ASTRON

Stormchaser;
PI: Vedantham

Expanding the search of radio exoplanets with LOFAR

Cristina-Maria Cordun

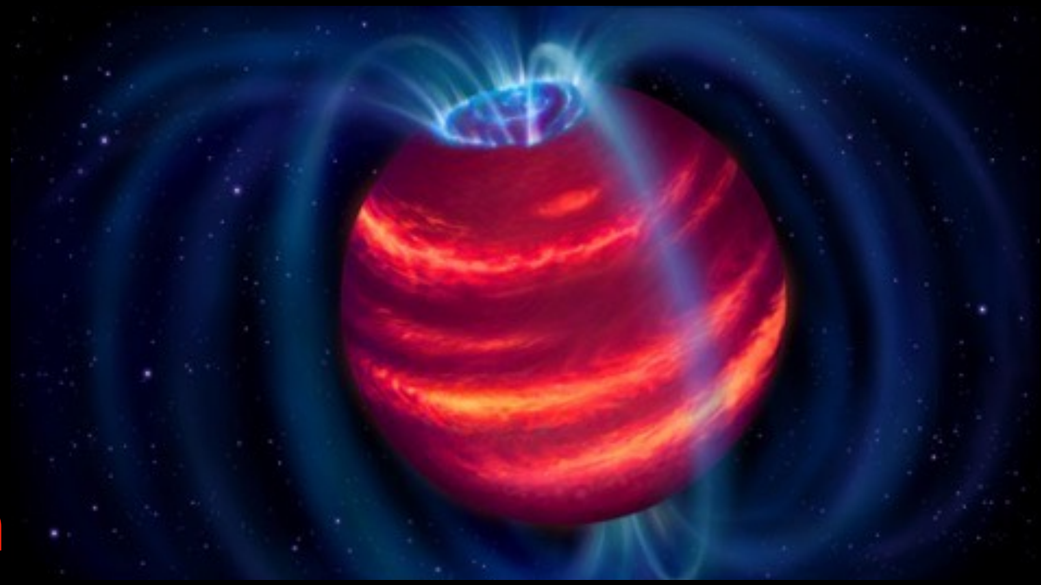
Advisors: Harish Vedantham, Michiel Brentjens, Floris van der Tak

Credit:
Johns Hopkins University

Emission mechanism - ECMI

- Hot Jupiters = best candidates
- Mostly pulse-like emission
- Circularly polarized emission
- Electron cyclotron maser emission

$$f_c[MHz] = 2.8B[G]$$



Credit: Danielle Futselaar

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Results part 1: Tau Bootis b

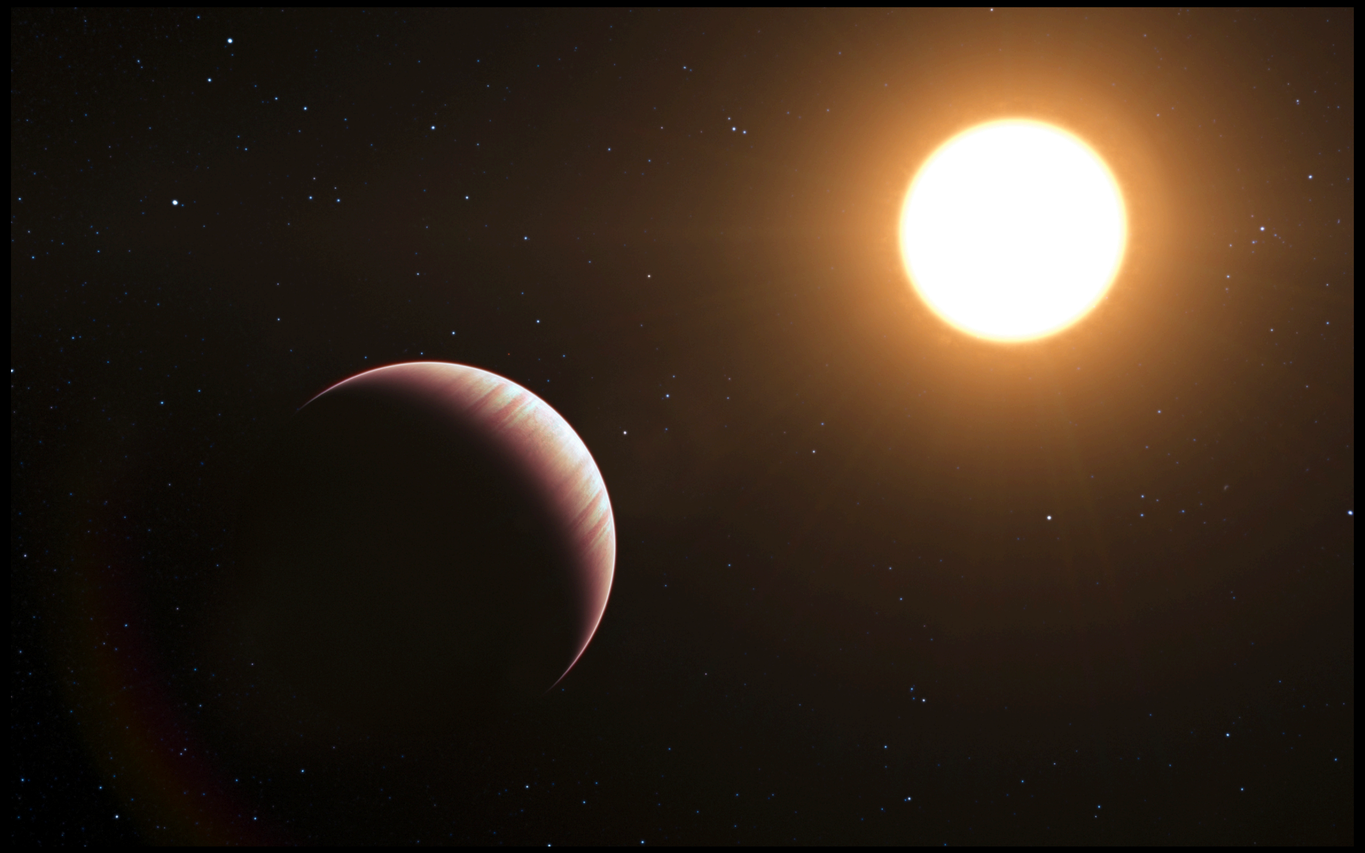
- Predicted the brightest

  (Griessmeier et. al. 2007, 2017)

- Tentative detection

  (Turner et. al. 2021, 2024)

- P = 3.3 days (TL)
- a = 0.05 AU
- M = 6 MJup
- R = 1.14 RJup
- d = 15 pc



Credit: ESO/L. Calçada

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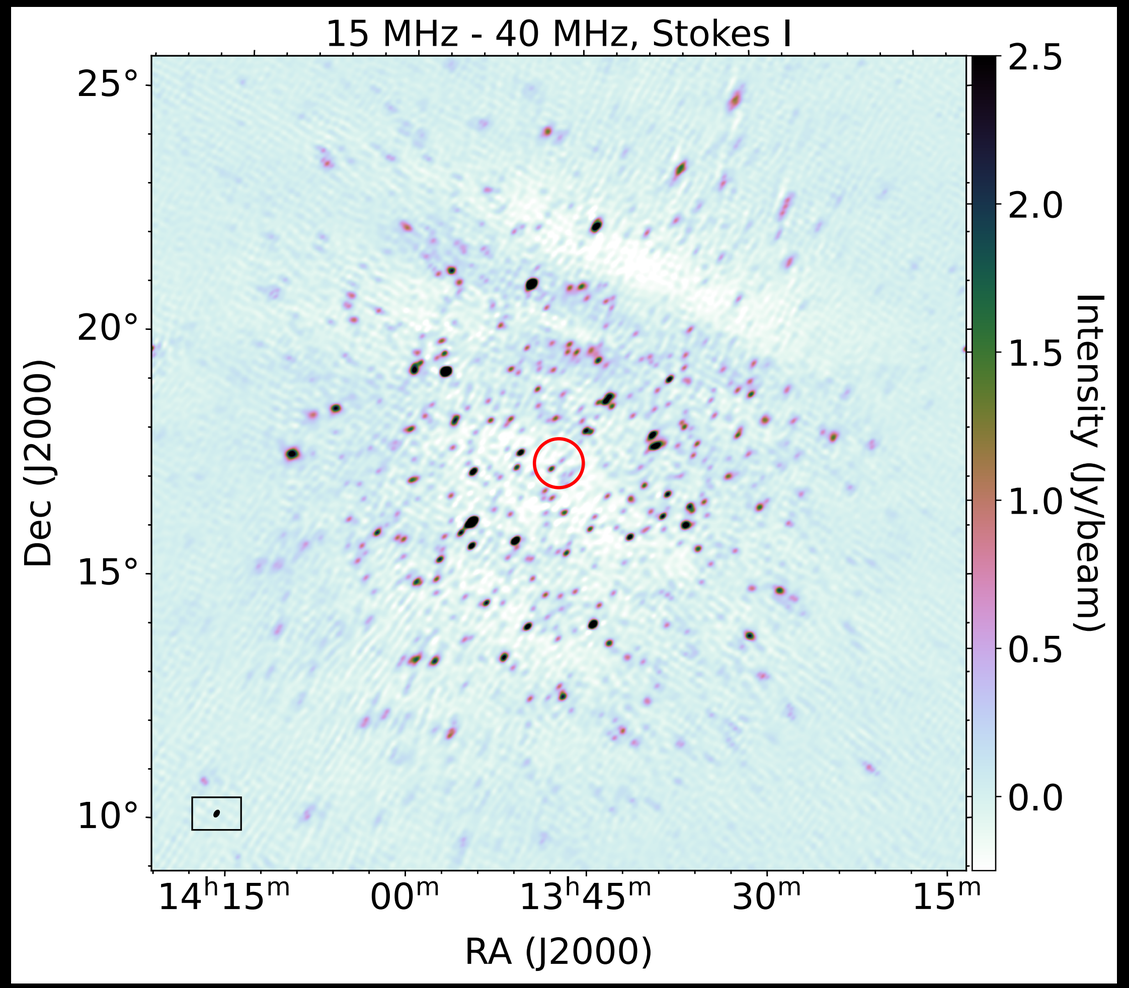
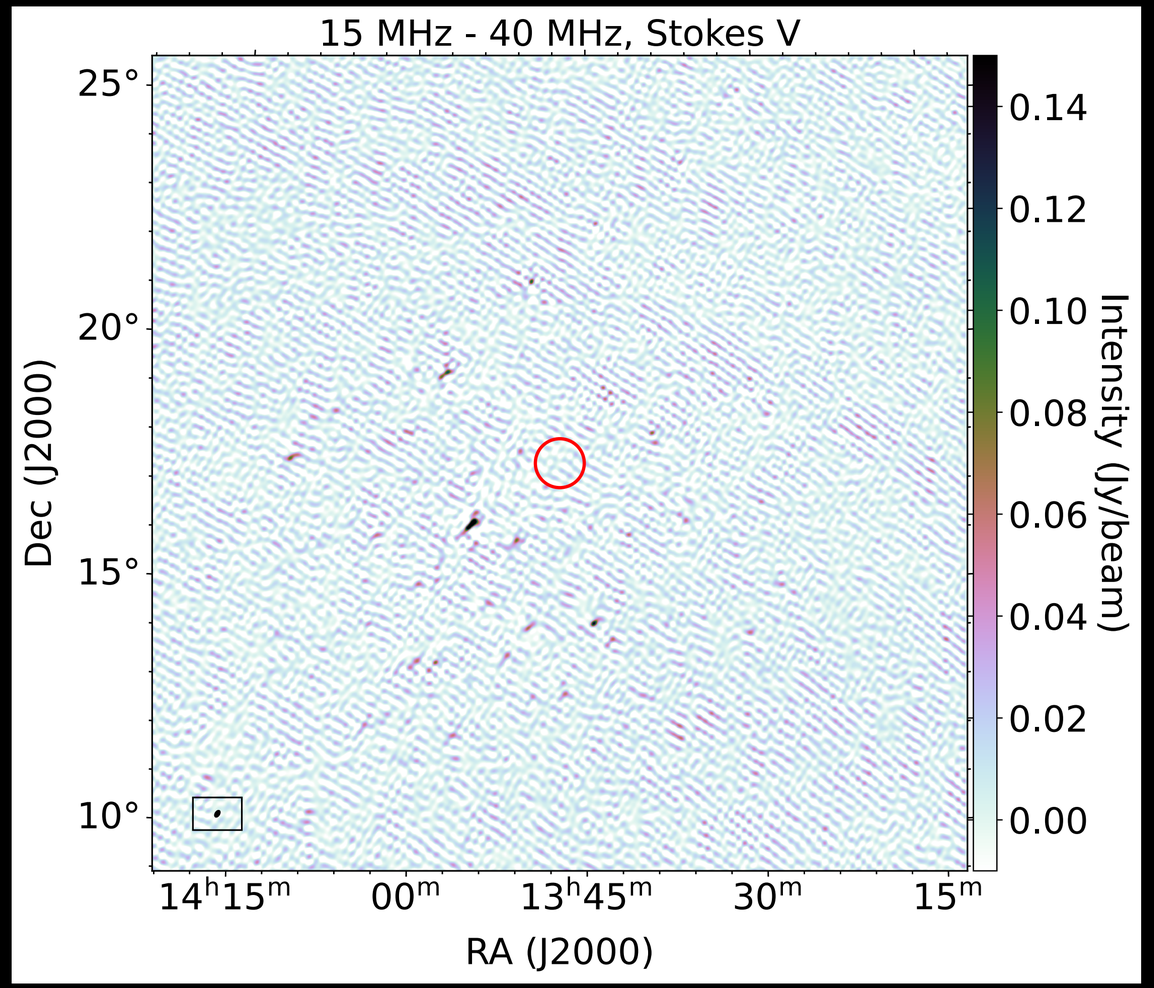
Results part 1.1: Tau Bootis b





Cordun et al. (2025)

56 hours of data

Follow-up data for Turner et. al. 2021

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Results part 1.2: Tau Bootis b

- Another 40 hours of data
- Better sensitivity
- Better resolution
- 15-60 MHz
- Worse conditions

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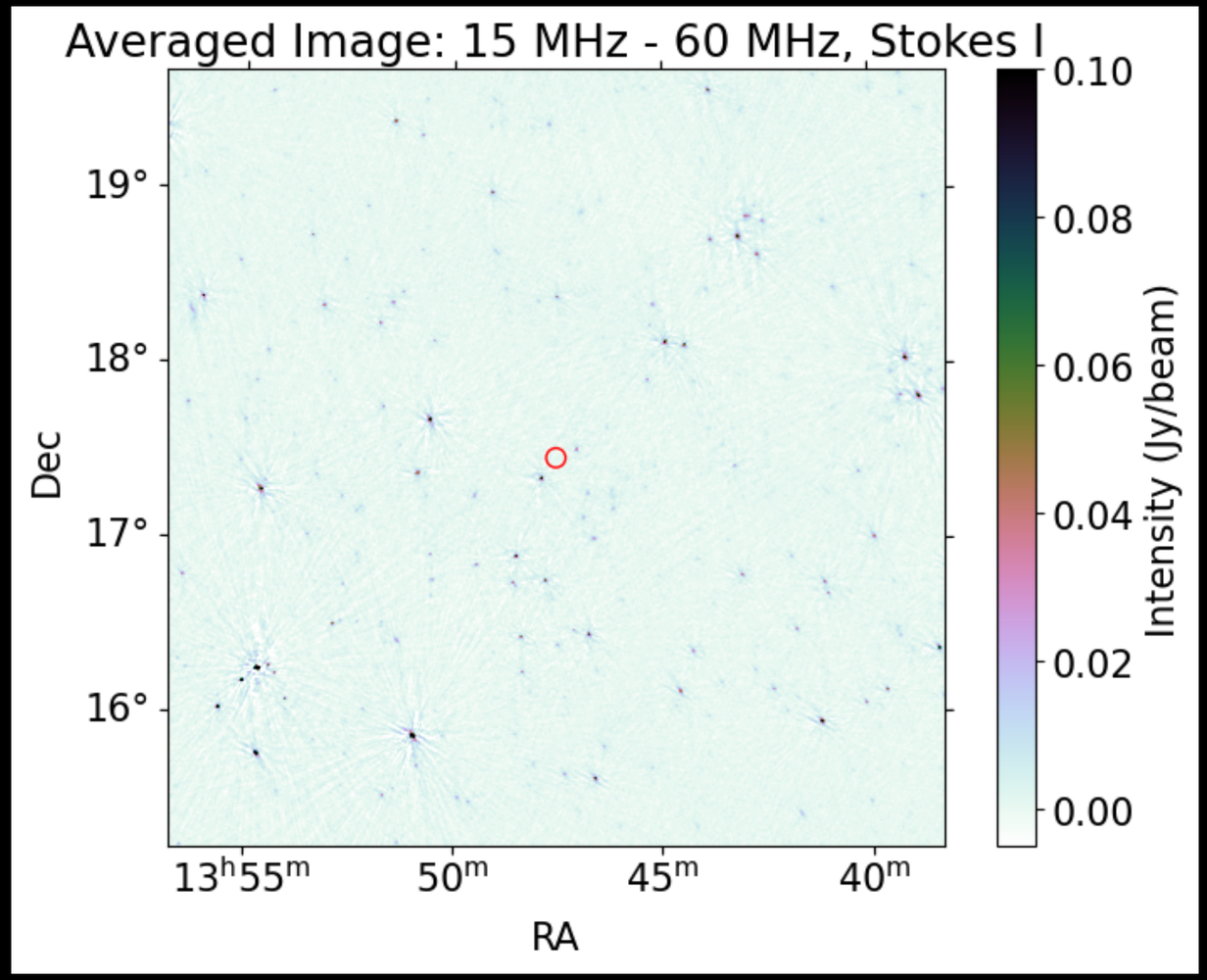
Results part 1.2: Tau Bootis b

Half of the data processed so far



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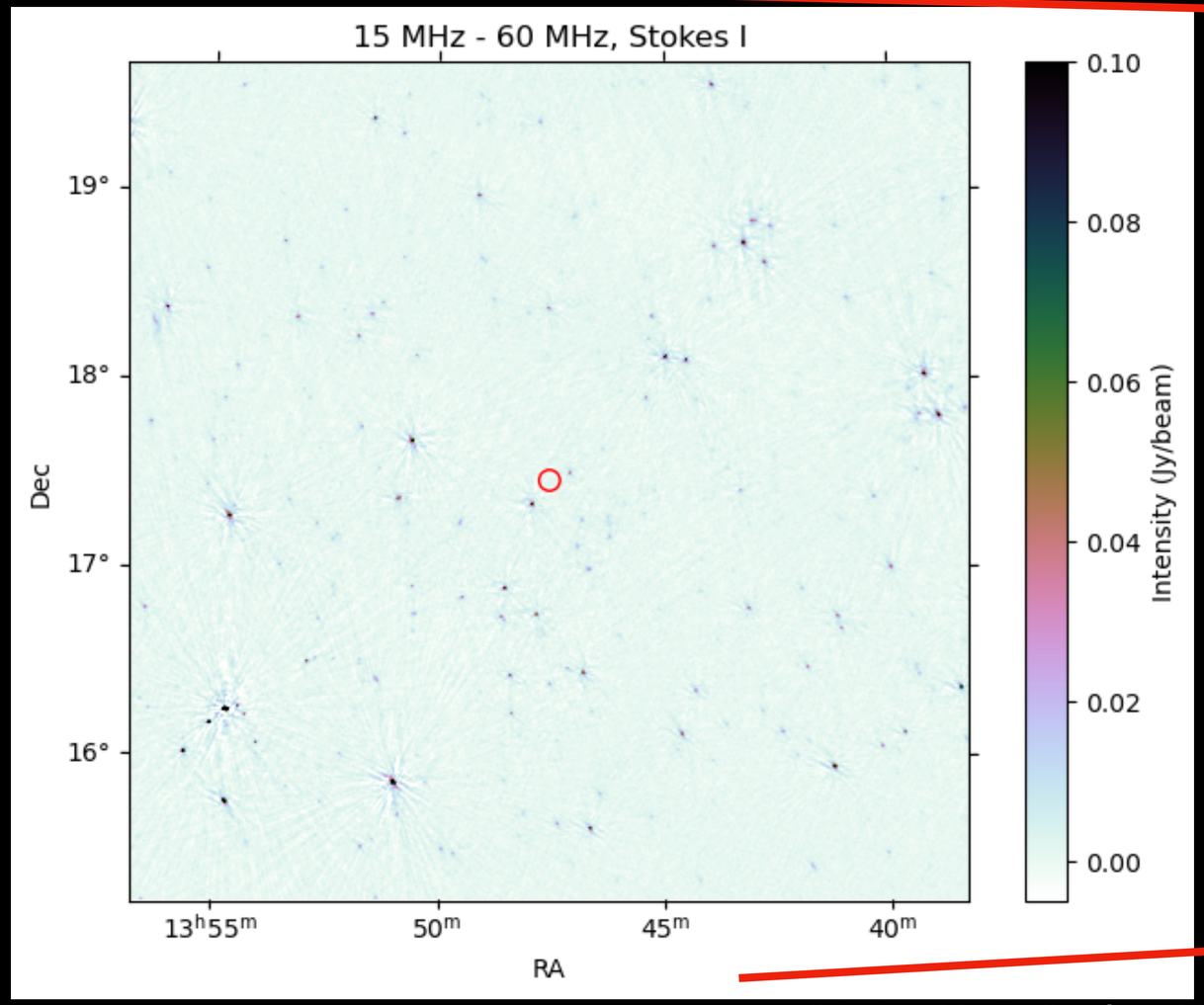
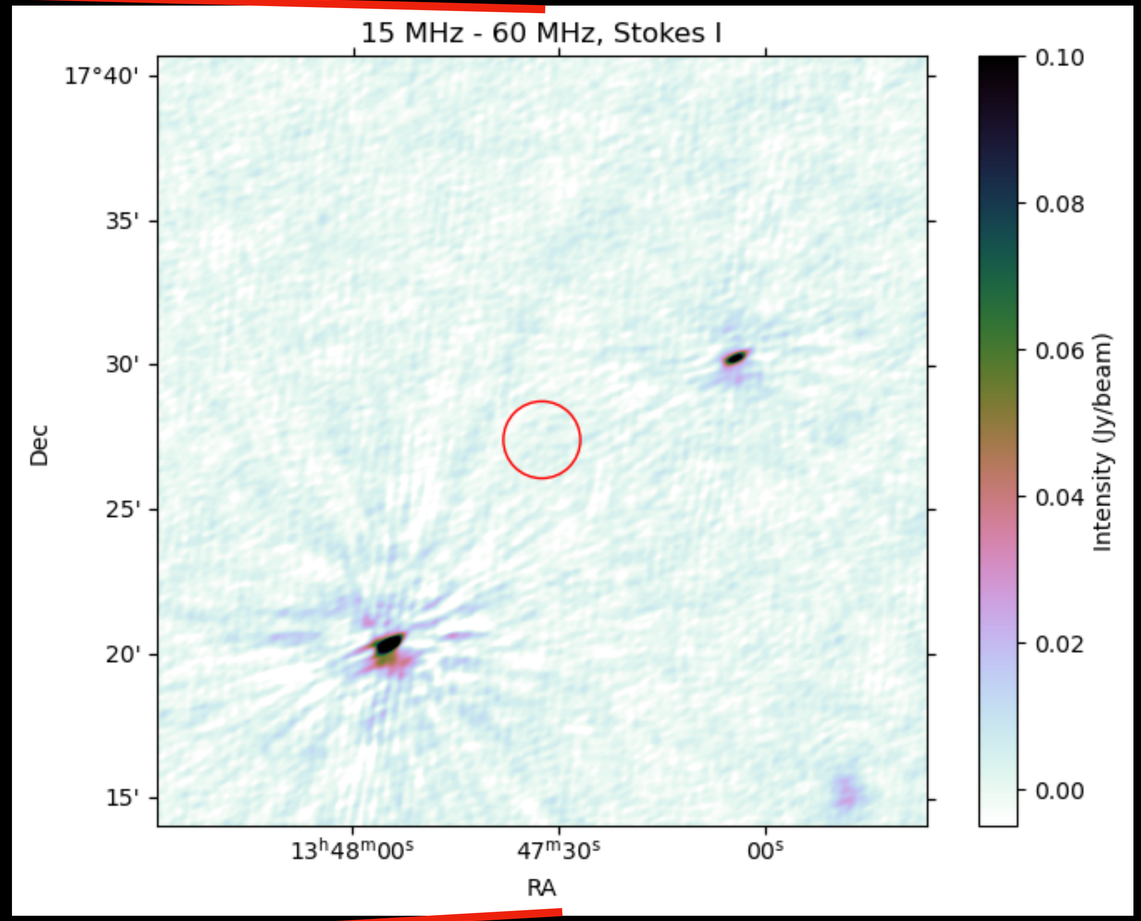
Results part 1.2: Tau Bootis b

20 hours, 2 m Jy/beam





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Results part 2: LoDeSS

- 5 hours/pointing
- Above 20 deg declination
- 15-30 MHz
- Solar minimum
- Dutch stations

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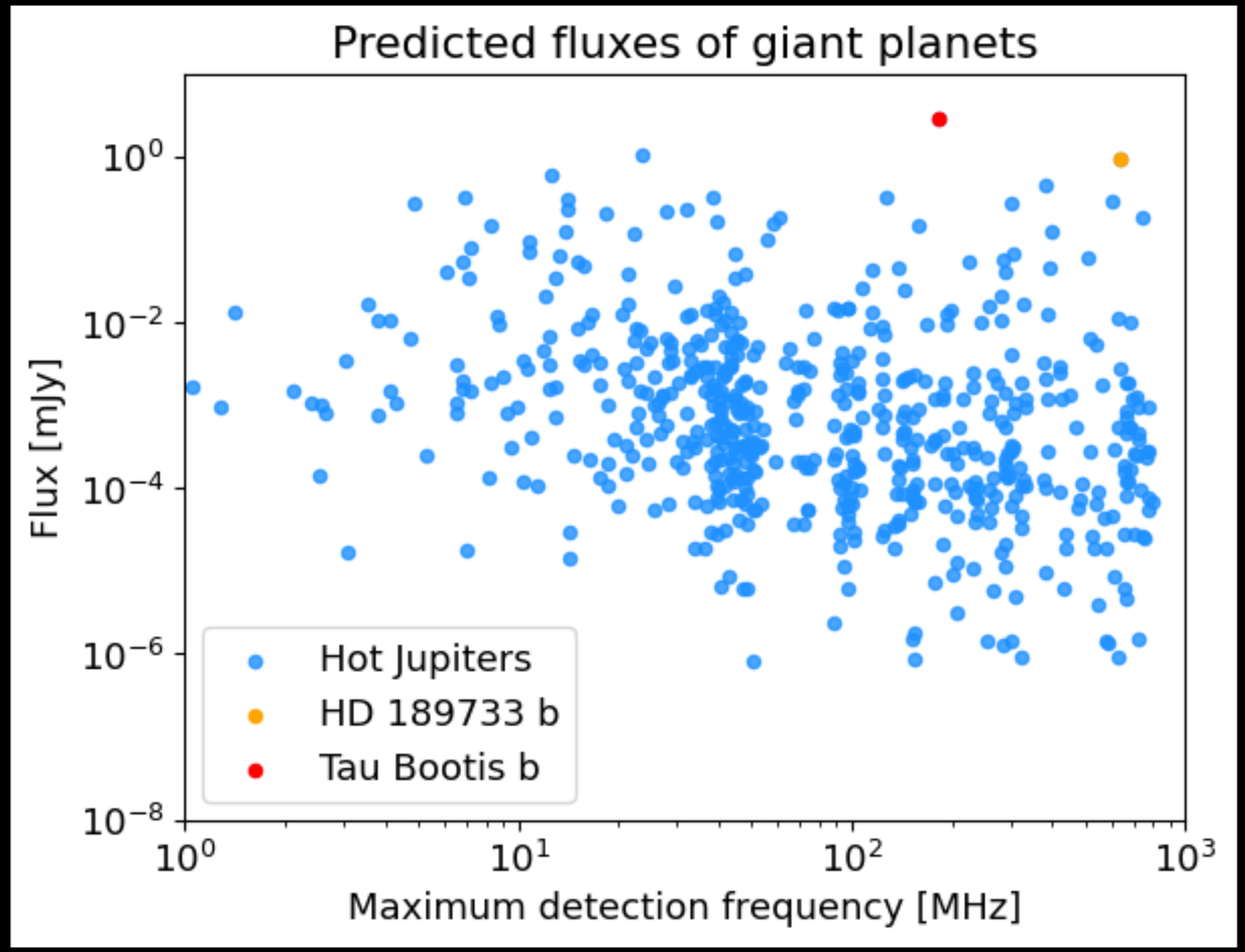
Results part 2: LoDeSS

- 28 candidates selected based on predicted fluxes with very simple model
- Currently processing



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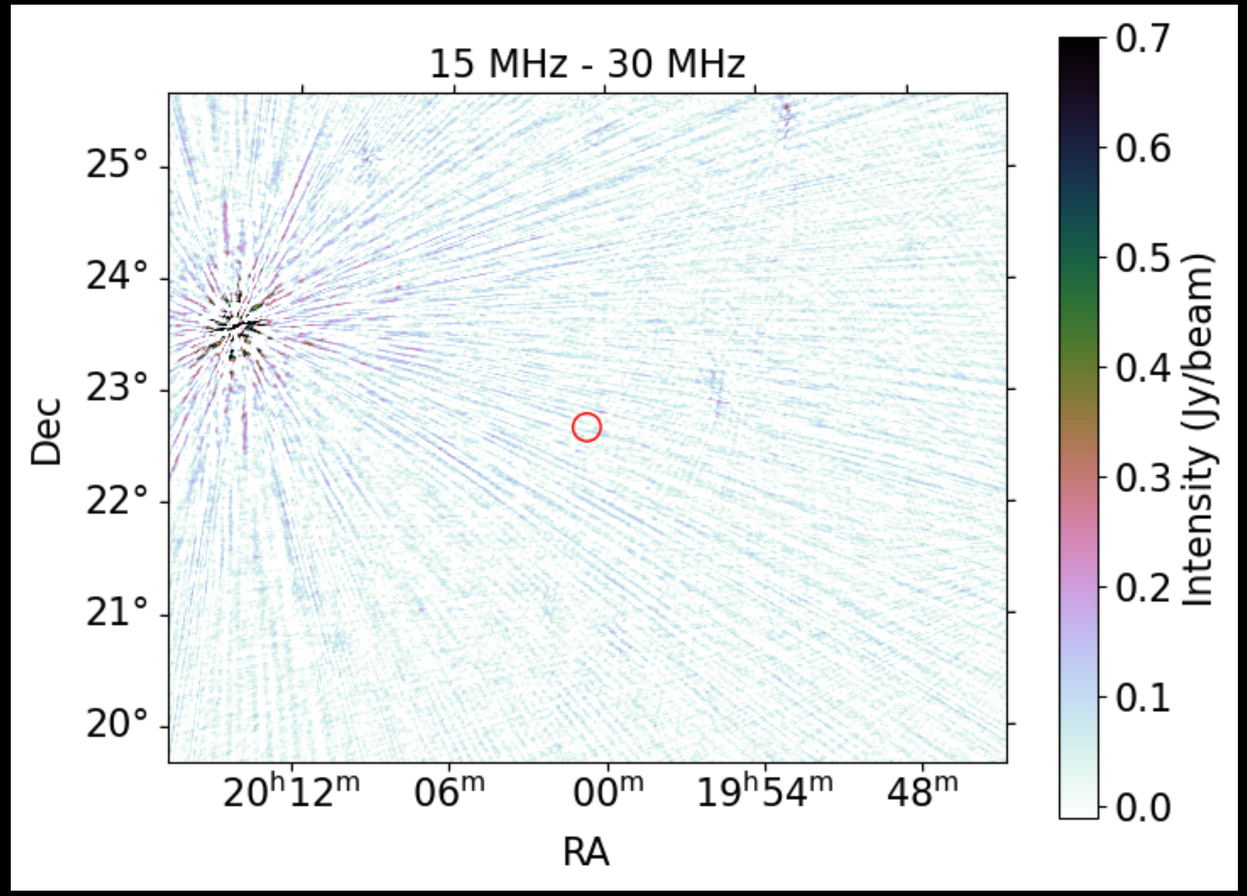
Results part 2: LoDeSS

HD 189733 b, 1 hour



80 mJy/beam

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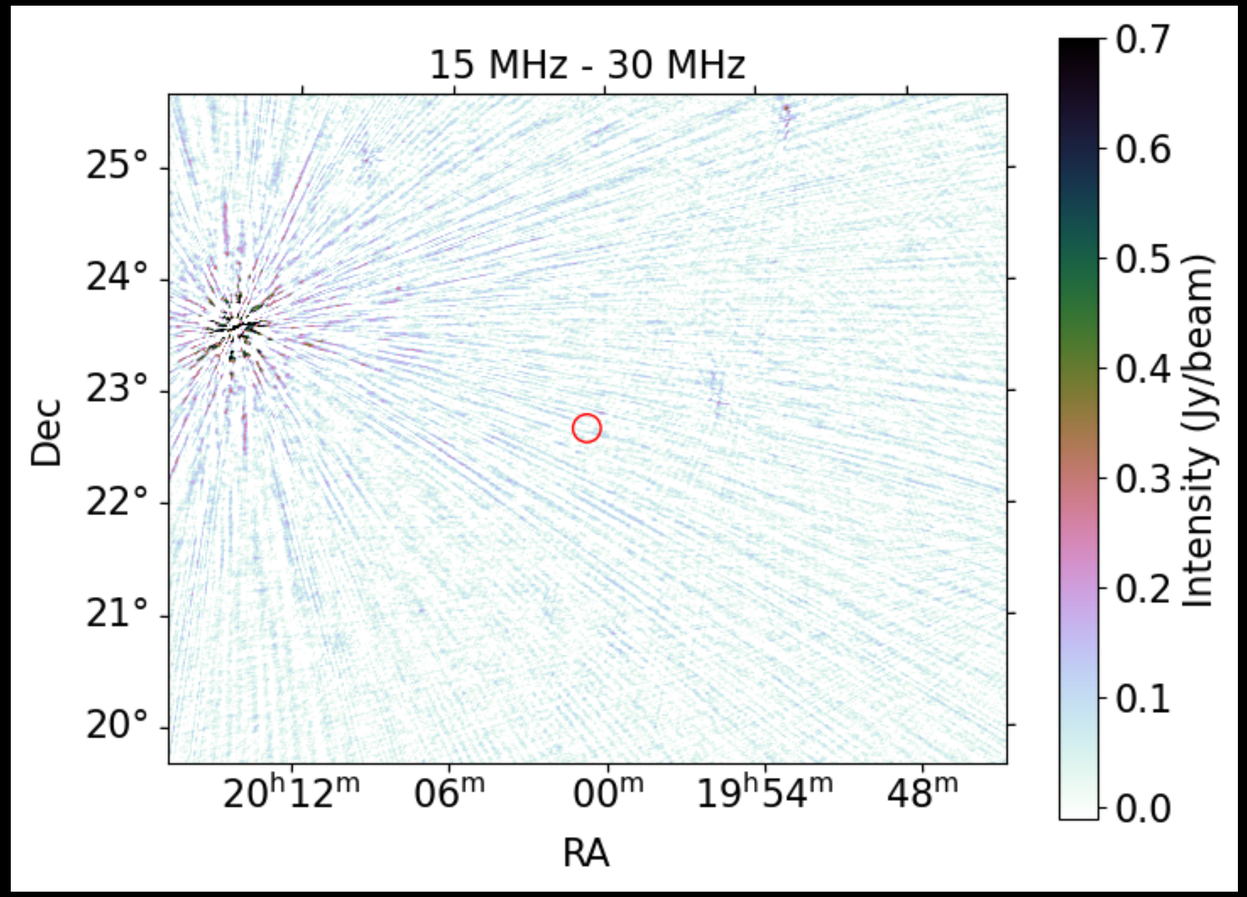
Results part 2: LoDeSS

HD 189733 b, 1 hour



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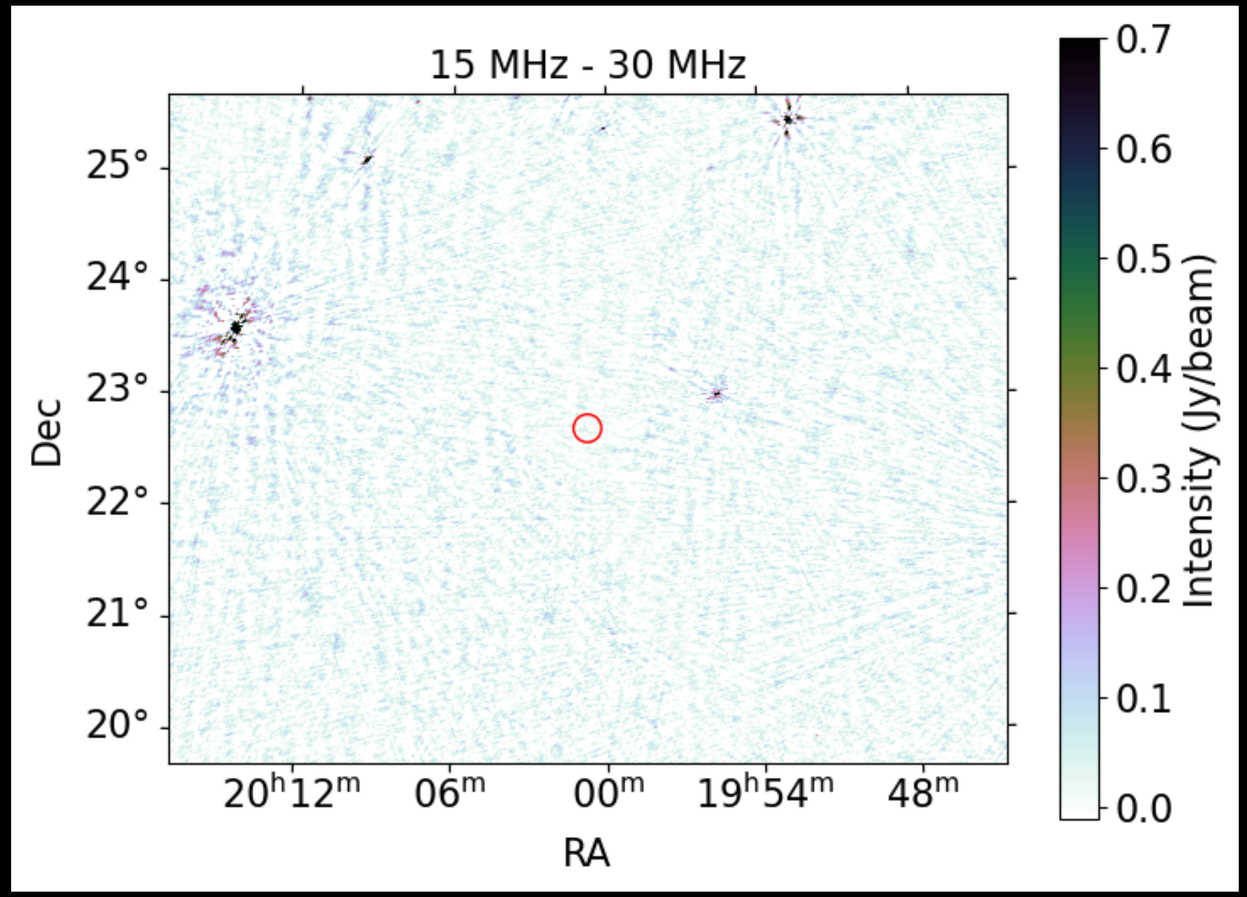

55 mJy/beam

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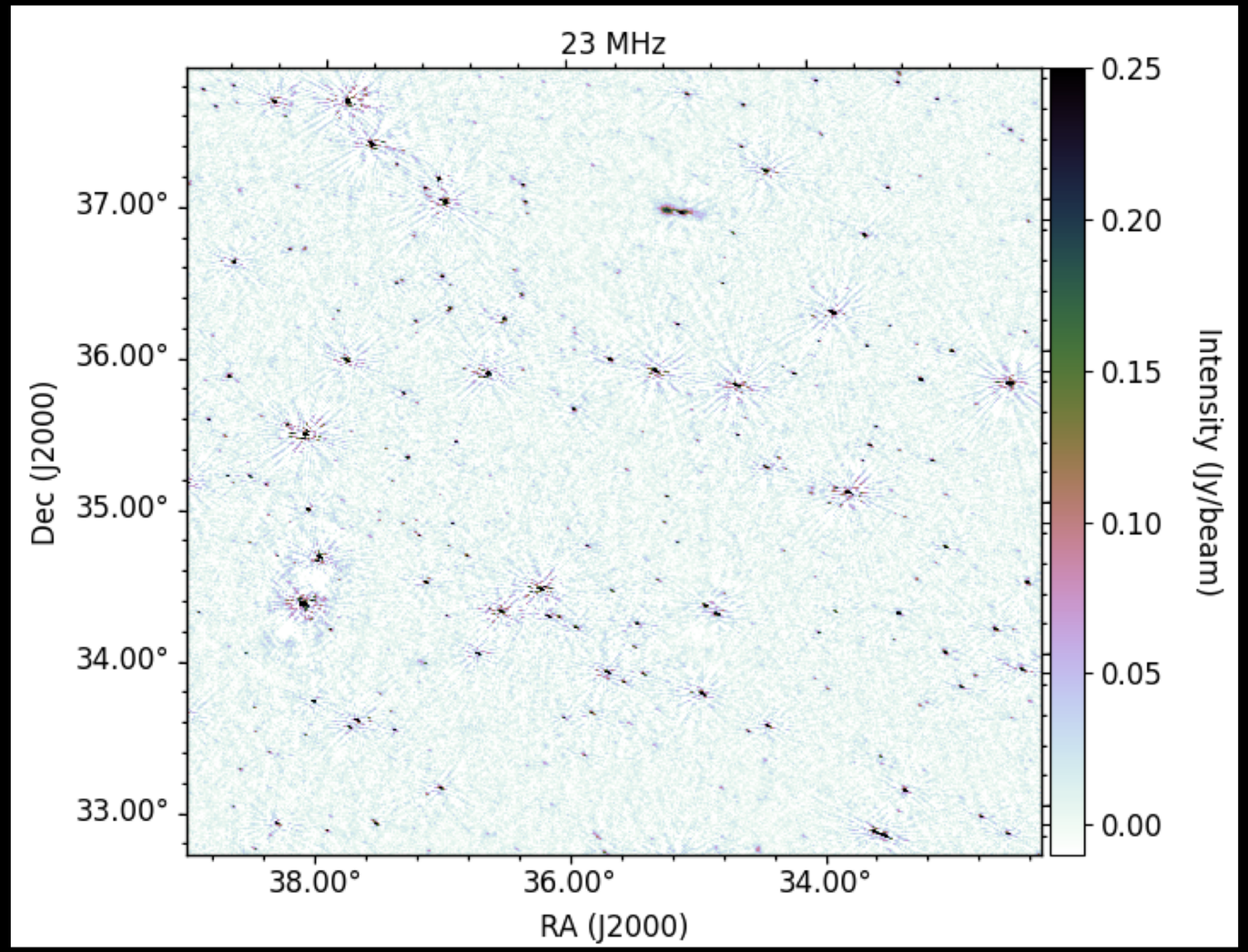
Results part 2: LoDeSS

5 hours, 7 mJy/beam



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What’s next?

- Finish all these
- LOFAR2

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- Finish all these
- LOFAR2

Conclusion

Planets in radio are very hard to find!

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Results part 2: LoDeSS

- More about the model:
  - Find stellar wind - Parker for v and X-rays for Mloss (Wood et all. (2021))
  - Find interplanetary magnetic field - Rosby number (Rodriguez-Mozos and Moya (2019))
  - Find planet's magentic moment - (Reiners and Christensen (2010))
  - Find standoff distance - pressure equilibrium
  - Find flux - Bode's law

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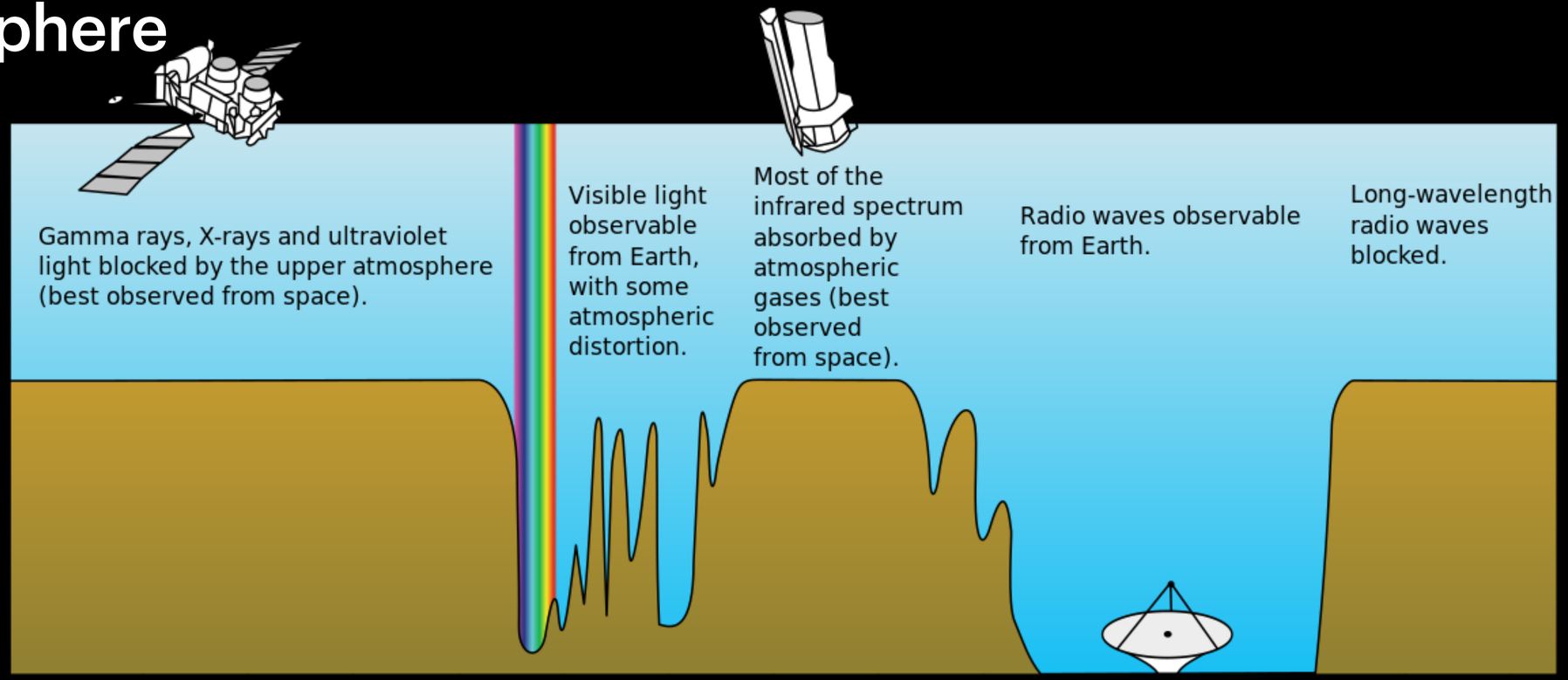
The hardest obstacle

- Ionosphere



Credit: Wiki

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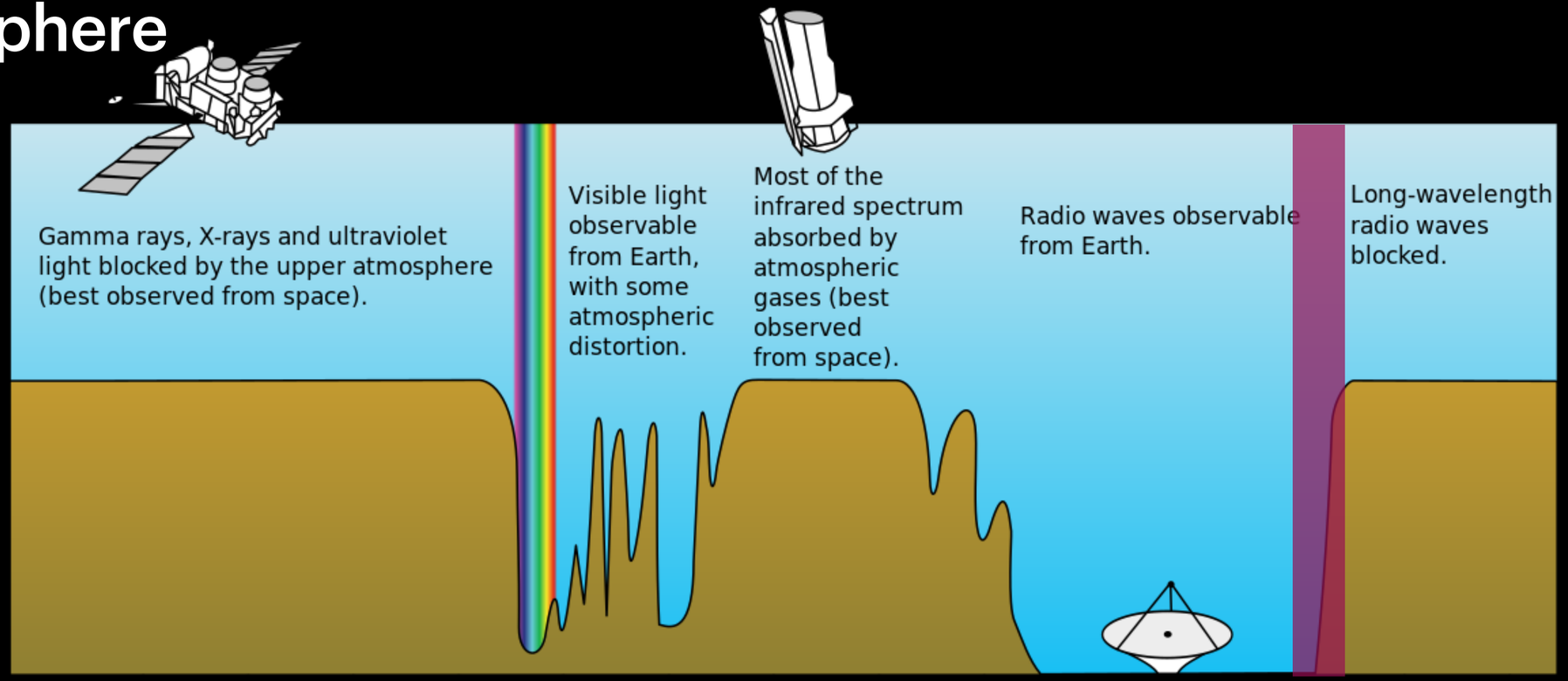
The hardest obstacle

- Ionosphere



Credit: Wiki

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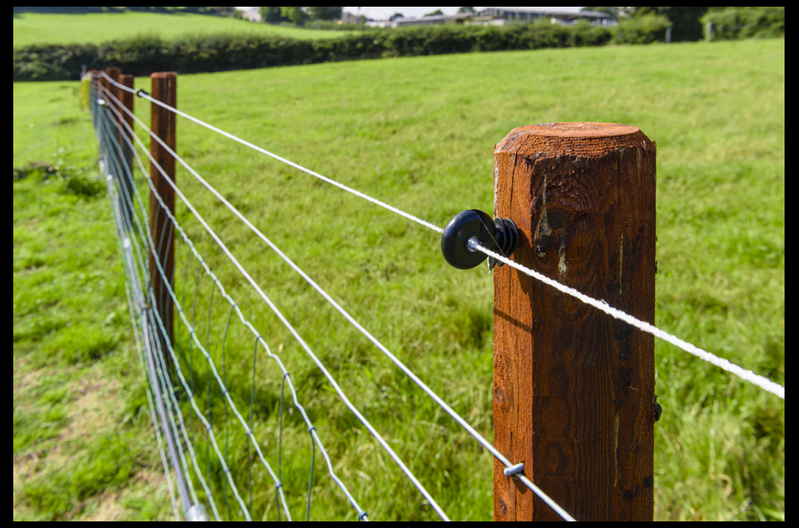
Difficulties

- Ionosphere
- Human made interference

Credit: WIRED

Credit: Erdosain



Credit: Stephen Barnes

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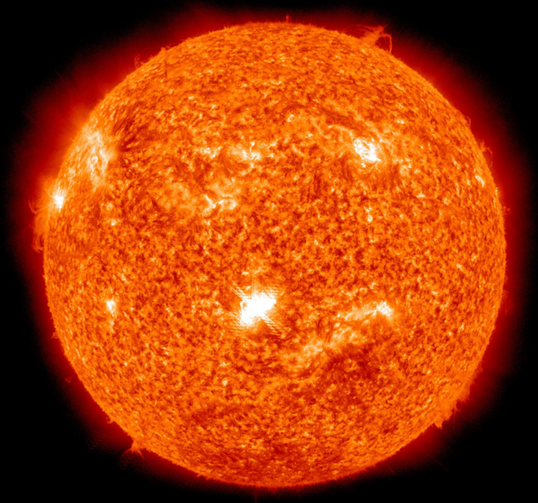
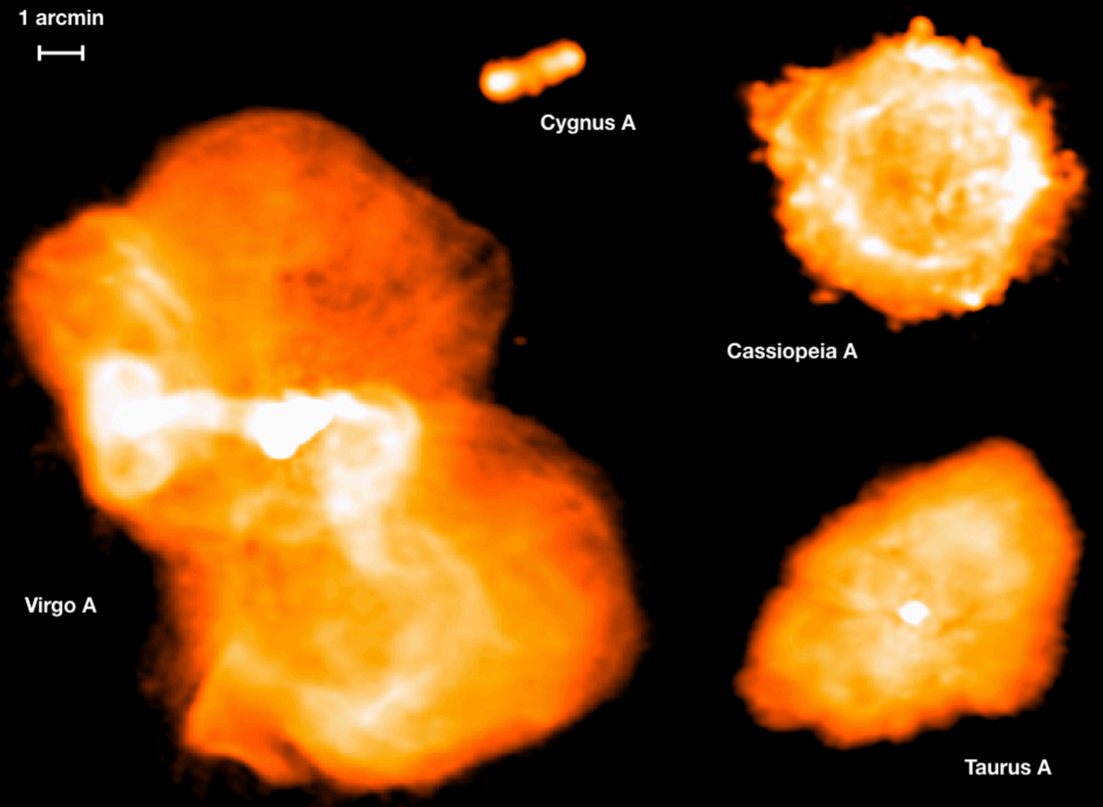
Difficulties

- Human made interference
- Rapid varying ionosphere
- Bright radio sources (FOV)



Credit: National Geographic



De Gasperin et. al. (2020)

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