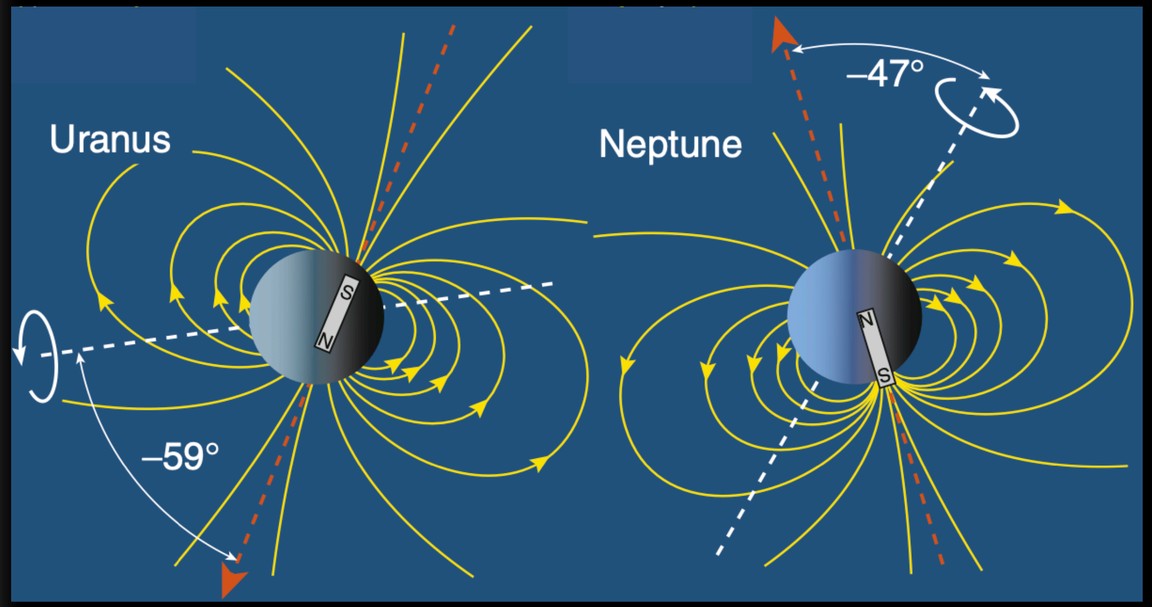


Unique magnetic field characteristics (Kavangh+ 2024)

Magnetic field characteristics of J0623



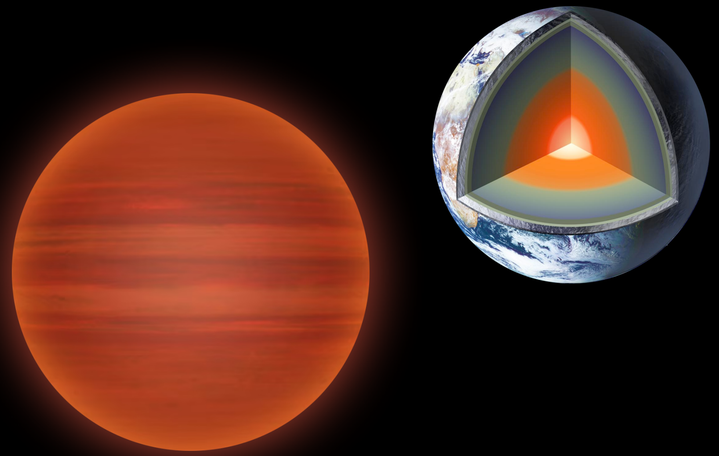
Bagenal (2013)



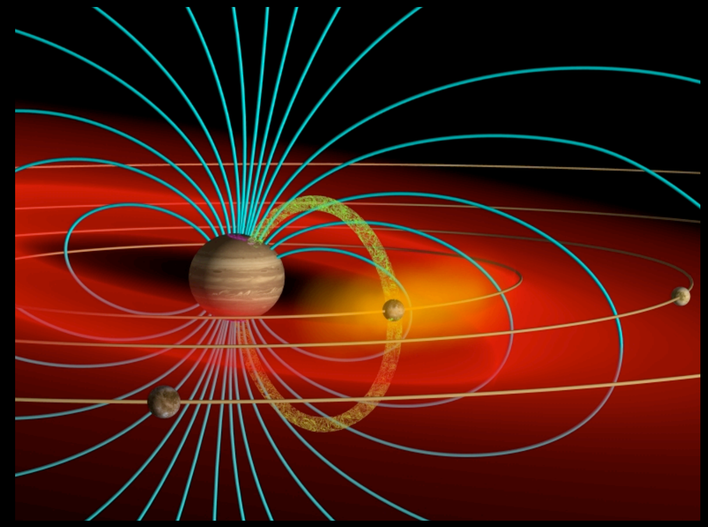
internal composition?

Take home

Radio facilitates magnetic field characterisations of ultracool dwarfs



Ultracool dwarfs bridge our understanding of magnetic field generation from stars to planets



Plasma source remains unknown for ultracool dwarfs – planets?