Cross-Collserola PhD Meeting in Astrophysics, Cosmology and Particles 2023

Planetary Like Radio Emission From Exoplanets and Massive Sub-Stellar Objects

PRESENTED BY Simranpreet Kaur

PRESENTED ON Oct 06, 2023

CSIC Institute of Space Sciences

EXCELENCIA MARÍA DE MAEZTU

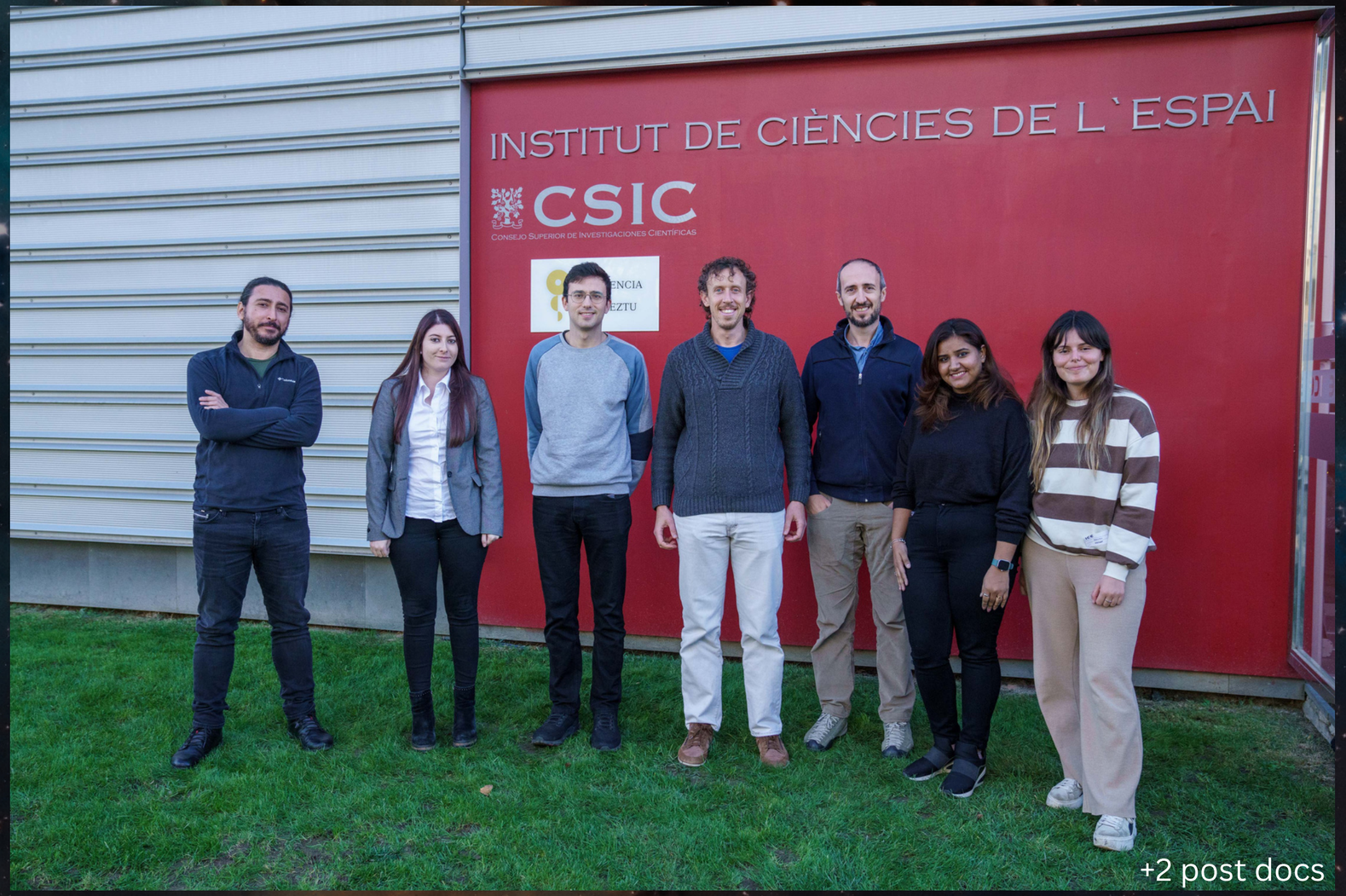
IEEC Institut d'Estudis Espacials de Catalunya

IMAGINE

About us!

IMAGINE

Imprints of **MAG**netic fields **IN** **E**xoplanets



+2 post docs

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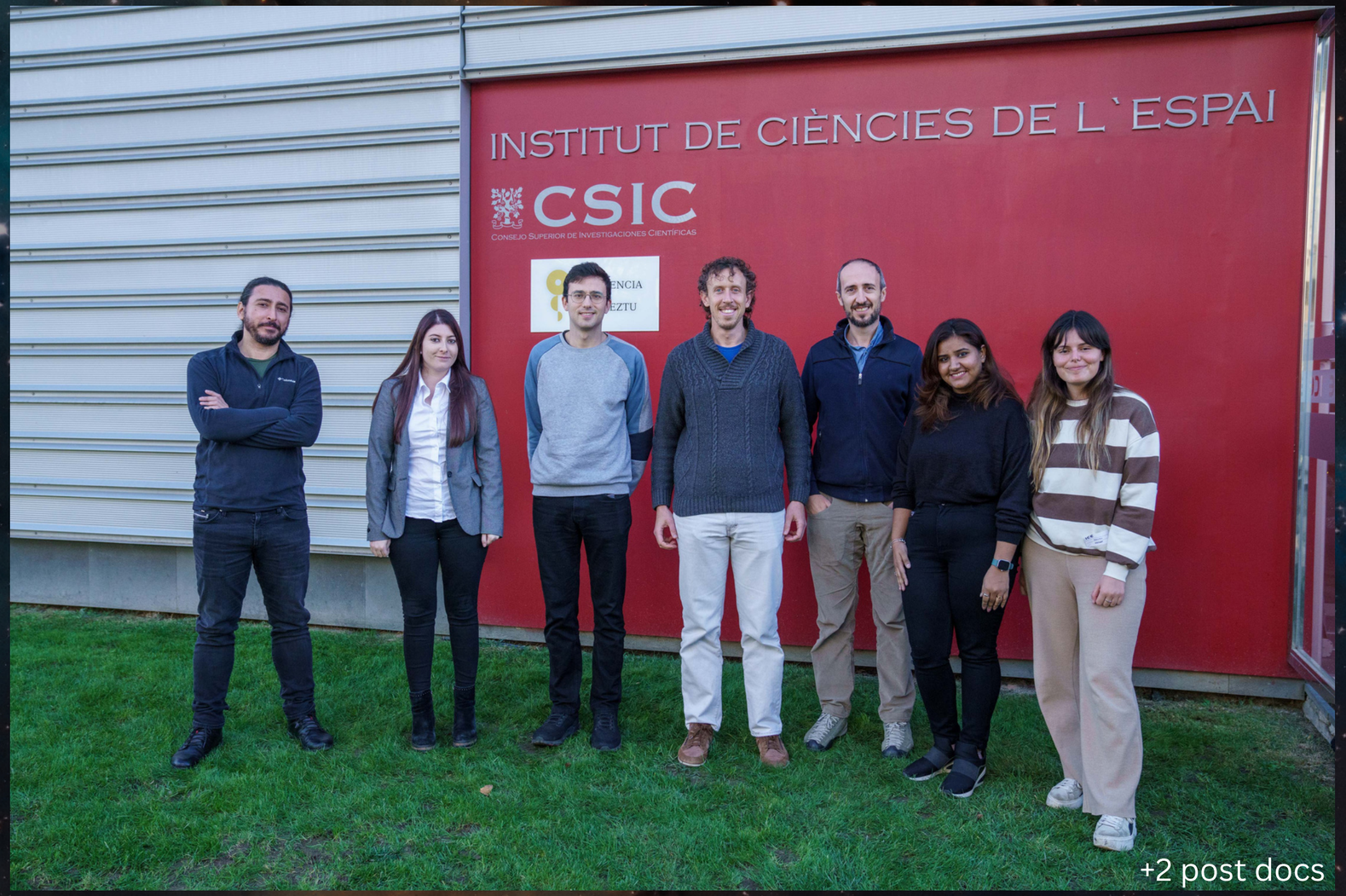
We study:

- Magneto-thermal evolution



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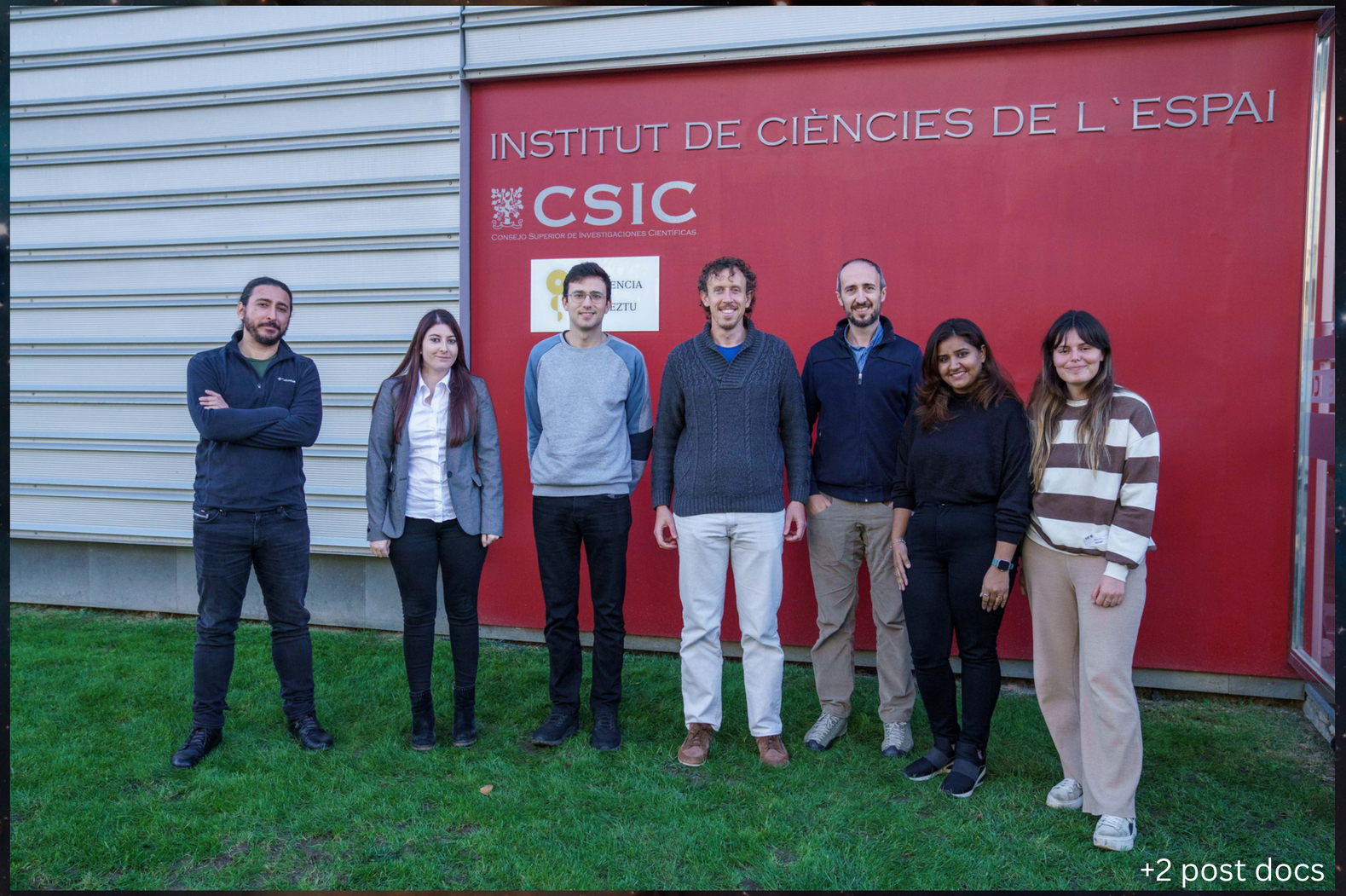

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But how can we link radio emission with magnetic fields?

Electron Cyclotron Maser (ECM)

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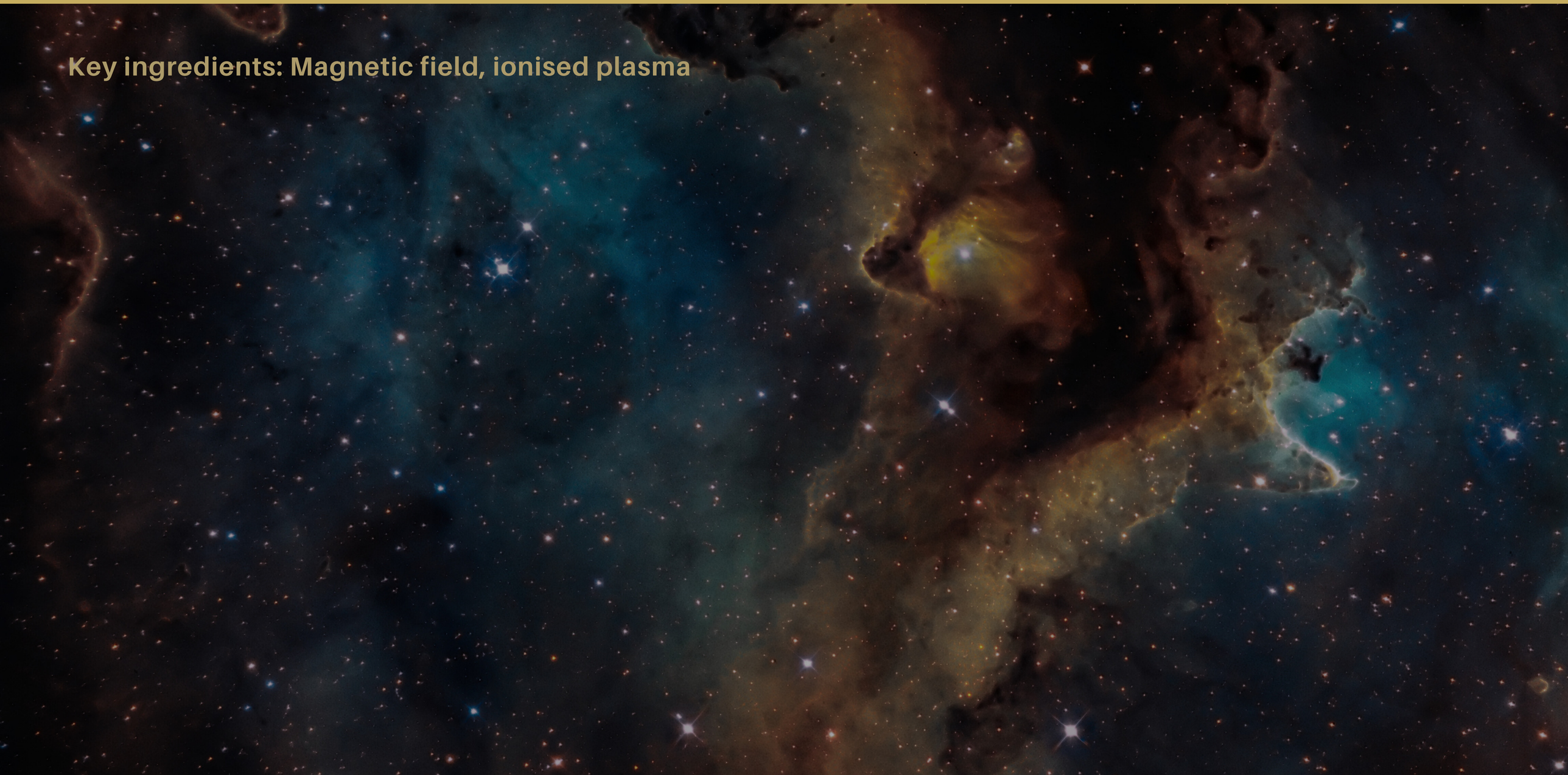

Key ingredients: Magnetic field, ionised plasma

The link between non-thermal Radio Emissions and Magnetism:
Electron Cyclotron Maser (ECM)

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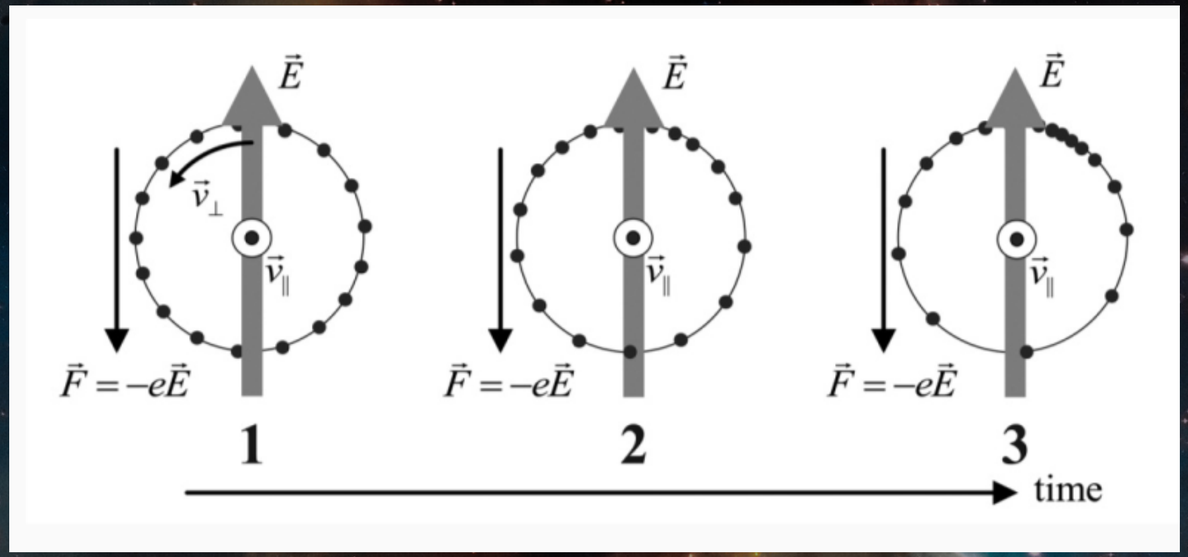
- Works on electrons' cyclotron motion, except the electrons here are mildly relativistic.
- Phase space bunching
- Emission occurs only upto second harmonics.



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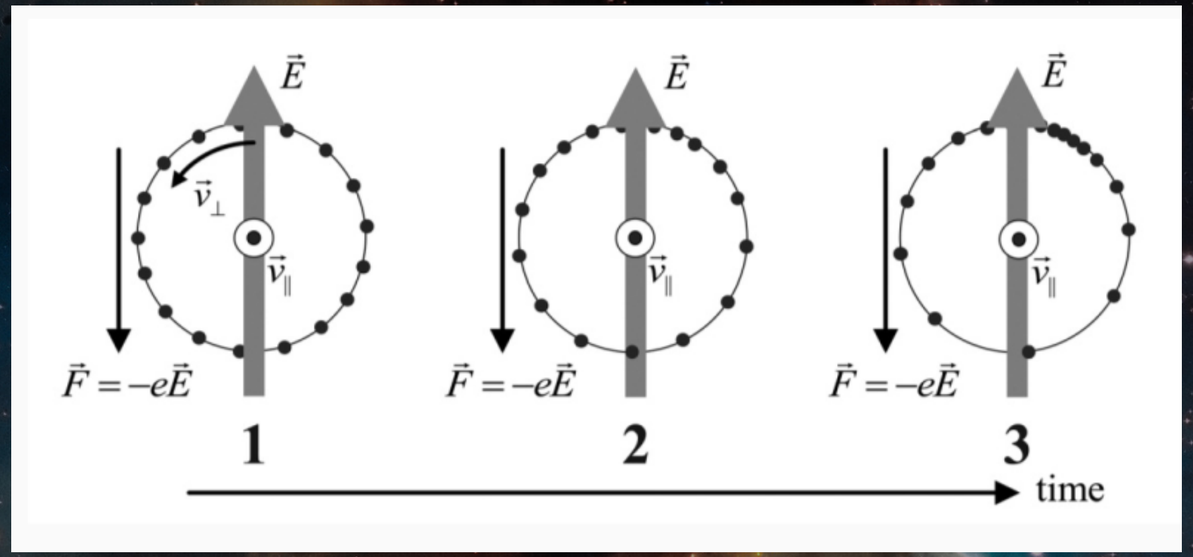

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$$\mathbf{Freq[MHz] = 2.8 * B[G]}$$

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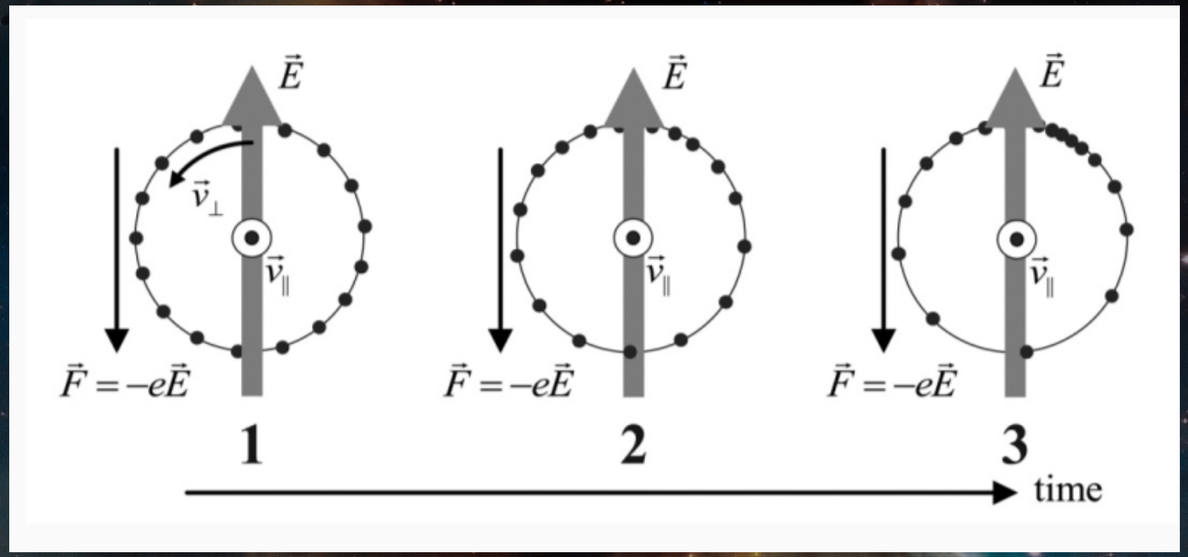

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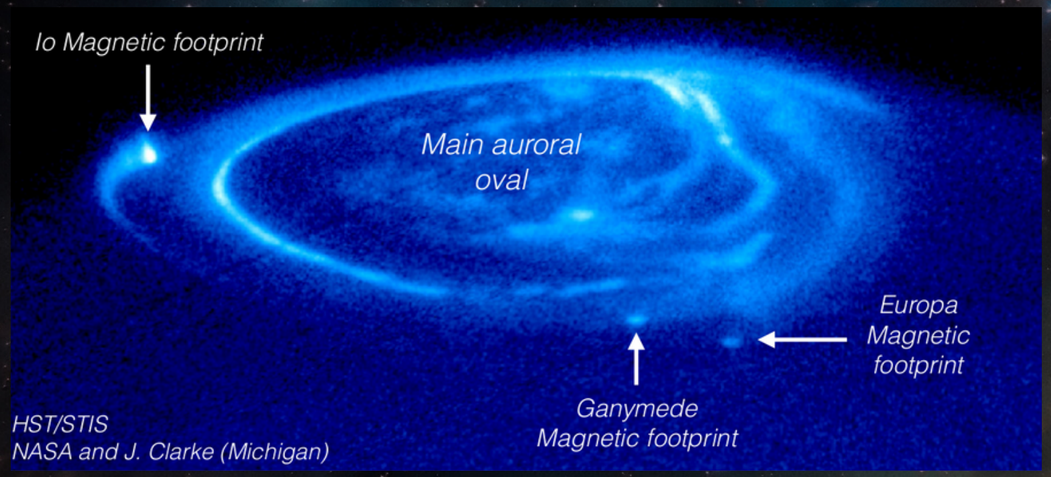
Features

- High degrees of circular polarization
- Very short time scales
- Narrow bandwidths, generally exhibit spikes

Planetary Radio Emissions: A key to understand the emissions from Exoplanets

Radio emission can provide direct measurements of planetary magnetism and other physical properties like rotation, etc.



- Jupiter's radio emissions serve as a benchmark reference to understand exo-planetary radio emissions

Possible scenarios leading to planetary radio emissions

Key Ingredients: charged particles + magnetic field

- **Planet**
  - Magnetised
  - Unmagnetised
- **Source of plasma density and energy** (usually stellar wind)
  - Magnetised
  - Unmagnetised

Possible scenarios leading to planetary radio emissions

Key Ingredients: charged particles + magnetic field

Planet

Magnetised

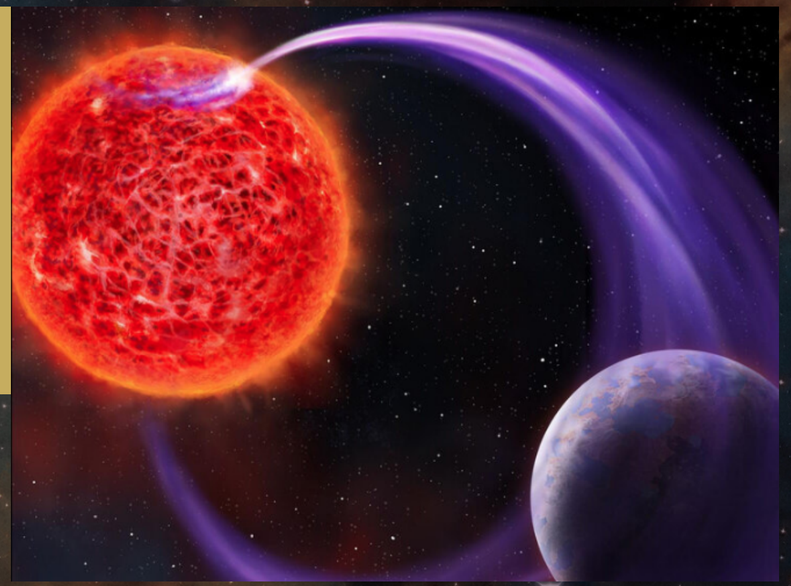
Unmagnetised

Source of plasma density and energy (usually stellar wind)

Magnetised

Unmagnetised

Freq depends upon B_star Emission
occurs closer to the stellar surface
Natural candidates: Hot jupiters/very close planets
(Analogous to Jupiter-Io system)



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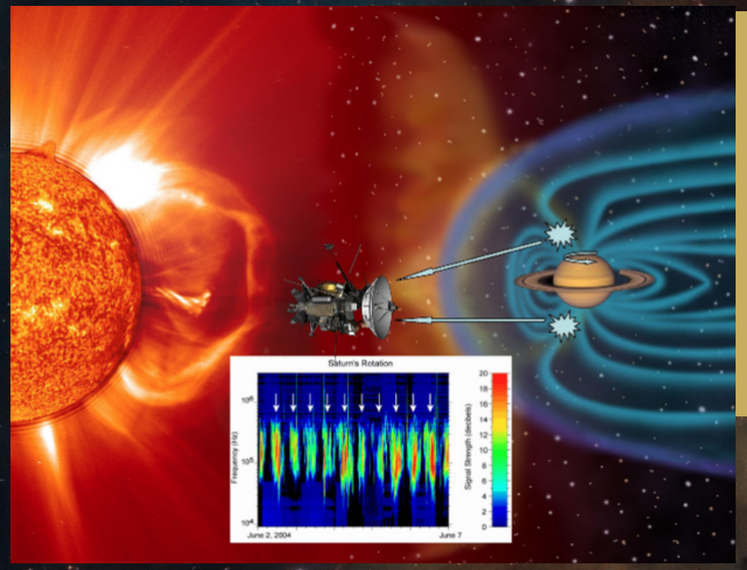
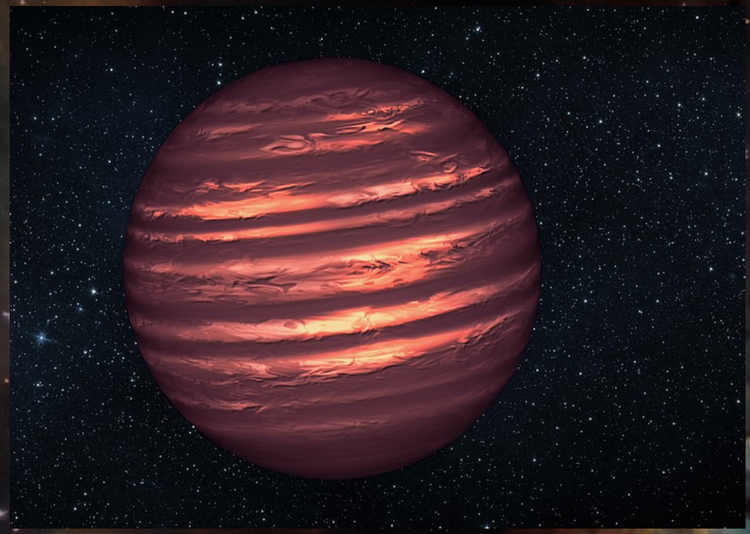


Freq depends upon the assumed B_planet
Emission occurs closer to the planet
Candidates: Massive objects (any separation, possibly young)

Radio emissions from Isolated Brown Dwarfs

- Are objects having a mass in between that of a giant planet like Jupiter and that of a small star.
- Expected magnetic fields: up to 10^3 G, compared to 0-10 G for planets



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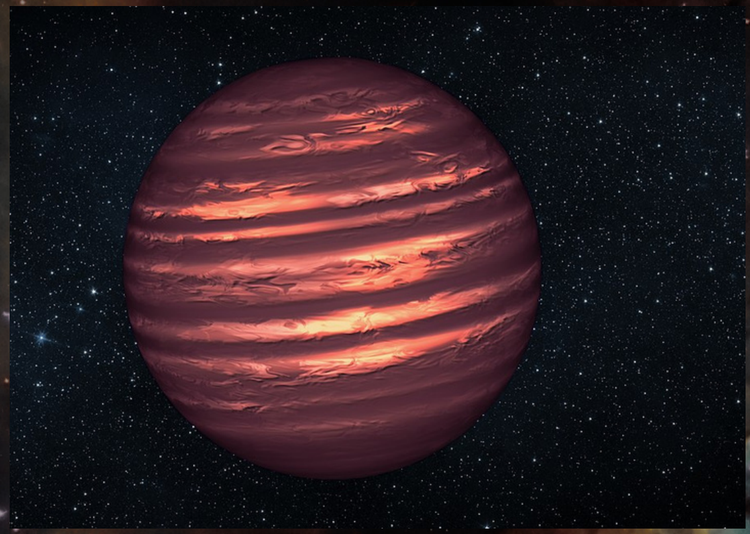

- The auroral radio emissions are arguably driven either by the co-rotation breakdown of the magnetospheric plasma.
- It can also results from the current generated by the relative motion of a planetary satellite with respect to the dwarf's magnetosphere, similar to the Io-Jupiter system.

(Upgraded) **Giant Meterwave Radio Telescope(uGMRT),** Khodad(India)

An array of 30 steerable parabolic telescopes, each of 45 m diameter Spans over 25 km, provides a total collecting area of about 30,000 sq. m at metre wavelengths, with a fairly good angular resolution (~arcsec)

Obseravtional bands (uGMRT)

- Band 2: 120MHz-250MHz
- Band 3: 250MHz-500MHz
- Band 4: 550MHz-850MHz
- Band 5: 1050MHz-1450MHz

LOFAR: 10MHz-240MHz

VLA: 74MHz-50GHz

Sky covered by uGMRT: +90d00' to -53d54'


thank
you

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