

Radio EXOPLANETS and Stars The lower - the better

Cristina-Maria Cordun



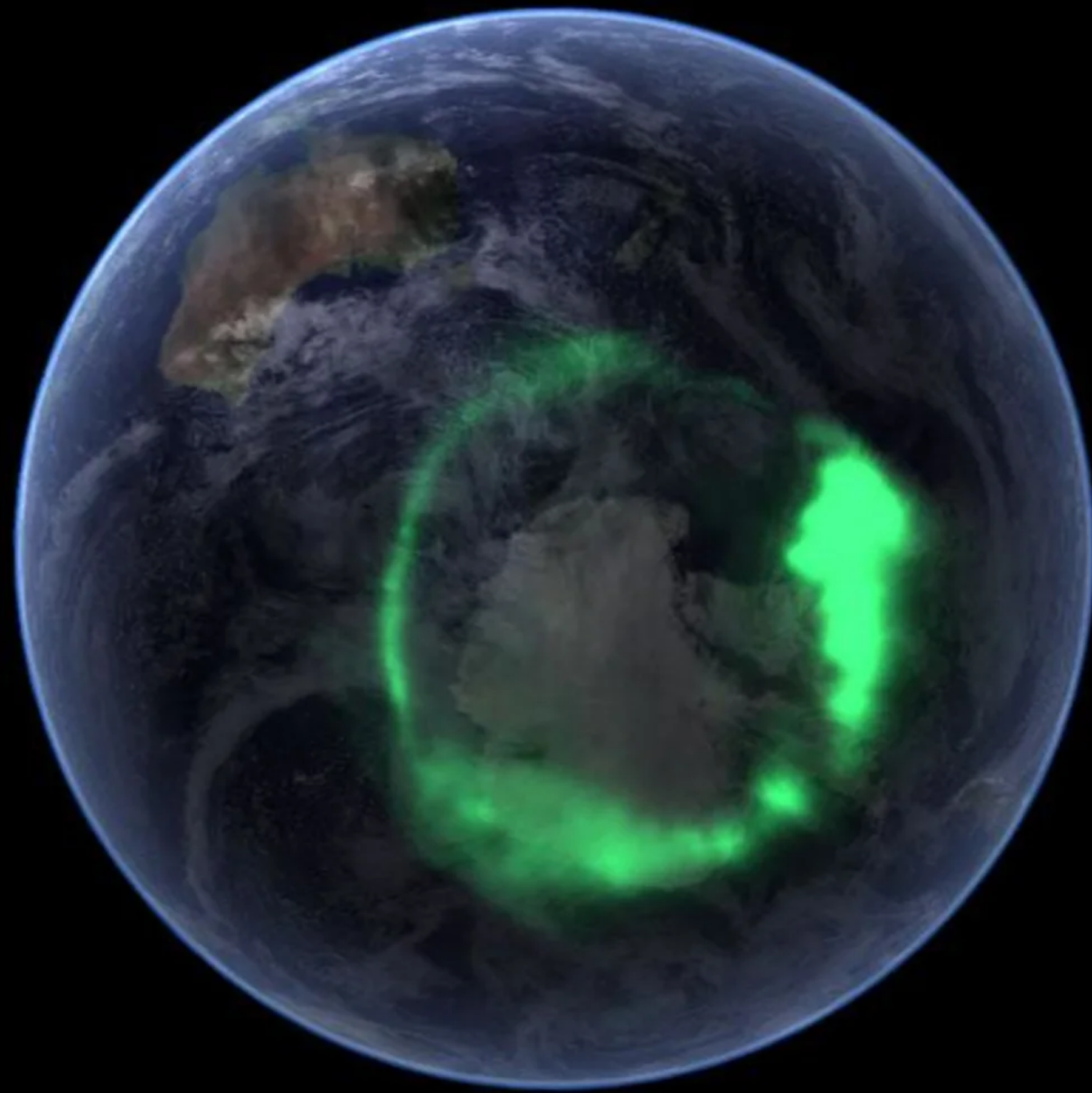
What is the closest radio emitter to us? (Not thermal)

What is the closest radio emitter to us?



**What is the closest NATURAL
radio emitter to us? (Not thermal)**

What is the closest NATURAL radio emitter to us?

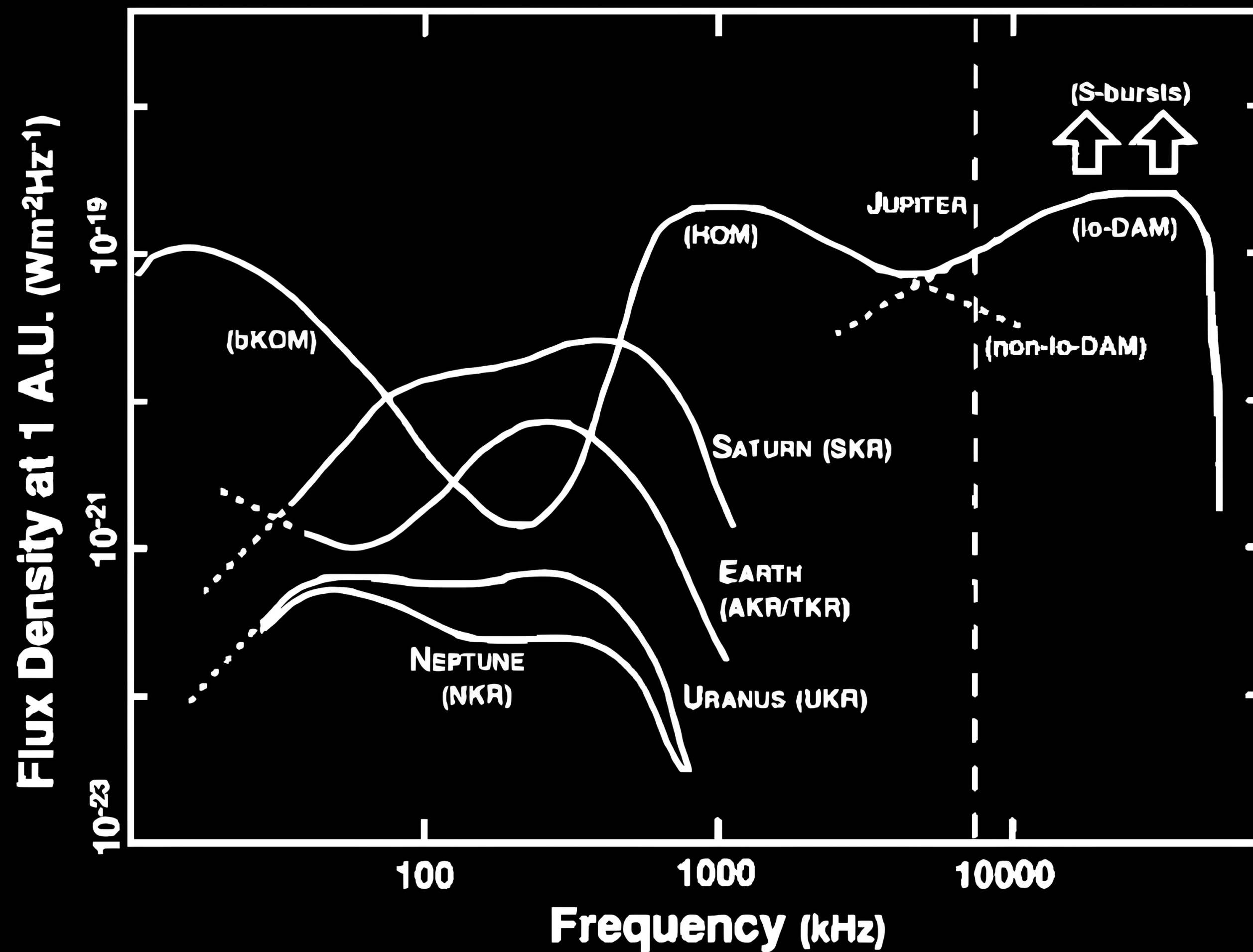


Credit: British
Antarctic Survey

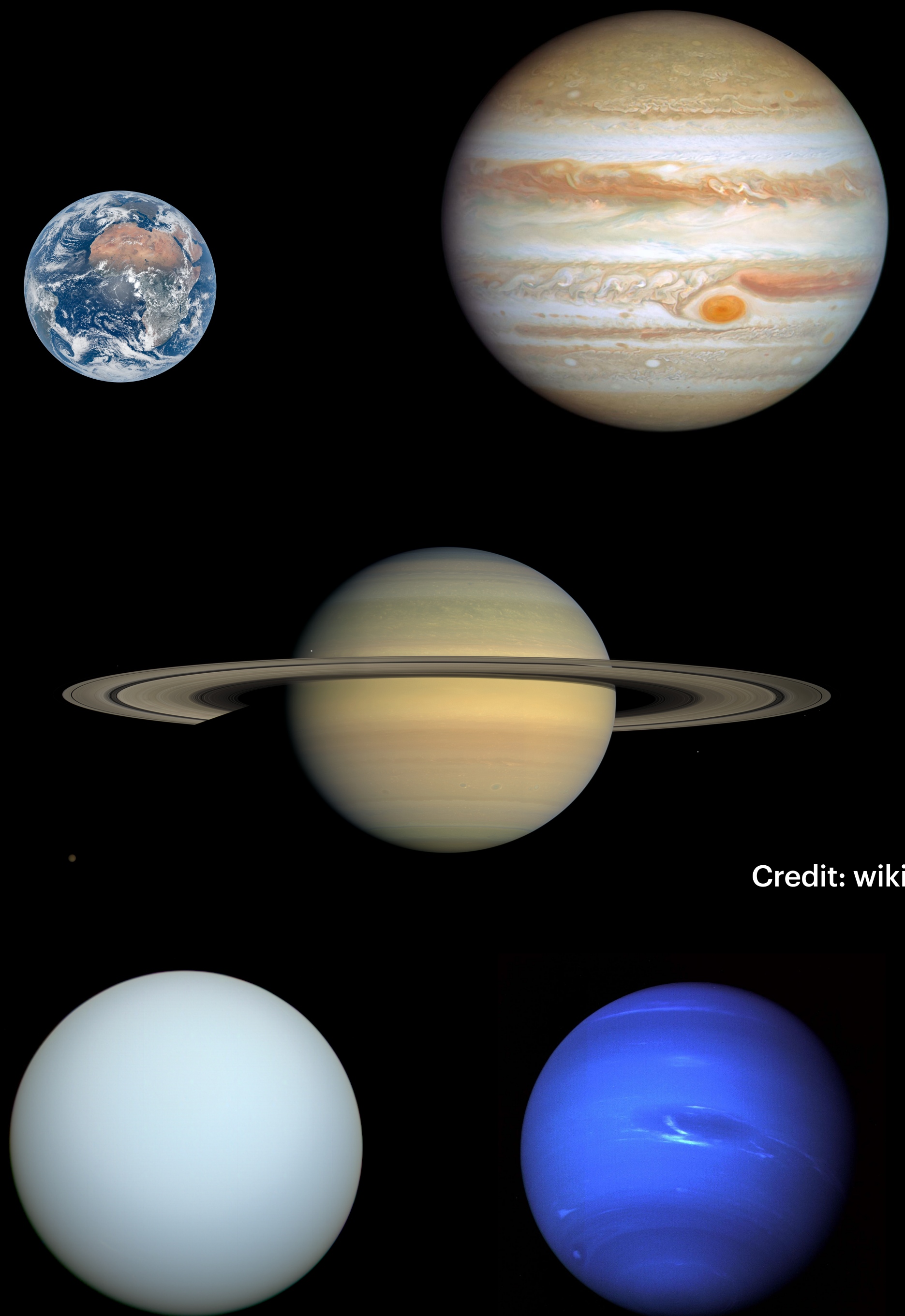


Credit: NASA

The Solar System



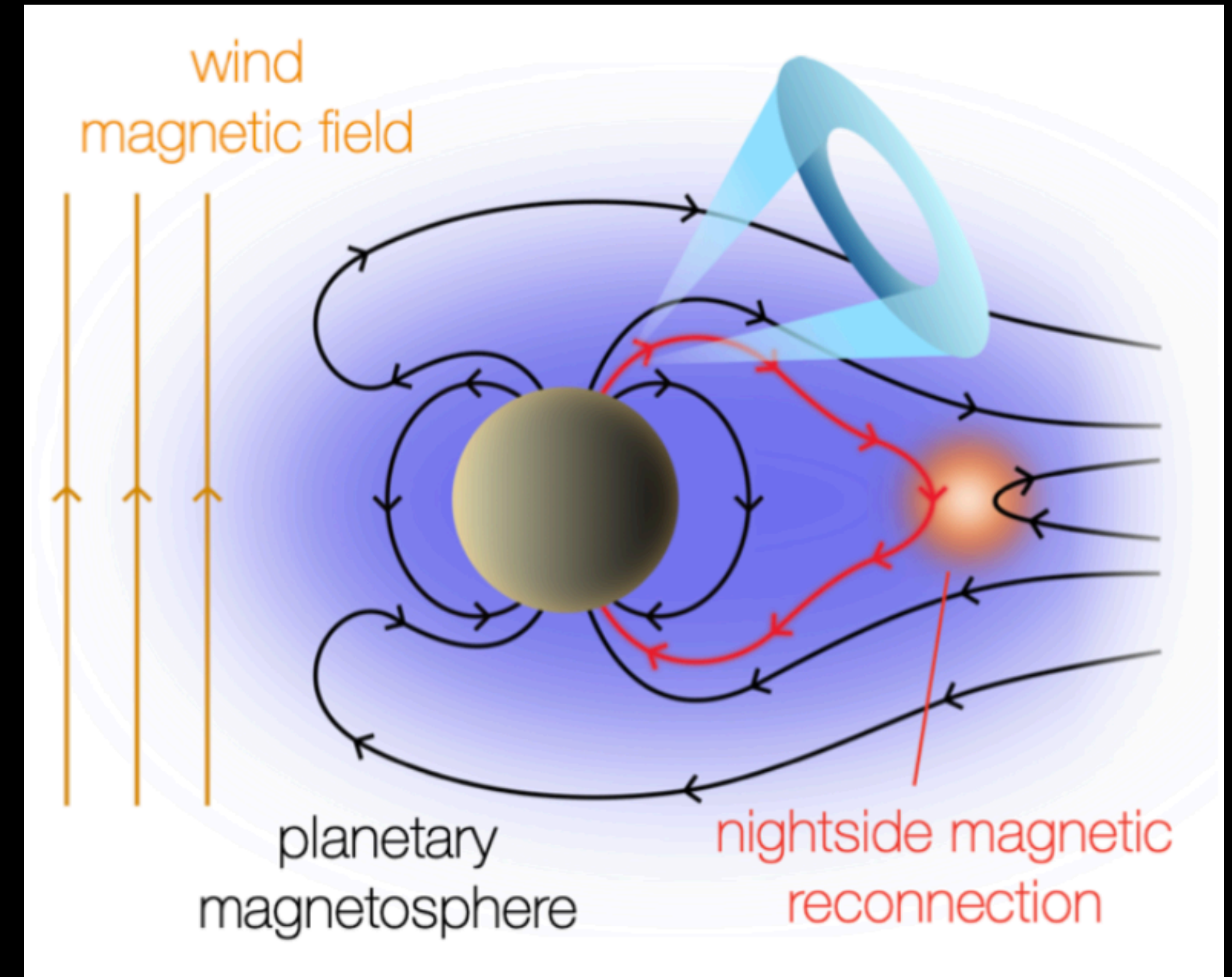
Zarka (1998)



Auroral emission

- ECMI
- Beamed
- Circularly polarized
- Planet rotation (Jupiter)
- Cut-off frequency

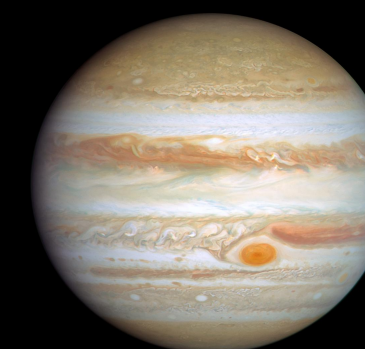
$$f_c[\text{MHz}] = 2.8B_{\text{Jupiter}}[\text{G}] \rightarrow f_c < 30 \text{ MHz}$$



Credit: Rob Kavanagh

Jupiter

(UV)

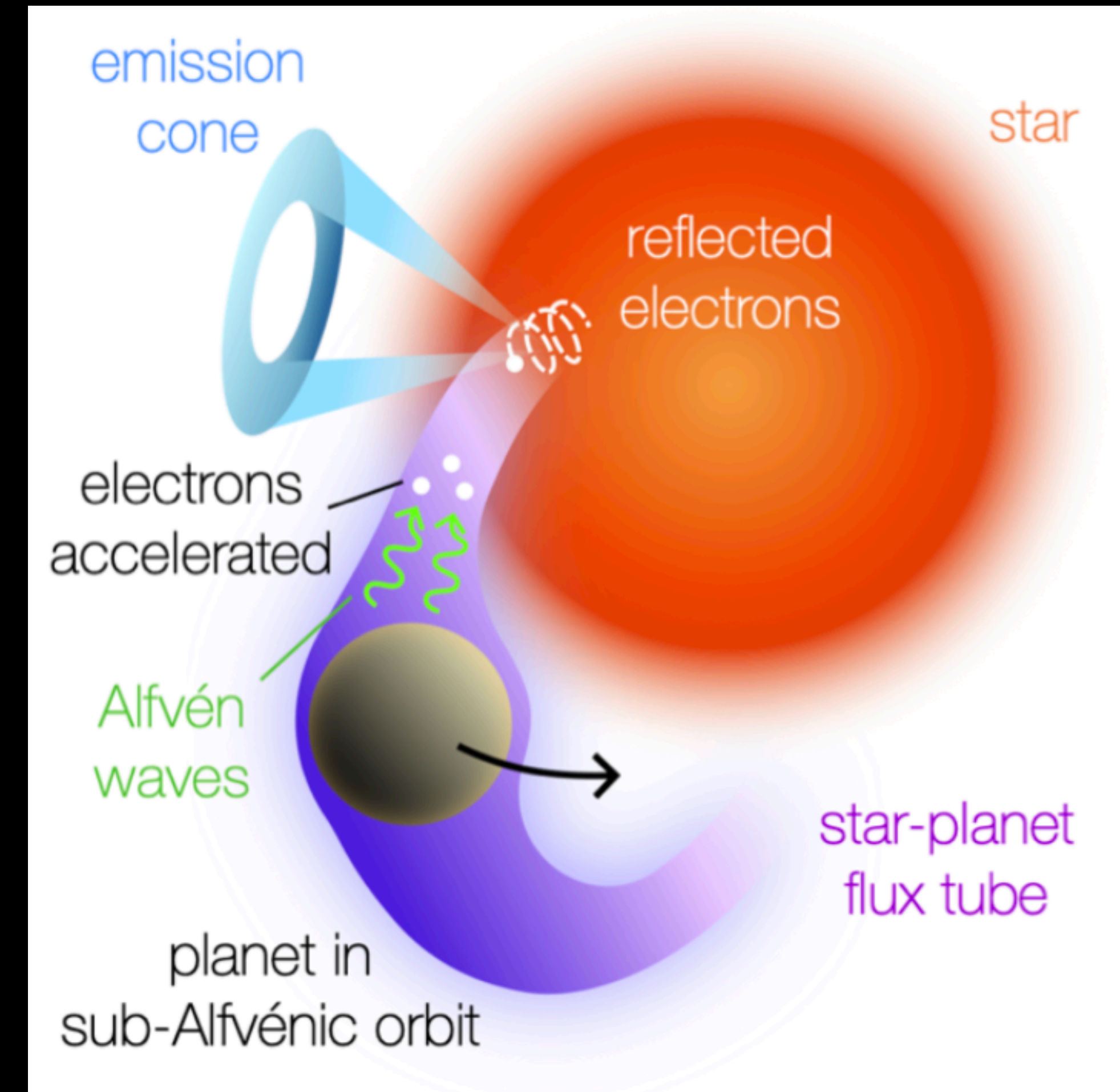


Credit: ESA

Jupiter - satellites (mostly Io)

- ECMI
- Beamed
- Circularly polarized
- Satellite revolution (Io)
- Cut-off frequency

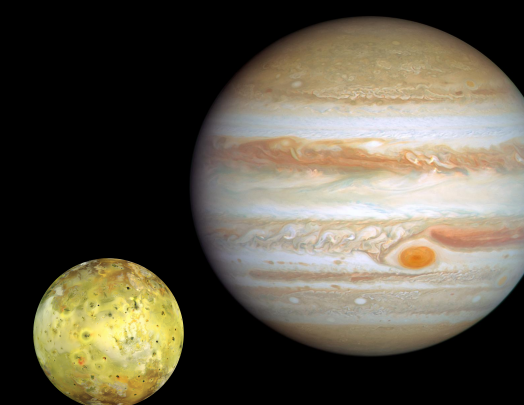
$$f_c[\text{MHz}] = 2.8B_{\text{Jupiter}}[\text{G}] \rightarrow f_c < 30 \text{ MHz}$$



Credit: Rob Kavanagh

Jupiter - satellites (mostly Io)

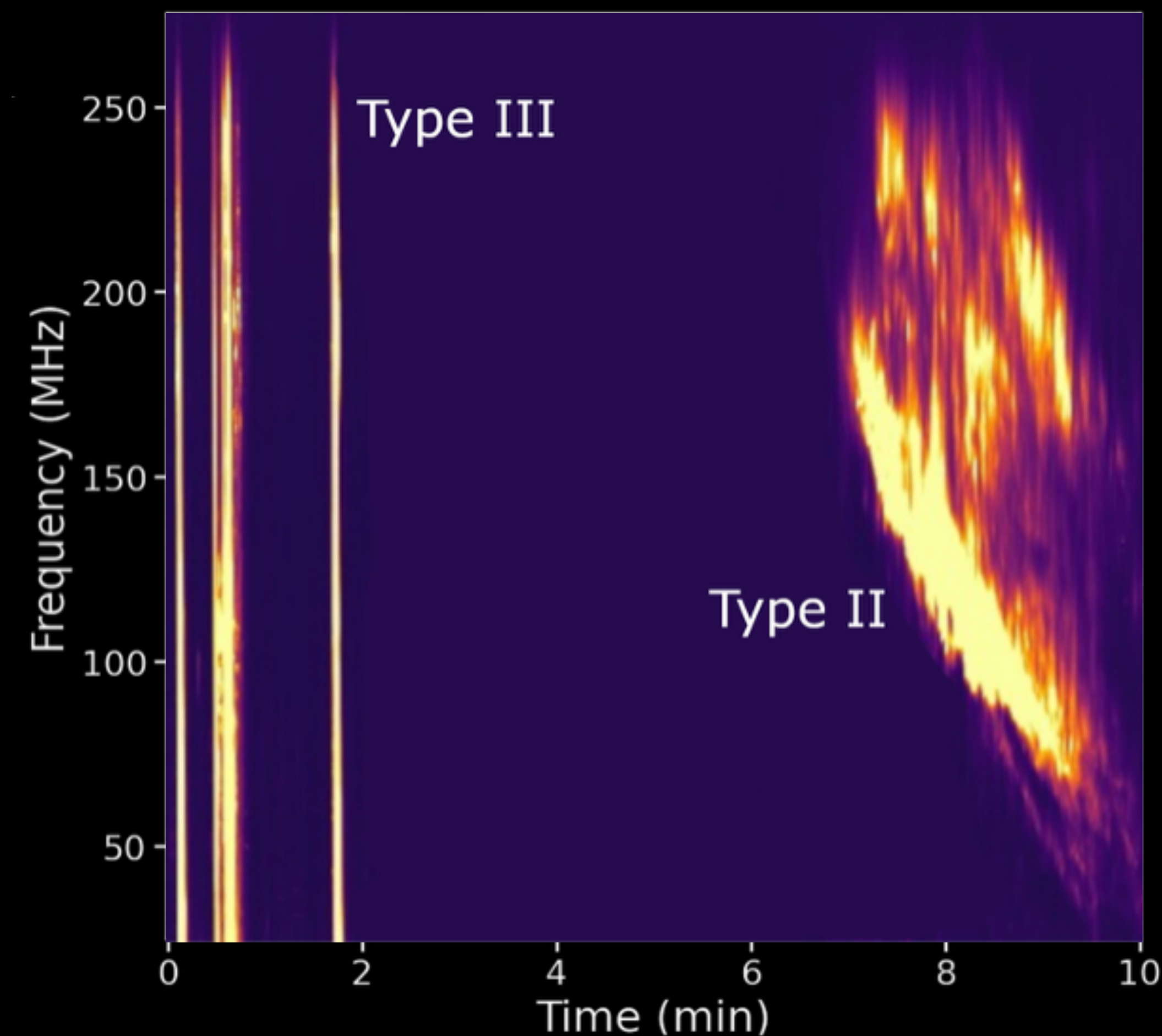
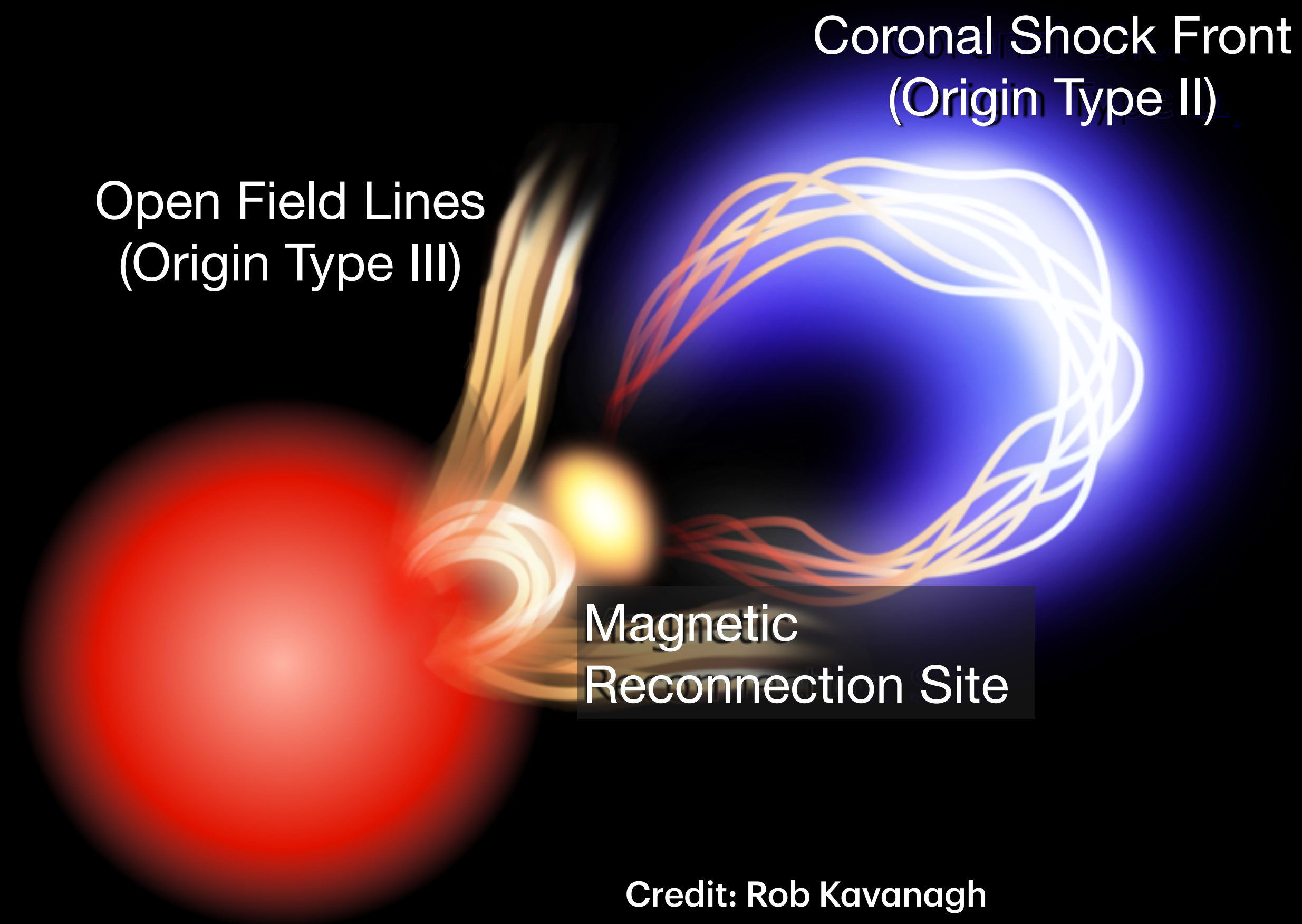
(UV)



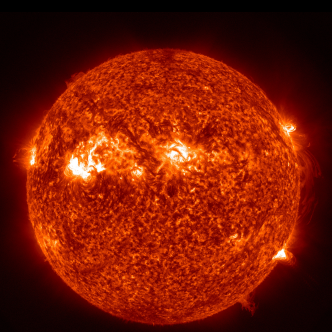
Credit: ESA

Sun

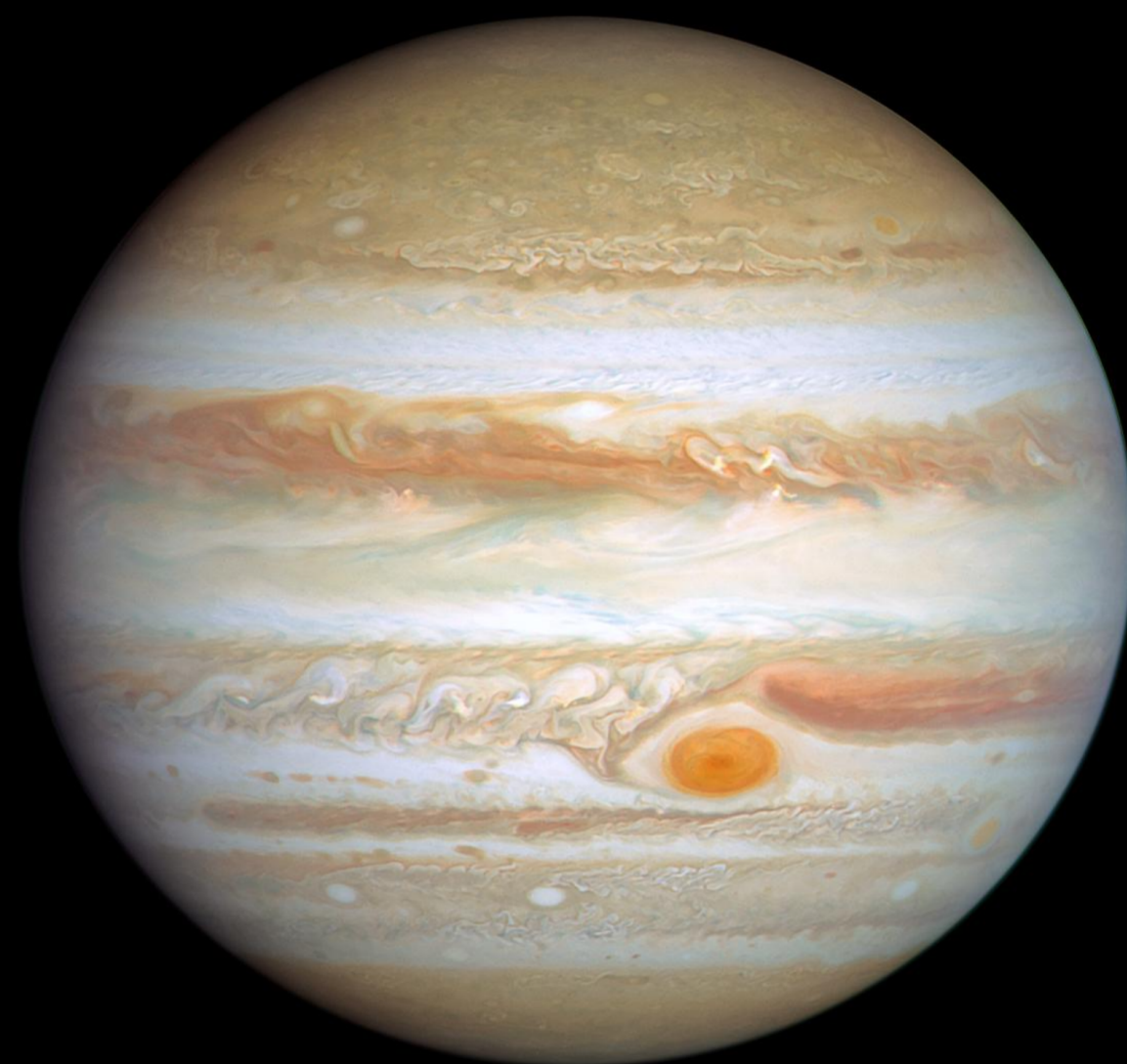
- Plasma emission (see solar session)



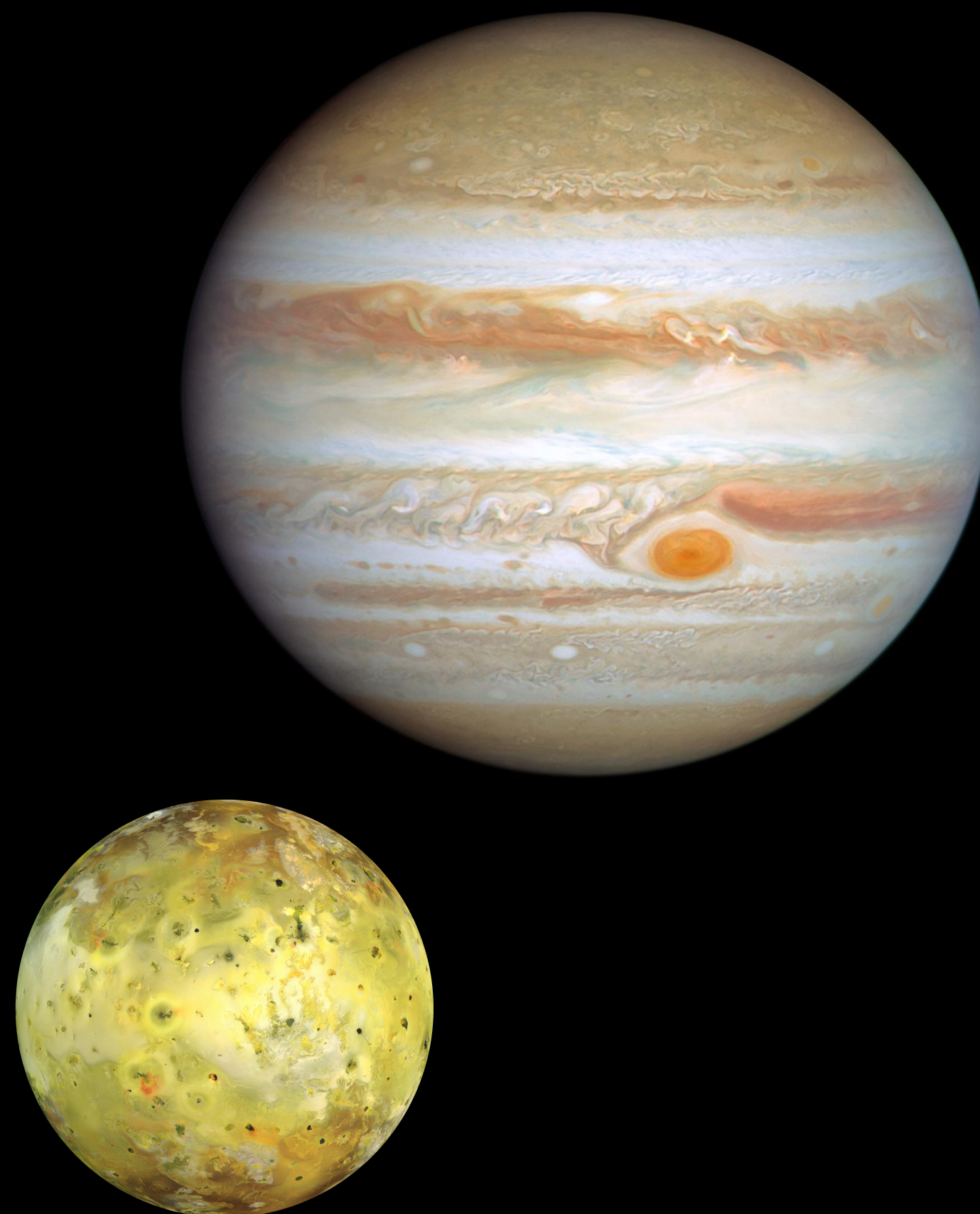
Credit: Joe Callingham



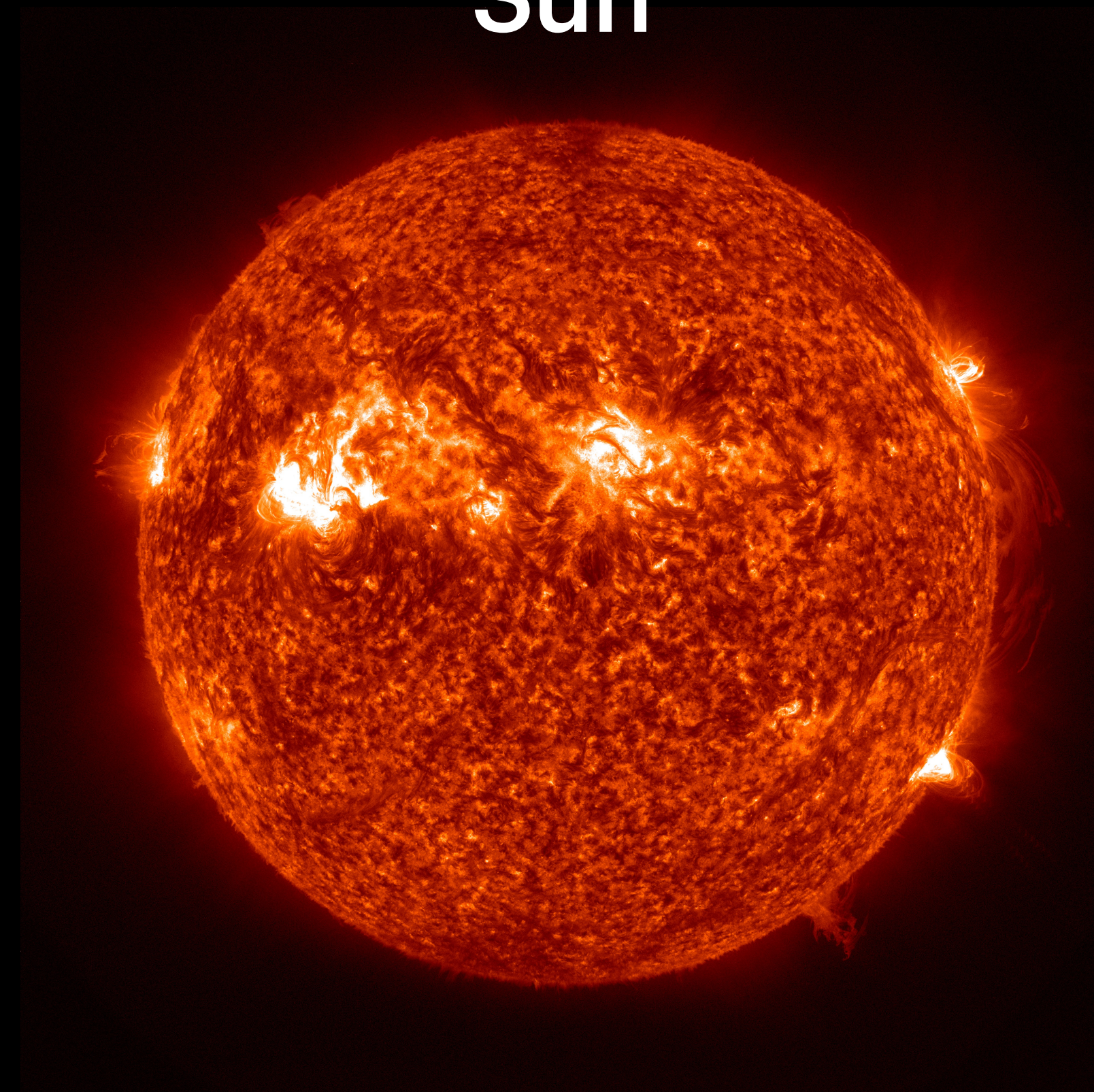
Jupiter



Jupiter - Io

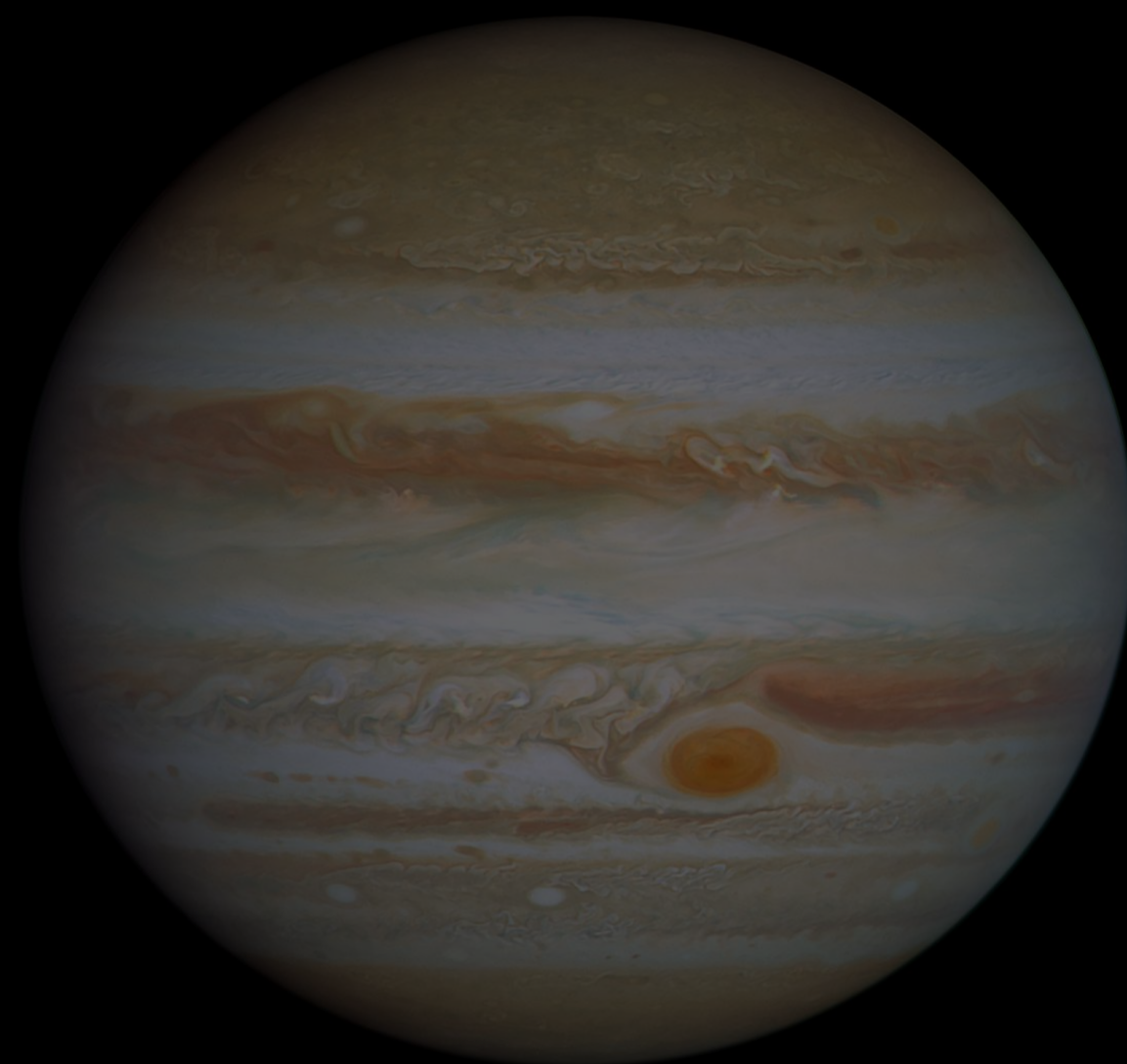


Sun

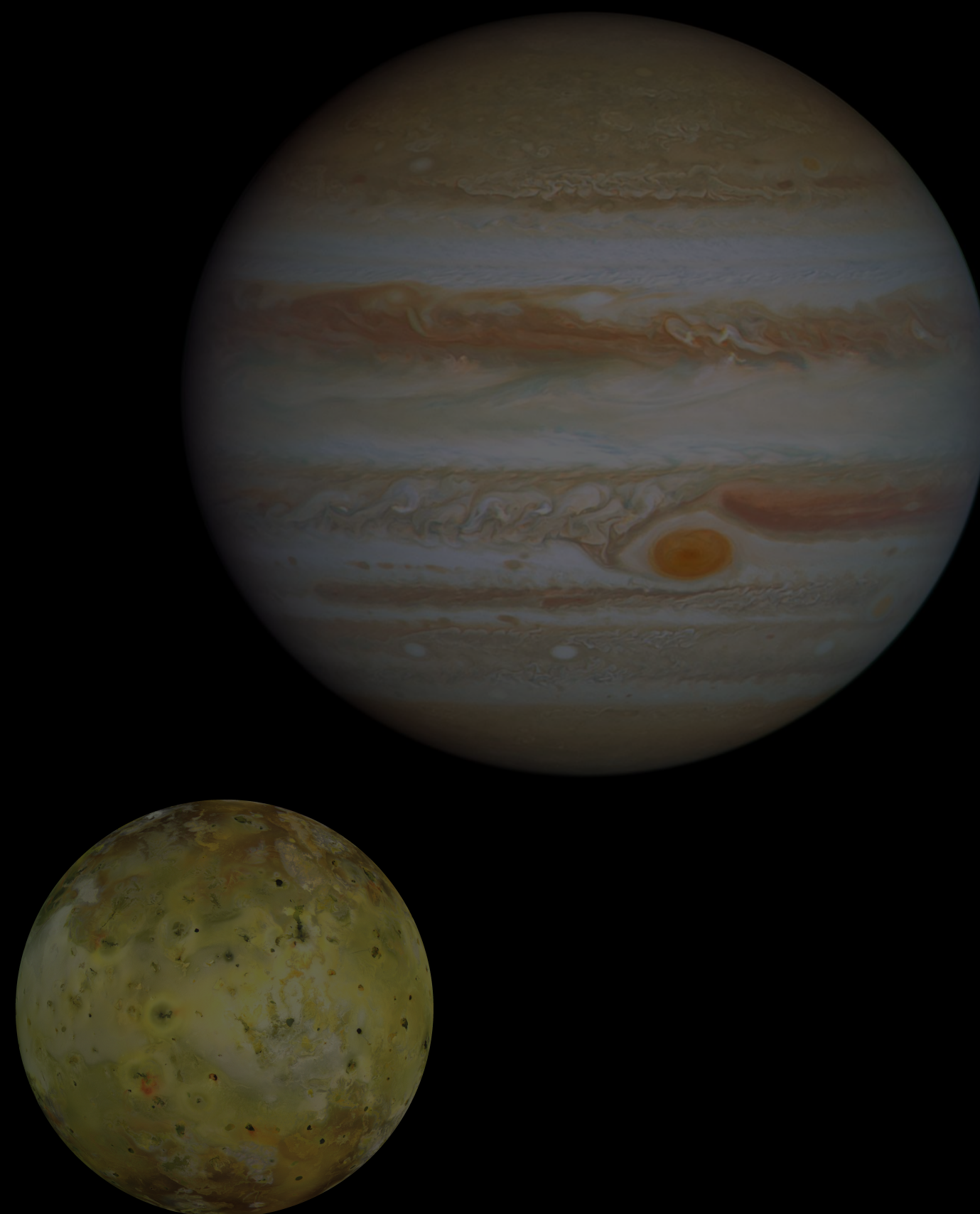


Credit: wiki

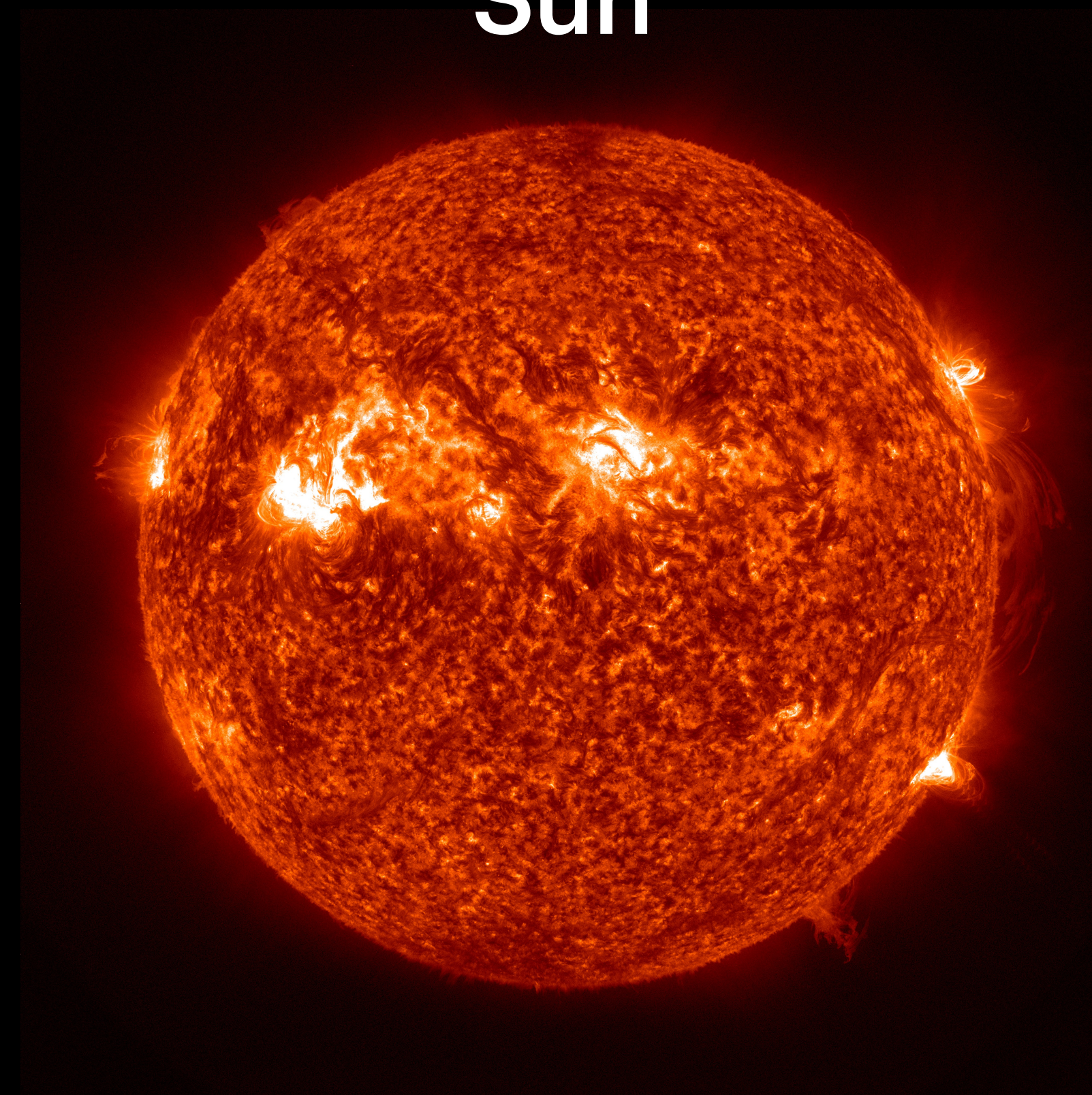
Jupiter



Jupiter - Io

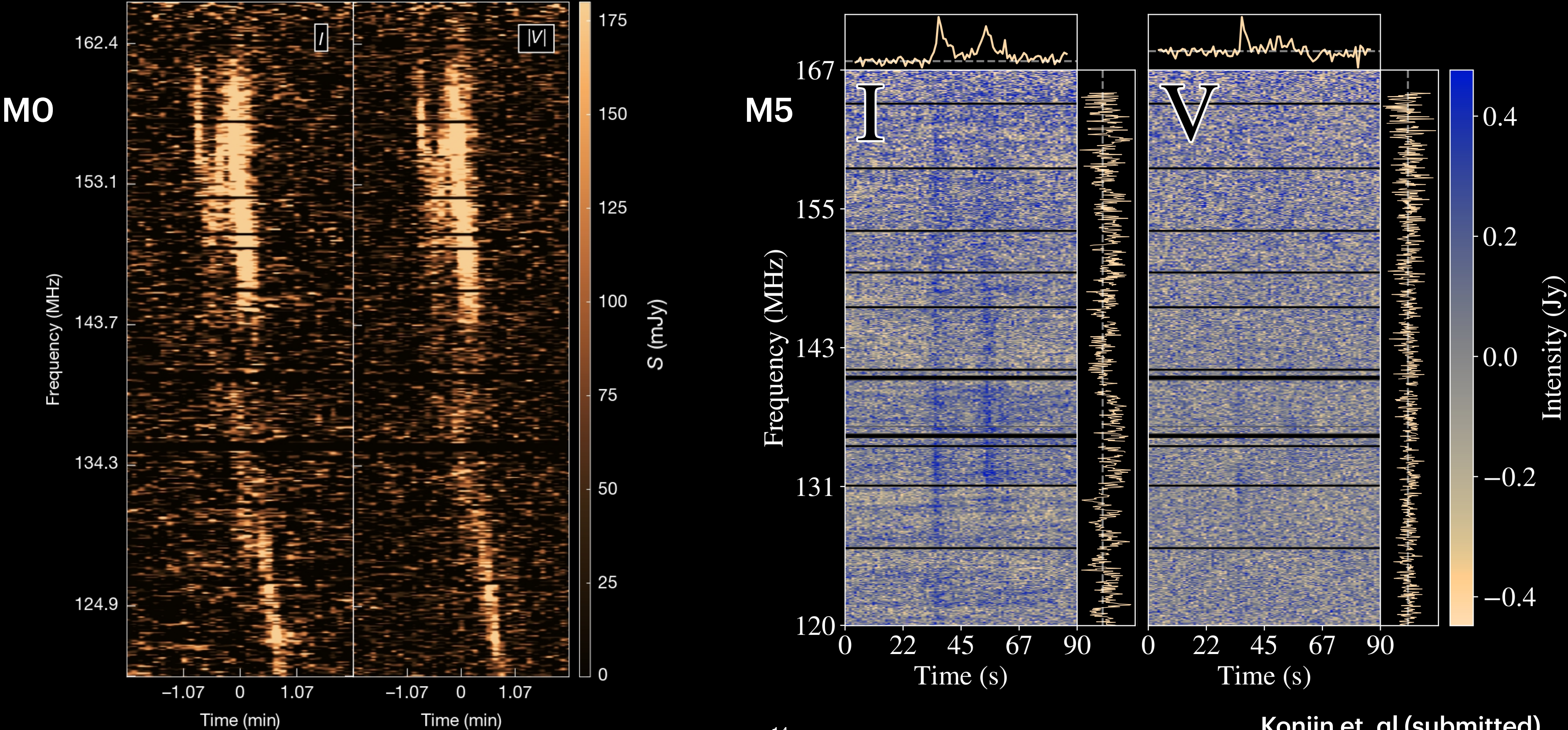


Sun

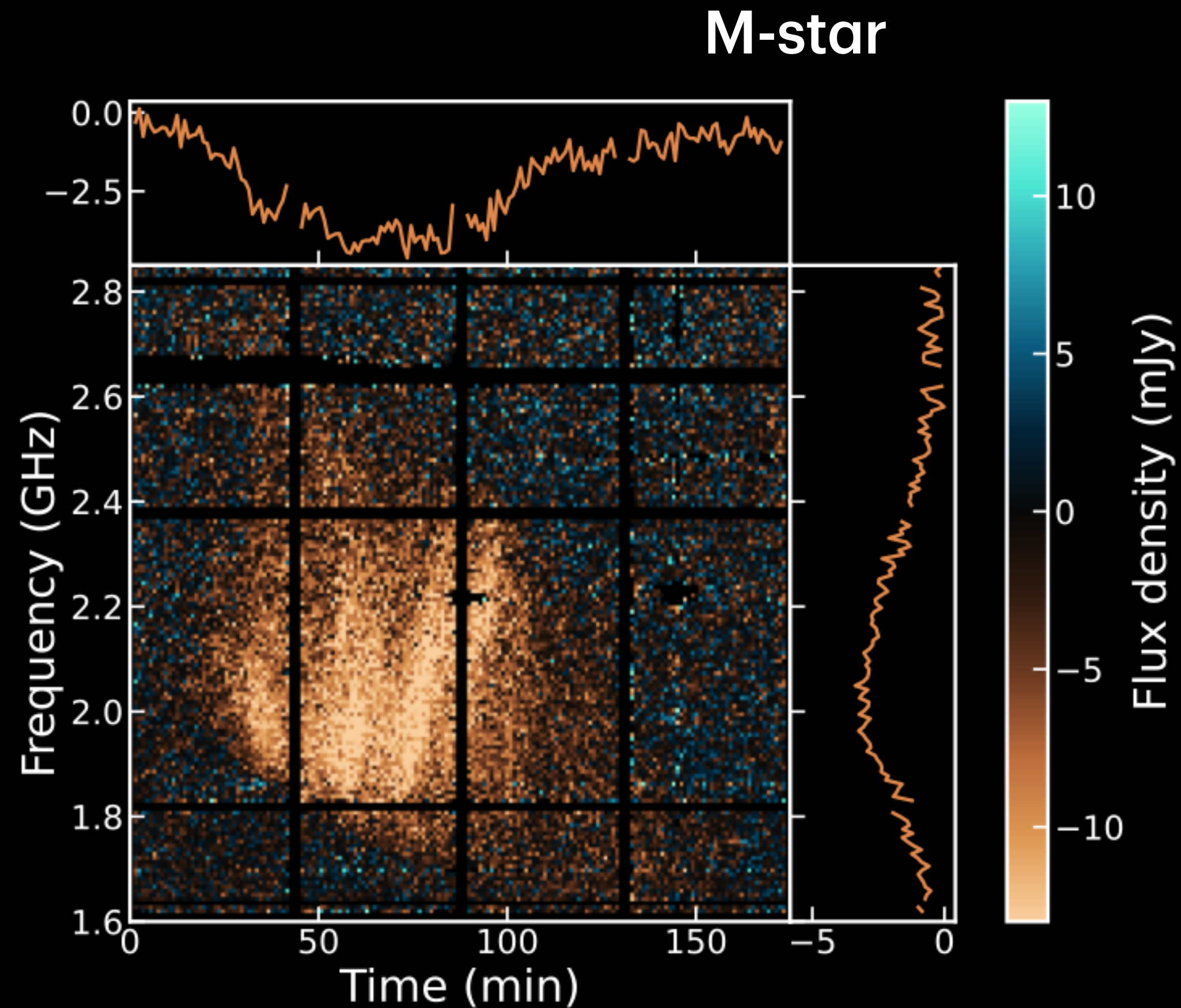


Credit: wiki

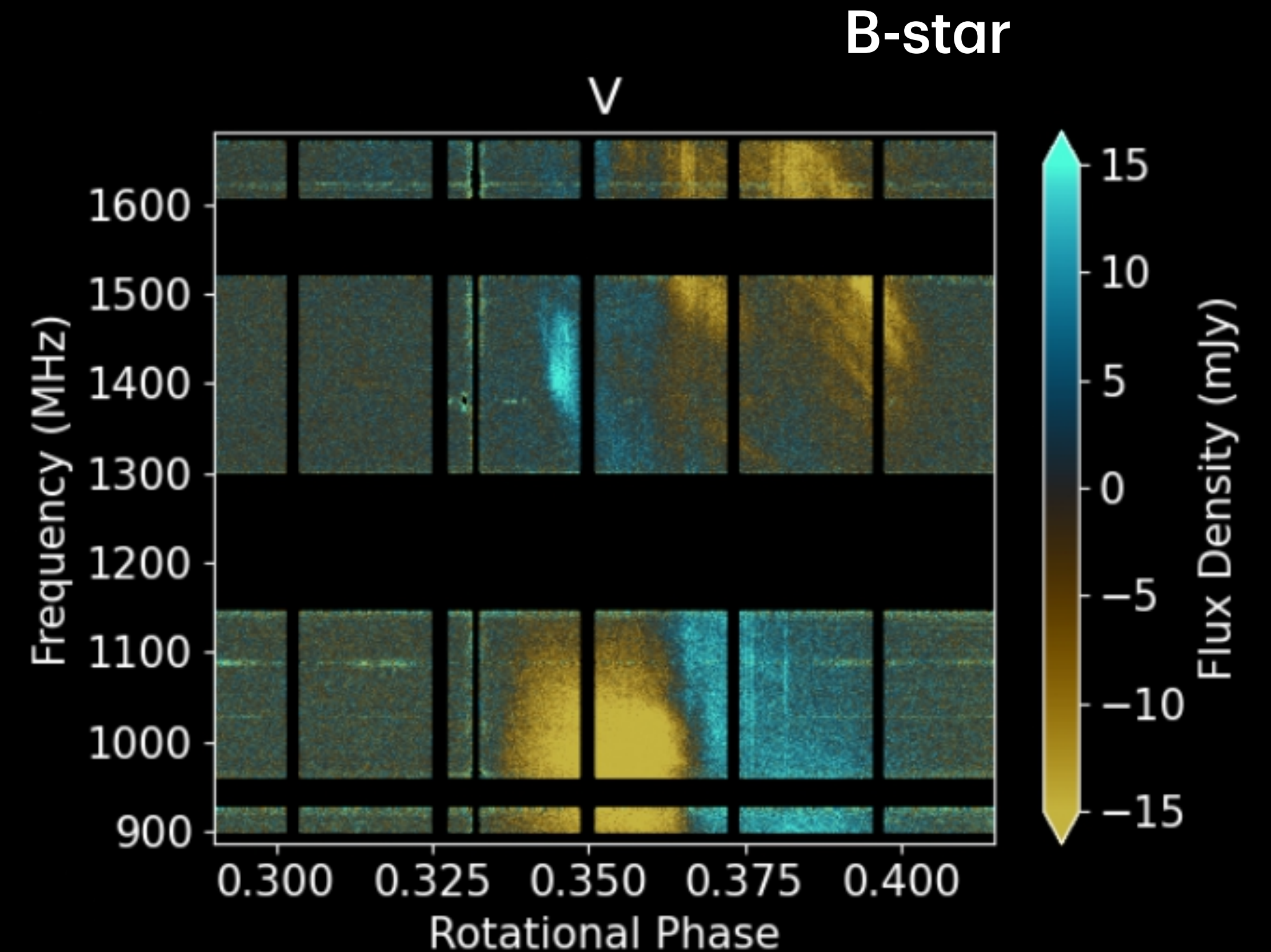
Sun like bursts on other stars



Other stellar bursts (ECMI)



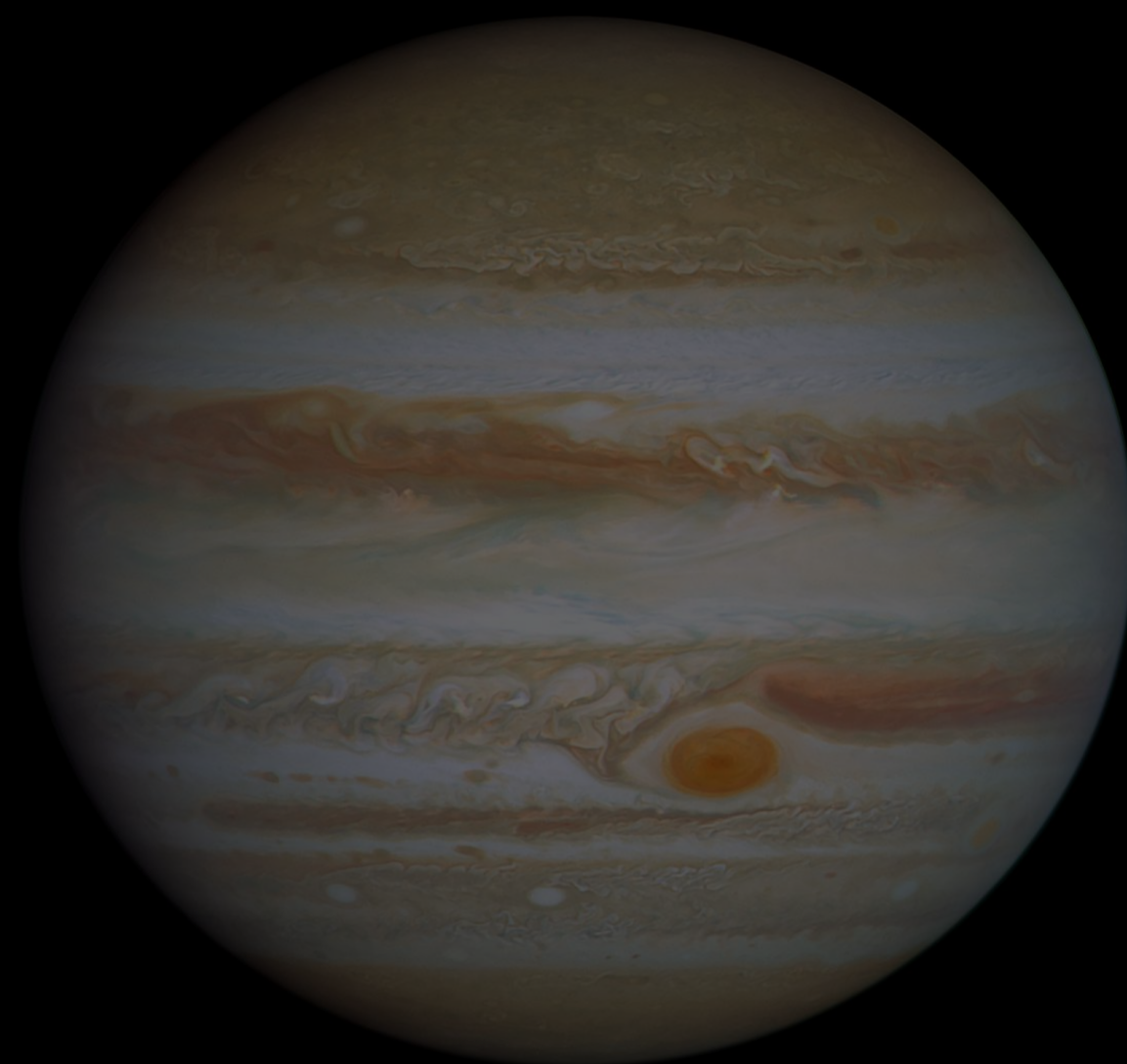
Blout et. al (2023)



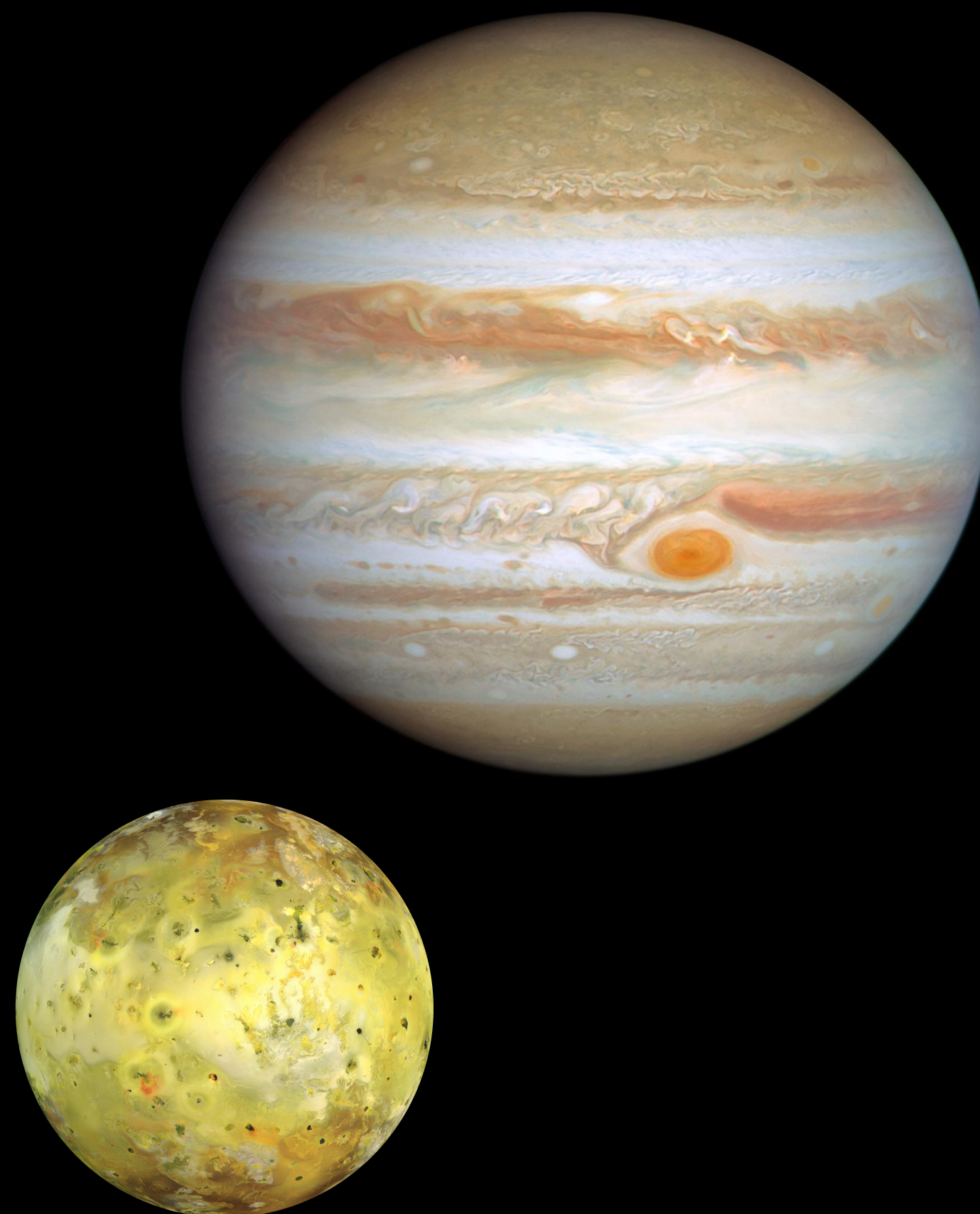
Das et. al (2025)

Other examples: Villadsen & Hallinan (2019), Bastian et. al (2022), Pineda & Villadsen (2023), Das et. al (2019), Das & Chandra (2023)

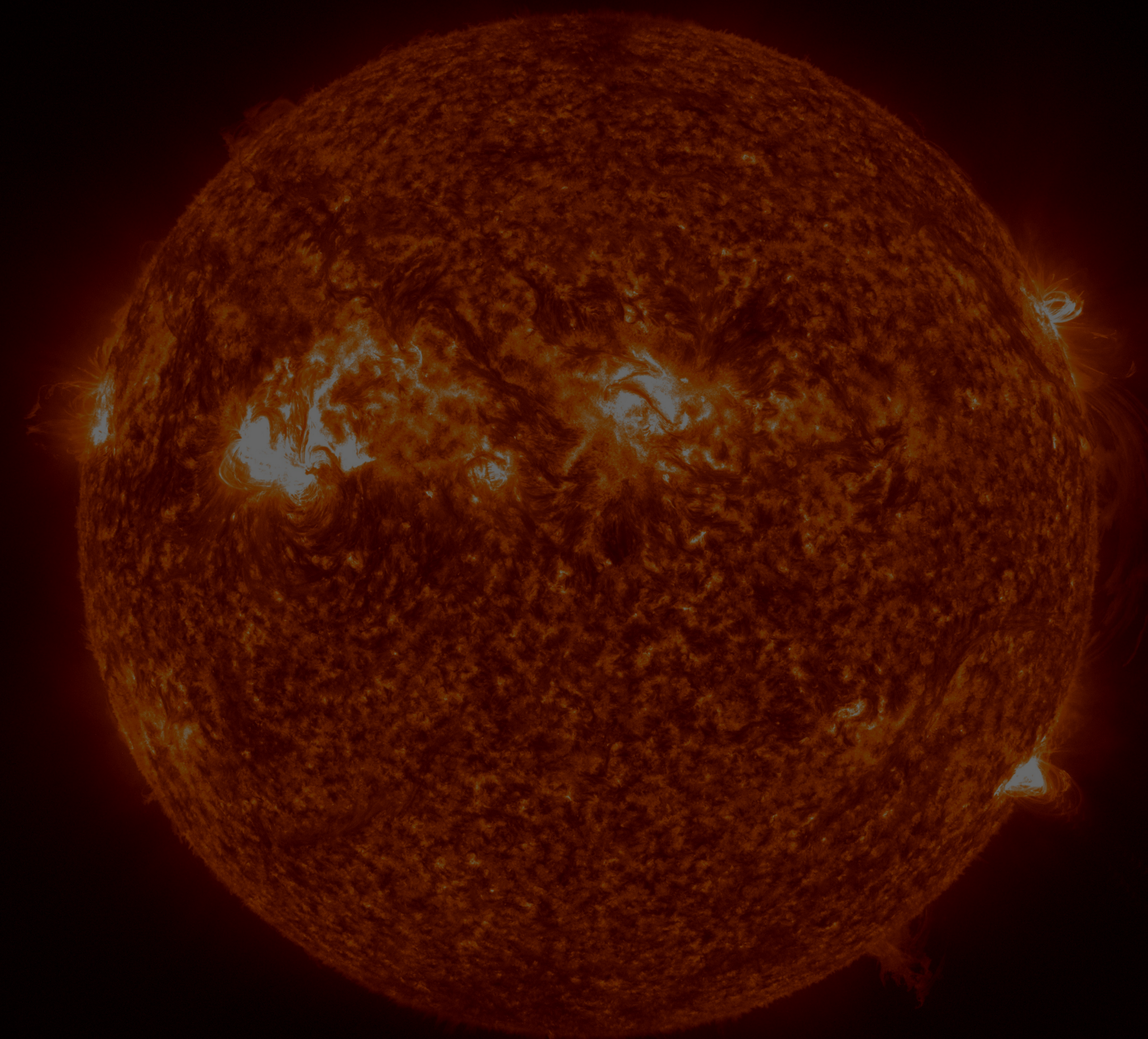
Jupiter



Jupiter - Io

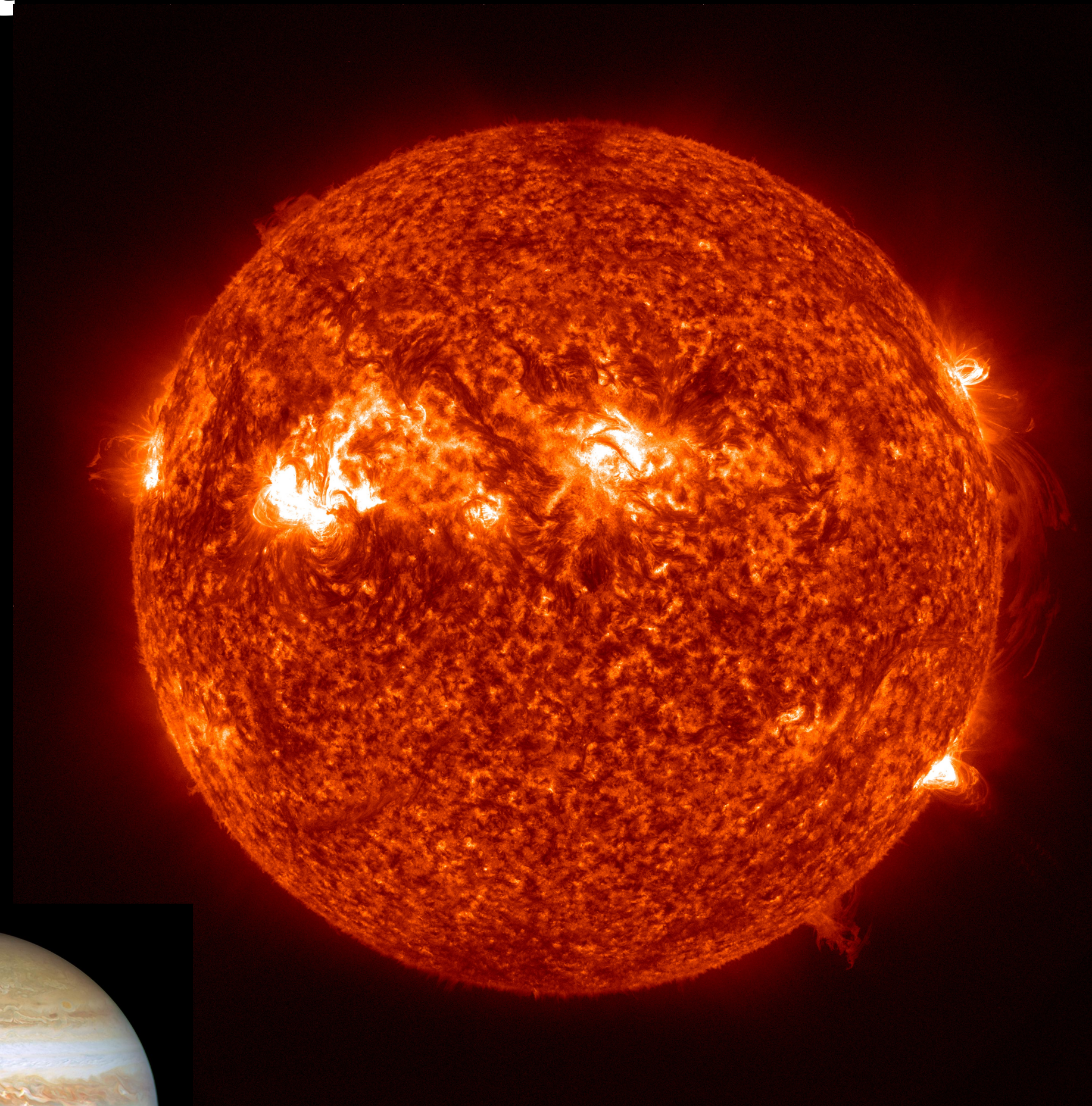
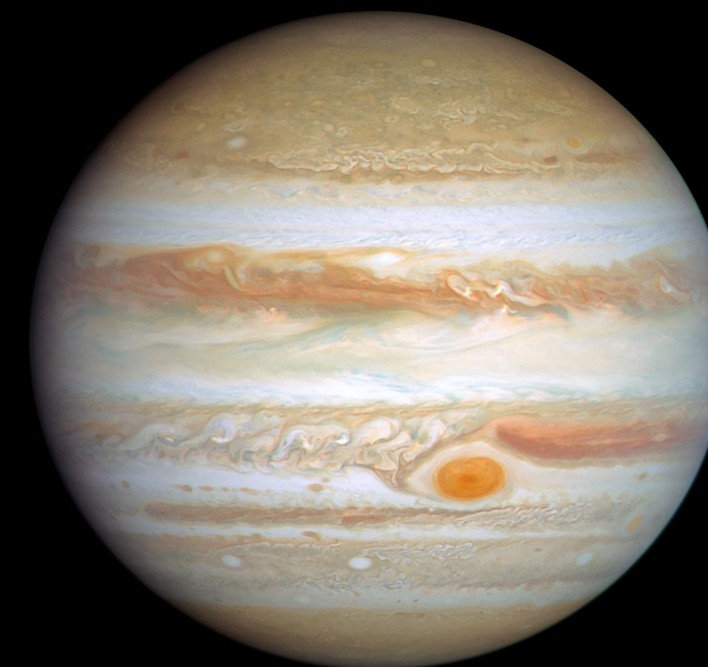
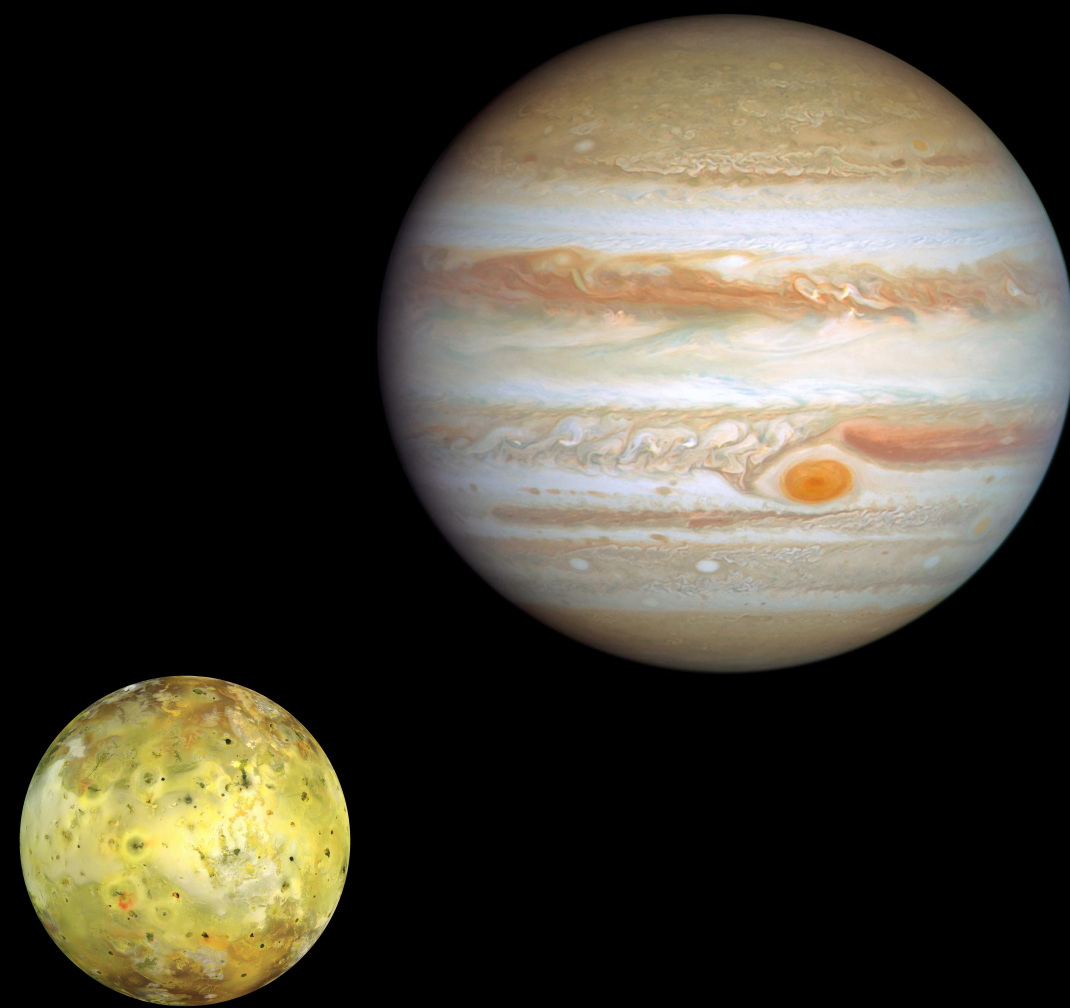


Sun



Credit: wiki

From Jupiter-Io to star-planet



Zarka (2007, 2018), Lanza (2012, 2013)

Credit: wiki

Previous studies

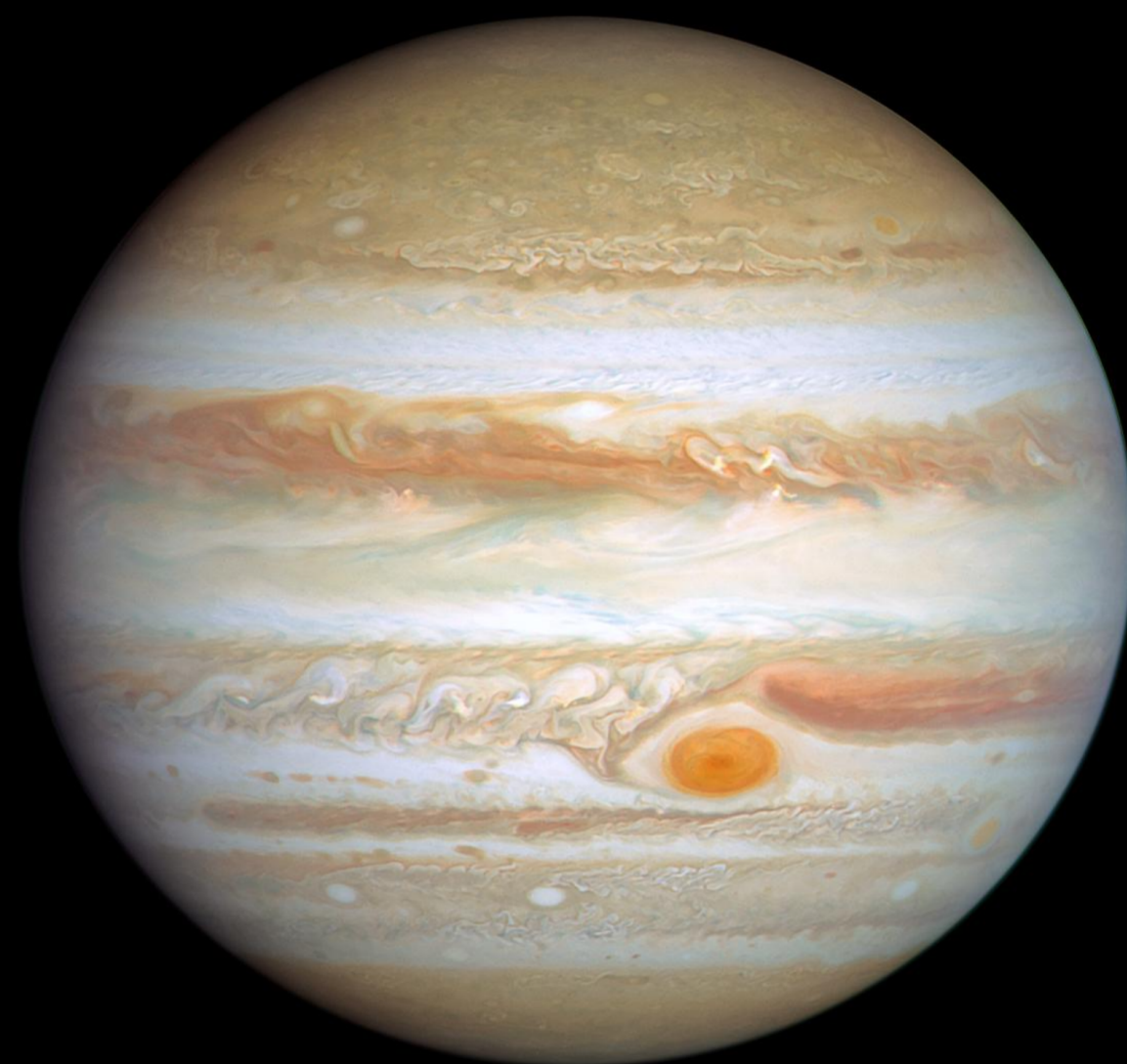
- e. g. Perez-Torres et al. (2019), Vedantham et al. (2020), Pineda & Villadsen (2023), Trigilio et al. (2023)
- Cut-off frequency

$$f_c[MHz] = 2.8B_{star}[G] \rightarrow \text{GHz or MHz regime}$$

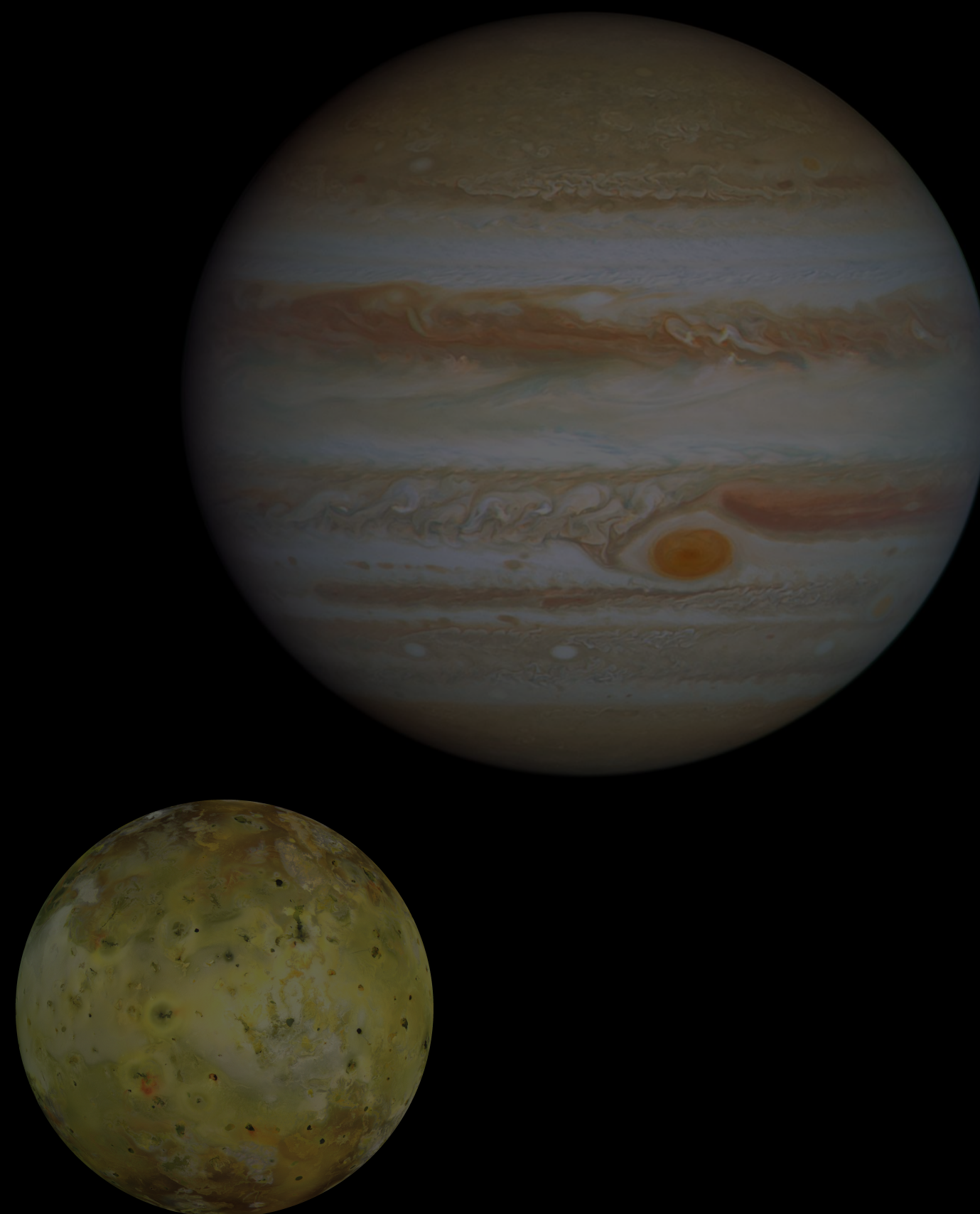
* In radio



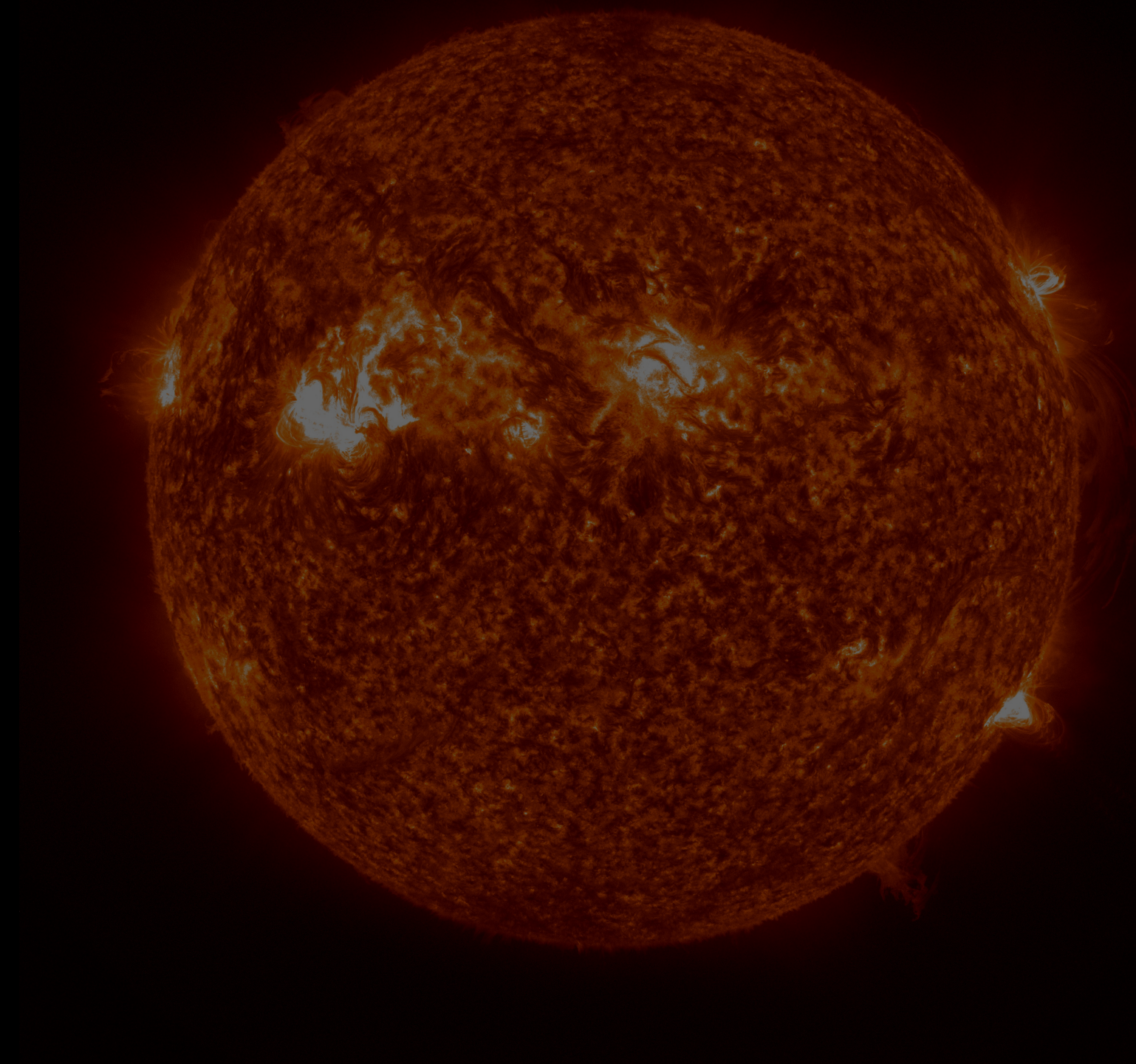
Jupiter



Jupiter - Io

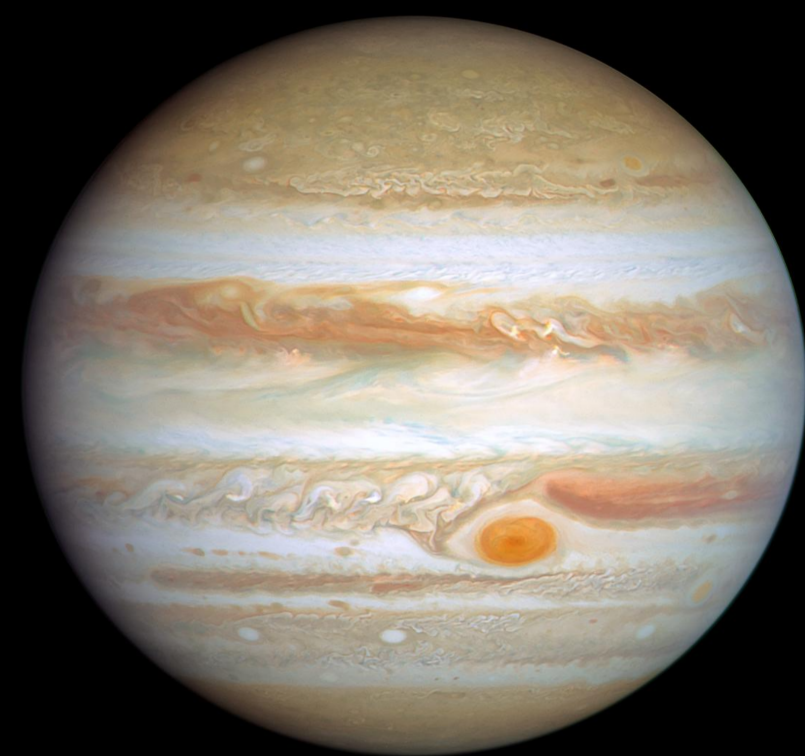


Sun

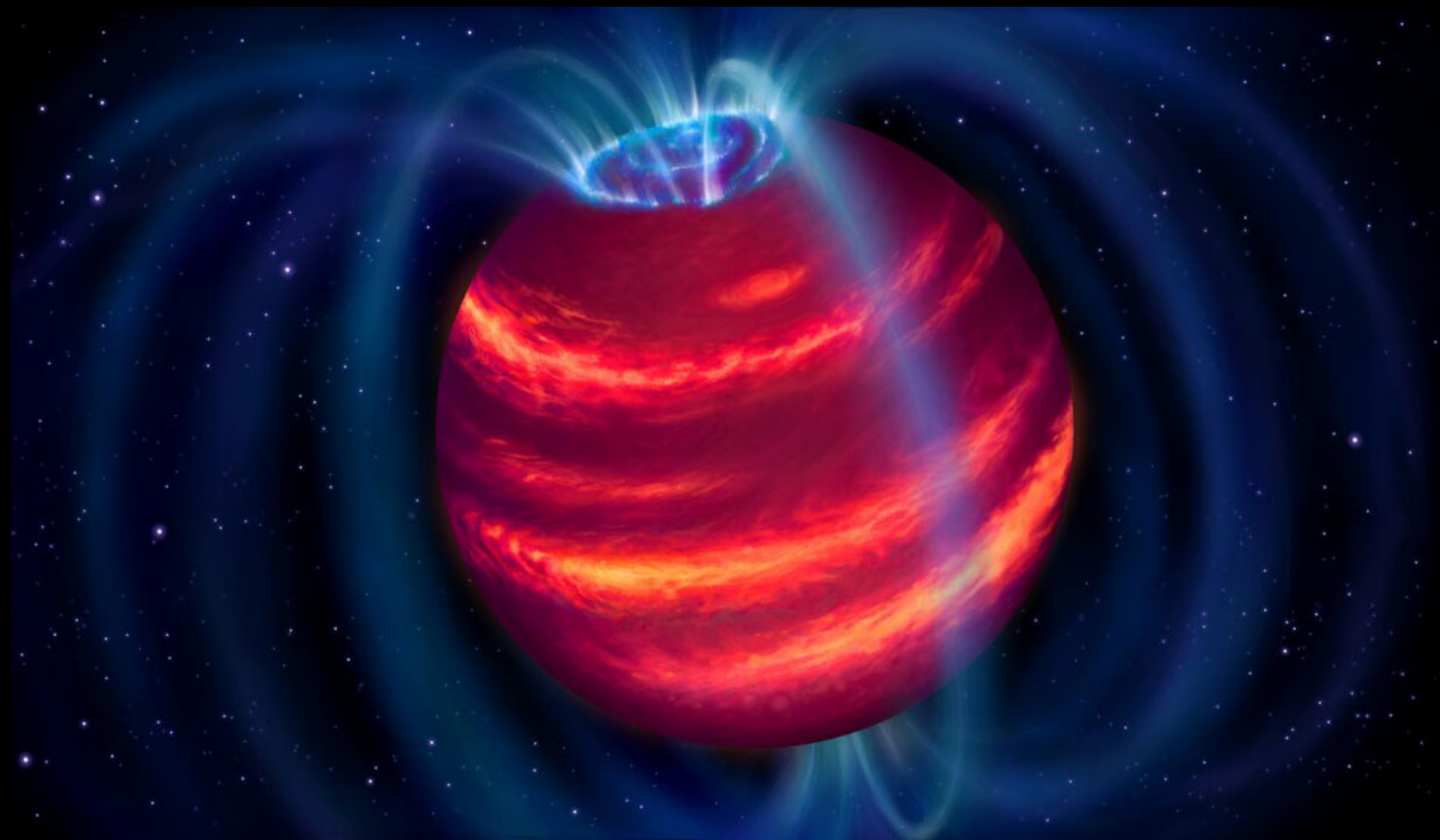


Credit: wiki

From Jupiter to Brown Dwarfs



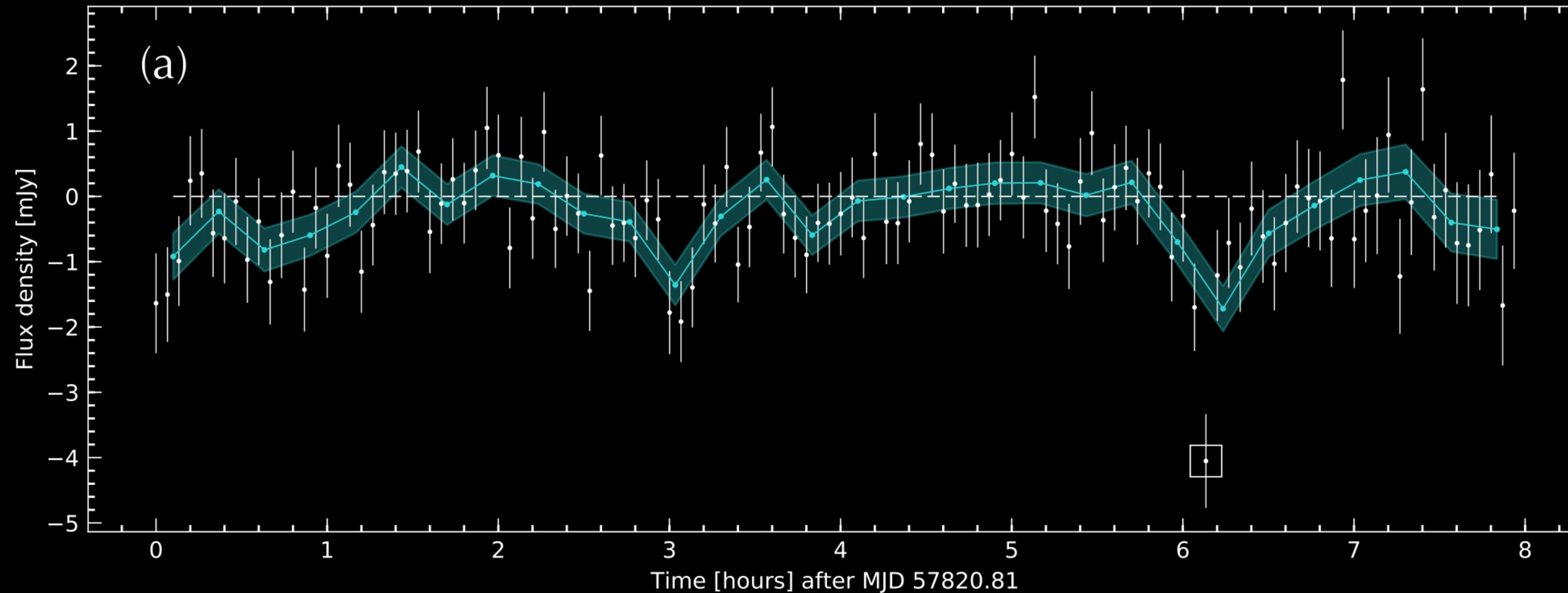
Credit: wiki



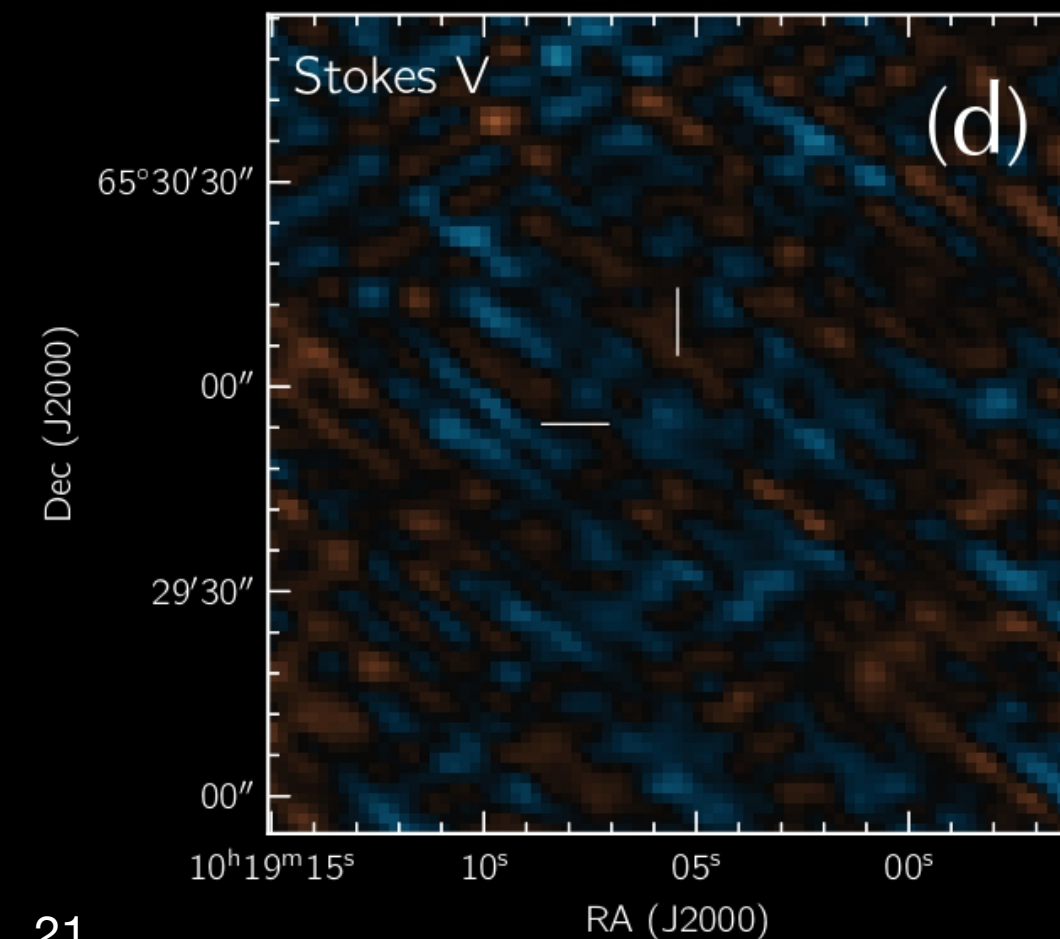
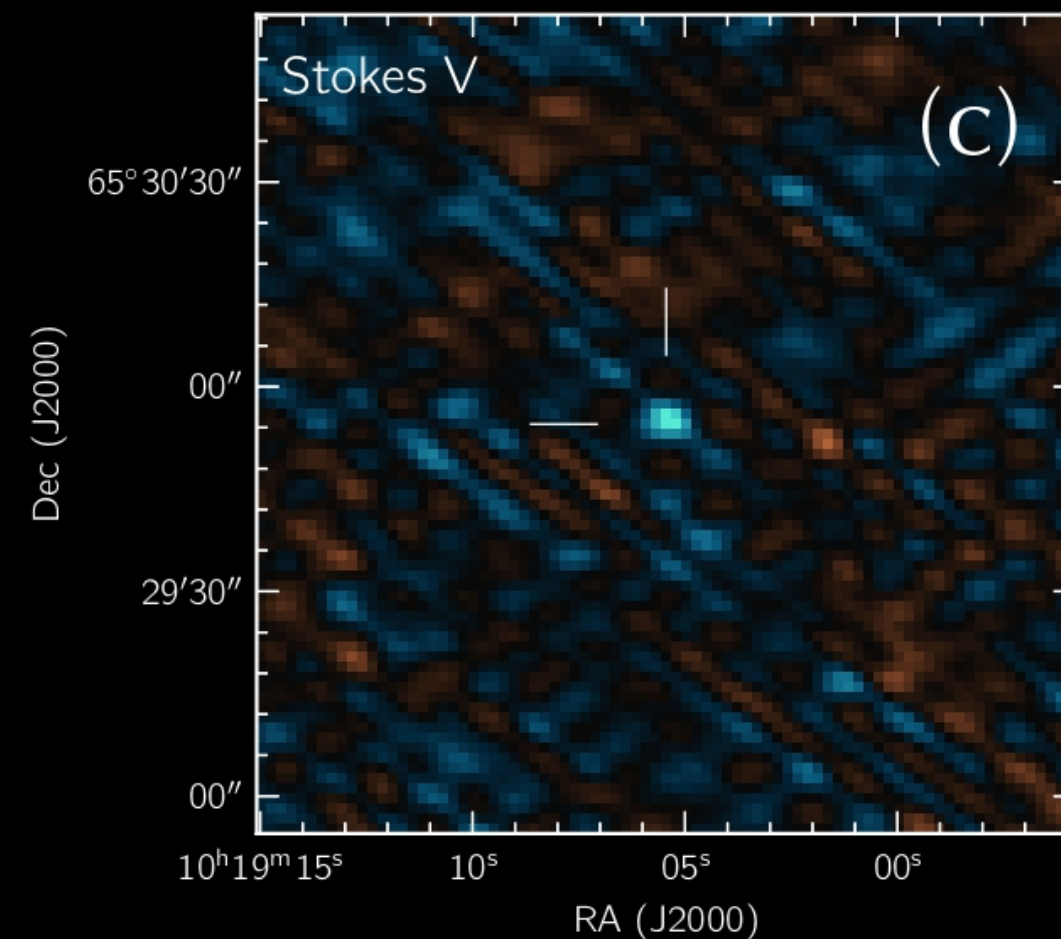
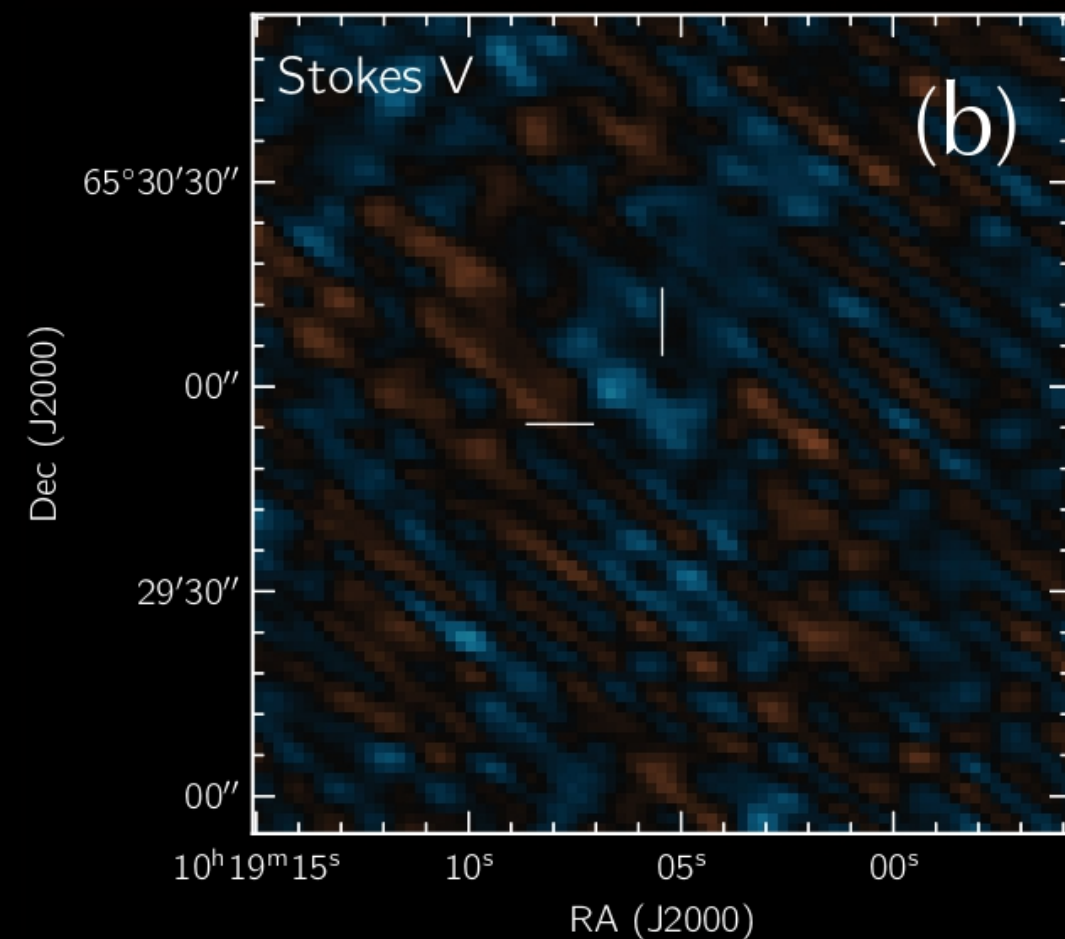
Credit: Danielle Futselaar

Case study with LOFAR - J1019+65

WISEPA J101905.63+652954.2 P156+65



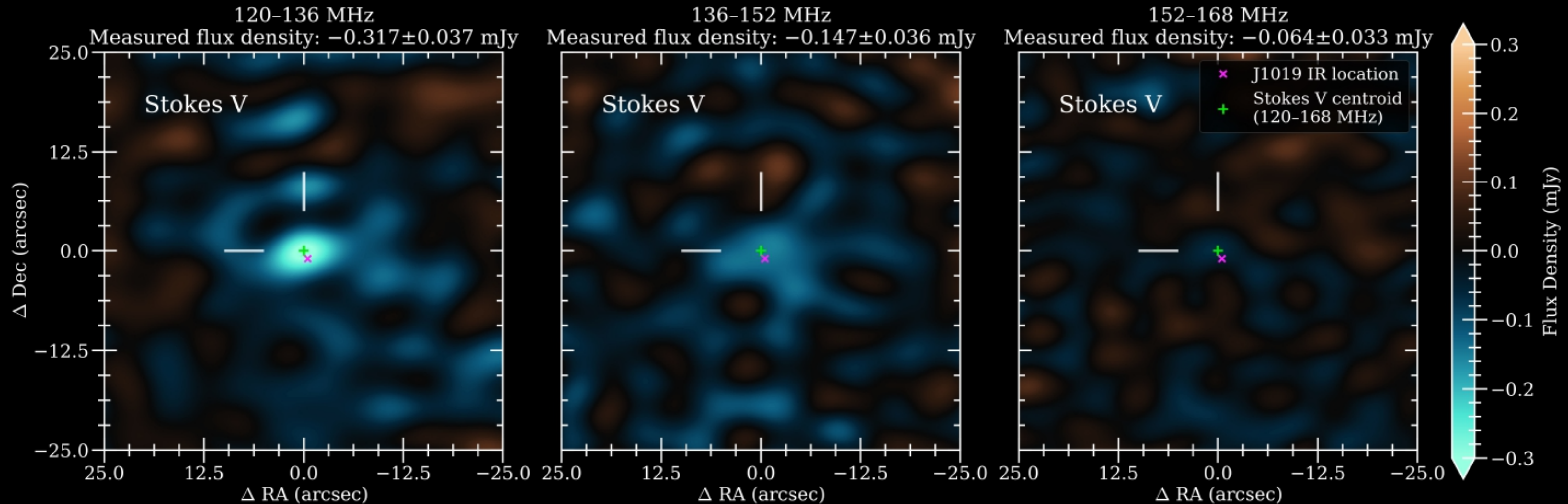
Vedantham et. al (2023)



Other BD detections:
 Berger et al. (2001),
 Berger et al. (2009),
 Kao et al. (2016),
 Richey-Yowell et al. (2020),
 Route & Wolszczan (2012),
 Route & Wolszczan (2016),
 Rose et al. (2023),
 Wandia et al. (2026).

J1019+65 - Cut-off frequency

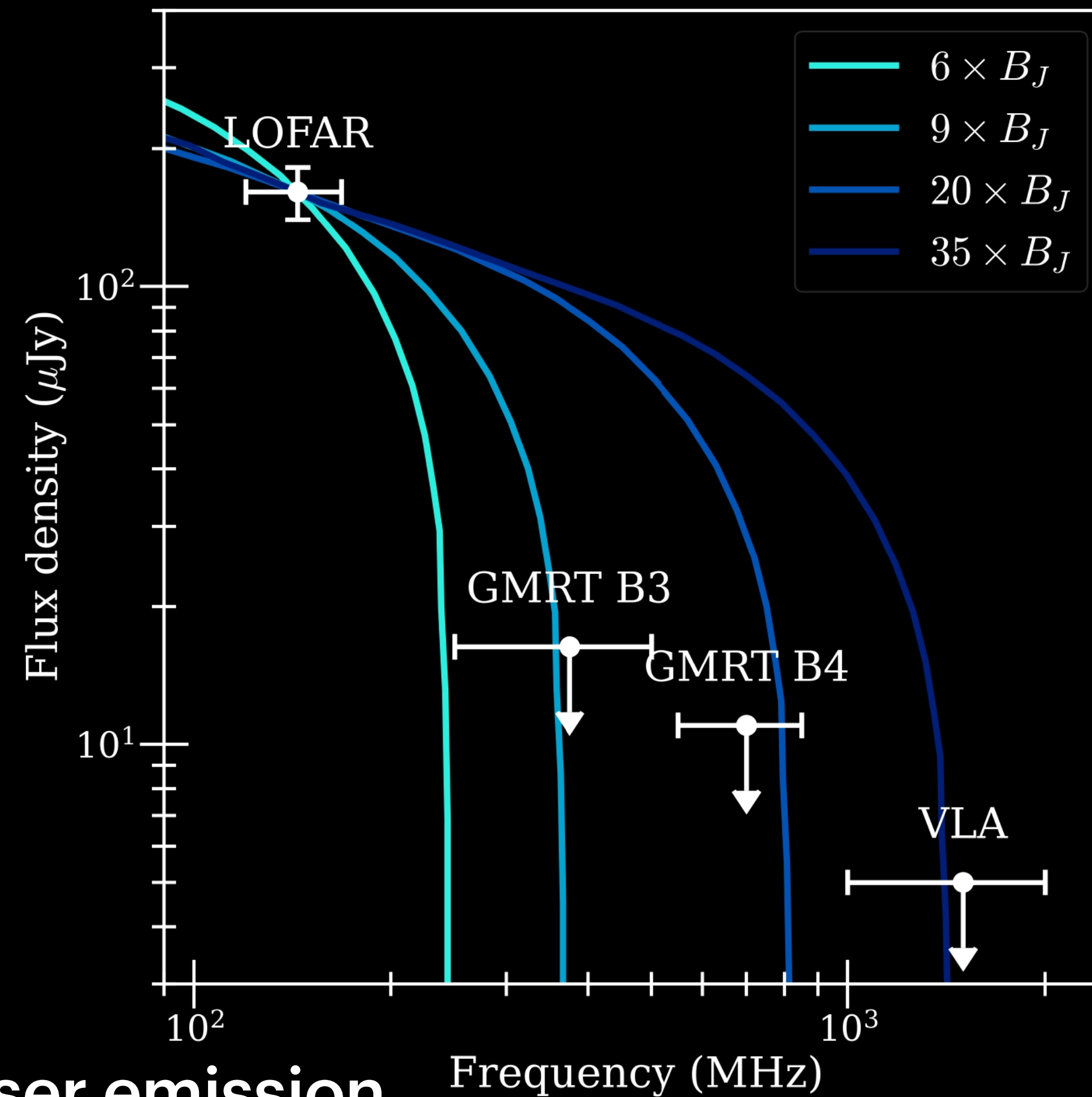
44 hours



Electron cyclotron maser emission

$$f_c [\text{MHz}] = 2.8 B_{J1019} [\text{G}] \quad \rightarrow \quad B < 120 \text{ G}$$

J1019+65 - Cut-off frequency



Yiu et. al (in prep)

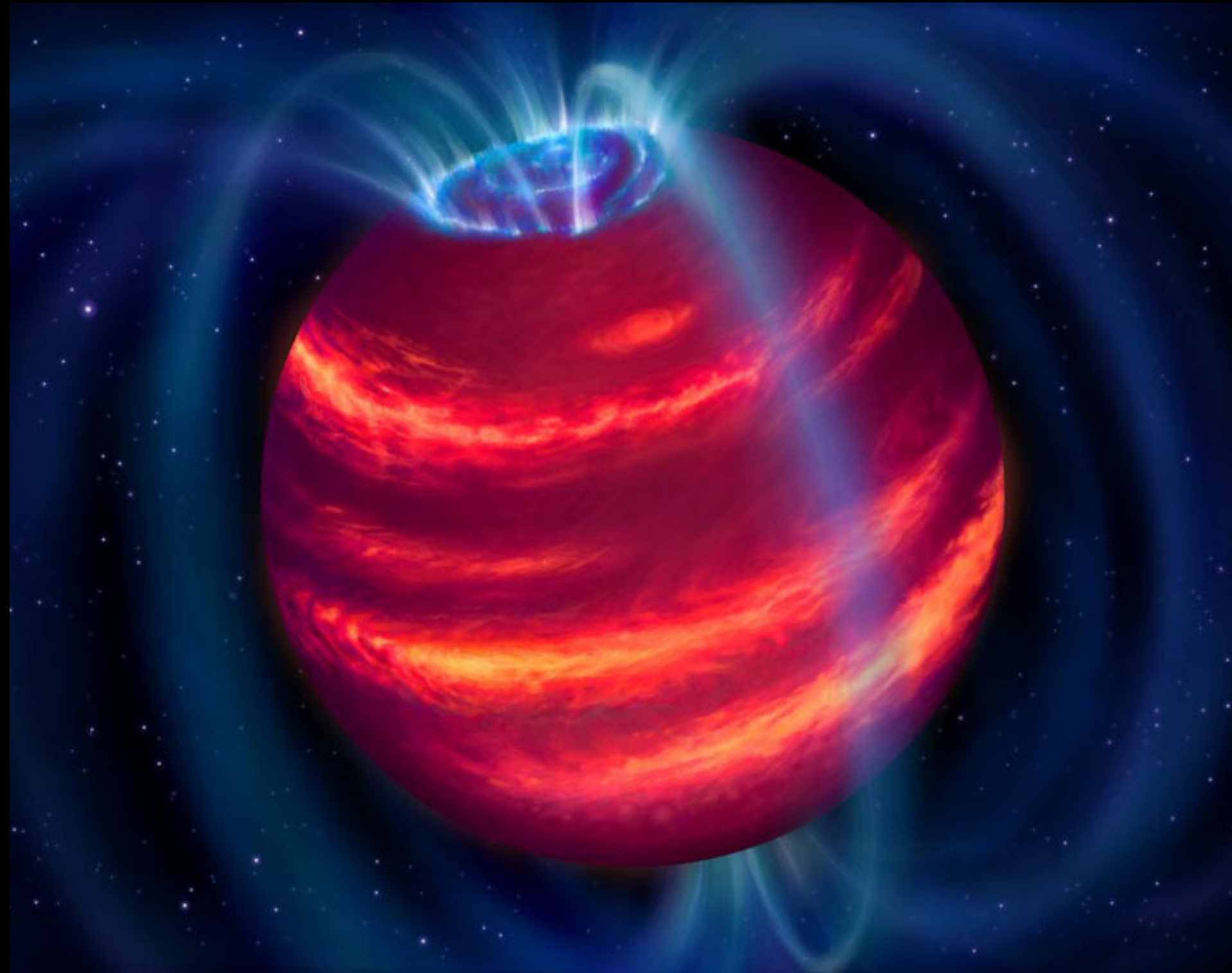
Electron cyclotron maser emission

$$f_c [\text{MHz}] = 2.8 B_{J1019} [\text{G}] \quad \rightarrow \quad B < 120 \text{ G}$$

What if we go lower in mass?

Lower mass -> lower magnetic field -> lower cutoff frequency

$$f_c[\text{MHz}] = 2.8B_{\text{planet}}[\text{G}]$$



Credit: Danielle Futselaar

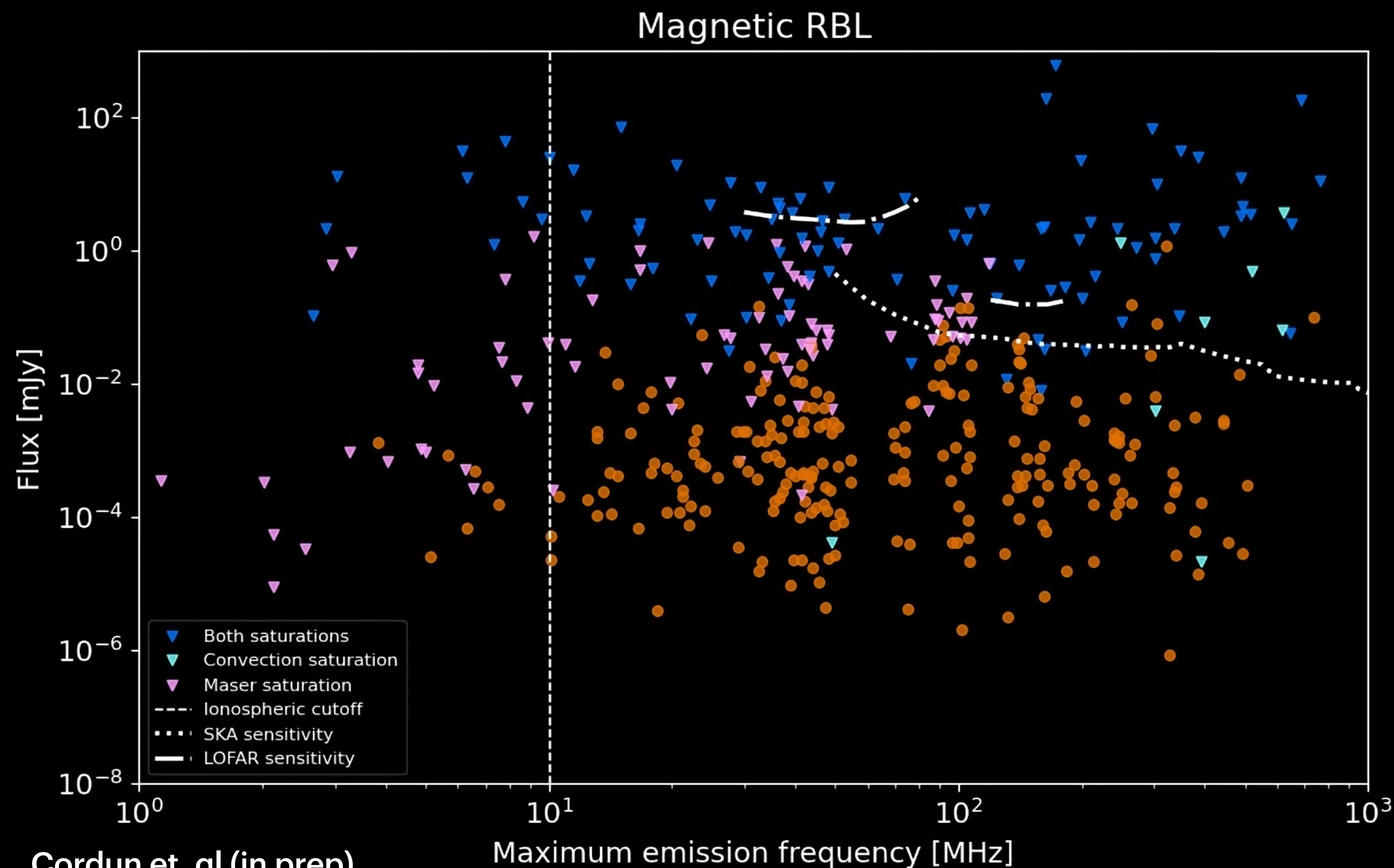


Credit: Fraiser Cain

What if we go lower in mass?

Non-detections	Tentative detections	Conclusive detections
Yantis et al. (1977) Winglee et al. (1986) Bastian et al. (2000) Lazio et al. (2007) Smith et al. (2009) Lazio et al. (2010) Hallinan et al. (2013) Murphy et al. (2015) Lunch et al. (2017) Lenc et al. (2018) Lynch et al. (2018) O'Gormal et al. (2018) De Gasperin et al (2020) Cendes et al. (2022) Route et al. (2023) Cordun et al. (2025)	Turner et al. (2021) Lecavelier des Etangs et al. (2013) Sirothia et al. (2014) Zhang et. al (2025)	

Predictions of exoplanets



Cordun et. al (in prep)

Algorithm based on:
Zarka (1992),
Grießmeier et. al (2007, 2011),
Nichols & Milan (2016)

Code and interactive
table on Git



R

radioExoFluxes

Current efforts in the community

LOFAR

High resolution (sub-arcmin)
Lower instantaneous
sensitivity
Limited time



Credit: Zabet Ahmadi

NenuFAR

Low resolution (~ 0.5 deg)
High instantaneous sensitivity
Constant monitoring
(Targeted)



Credit: Quest France

LWA

Low resolution (~ 0.5 deg)
High instantaneous sensitivity
High-cadence monitoring
(All-sky)



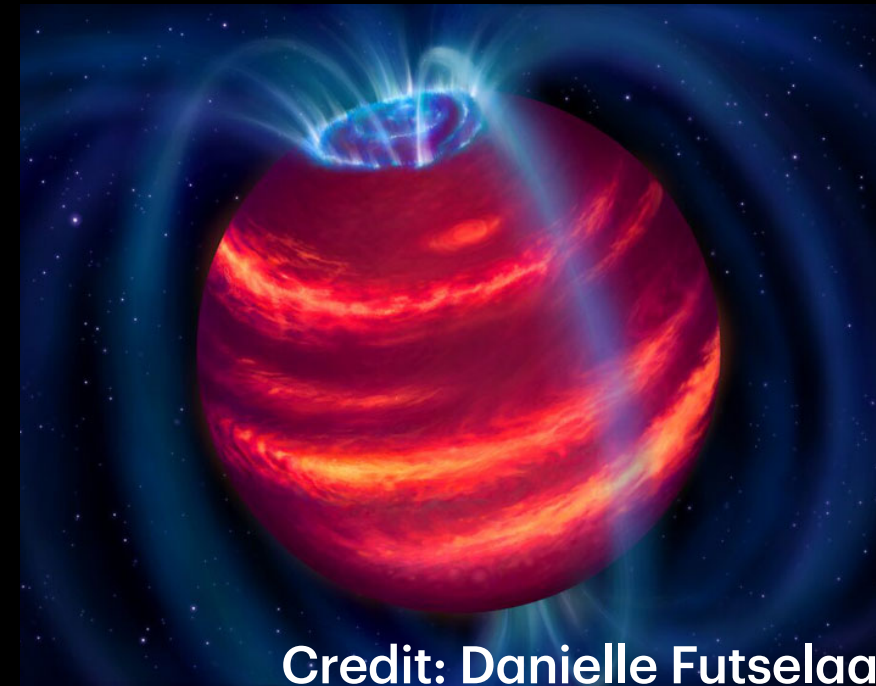
Credit: Gordon Wiltsie

LOFAR efforts

- Targeted searches: Turner et al. (2021, 2023), Cordun et. al (2025)



- LoTSS - 144 MHz: Stars and BD



Credit: Danielle Futselaar

- LoLSS - 54 MHz: Henrik's talk (next)
- LoDeSS - 23 MHz:** Christian's talk (galaxy clusters)
- no exoplanet detections in DR1 (Cordun et. al in prep)

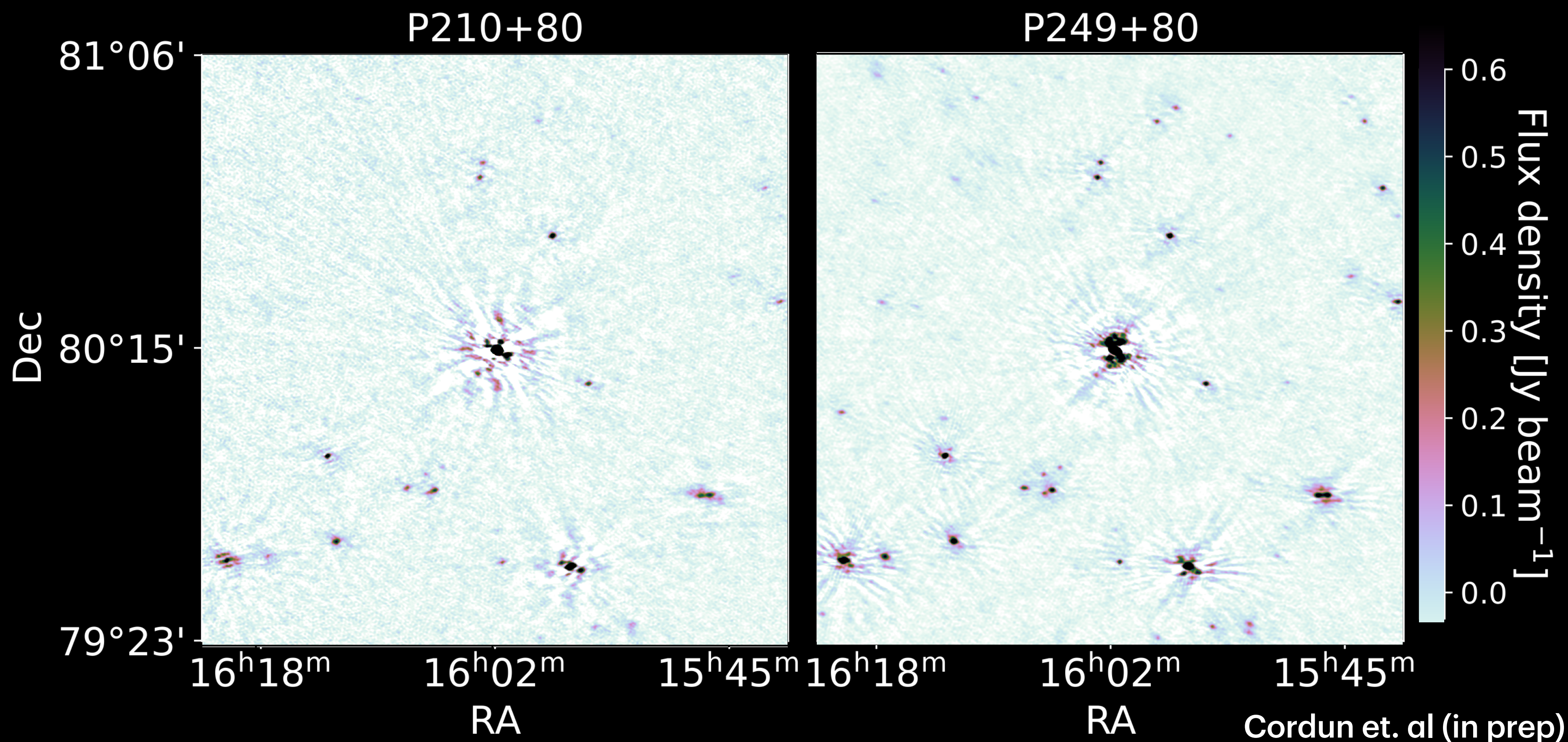


Credit: Fraiser Cain

Jupiter regime $f_c [MHz] = 2.8 B_{planet} [G]$

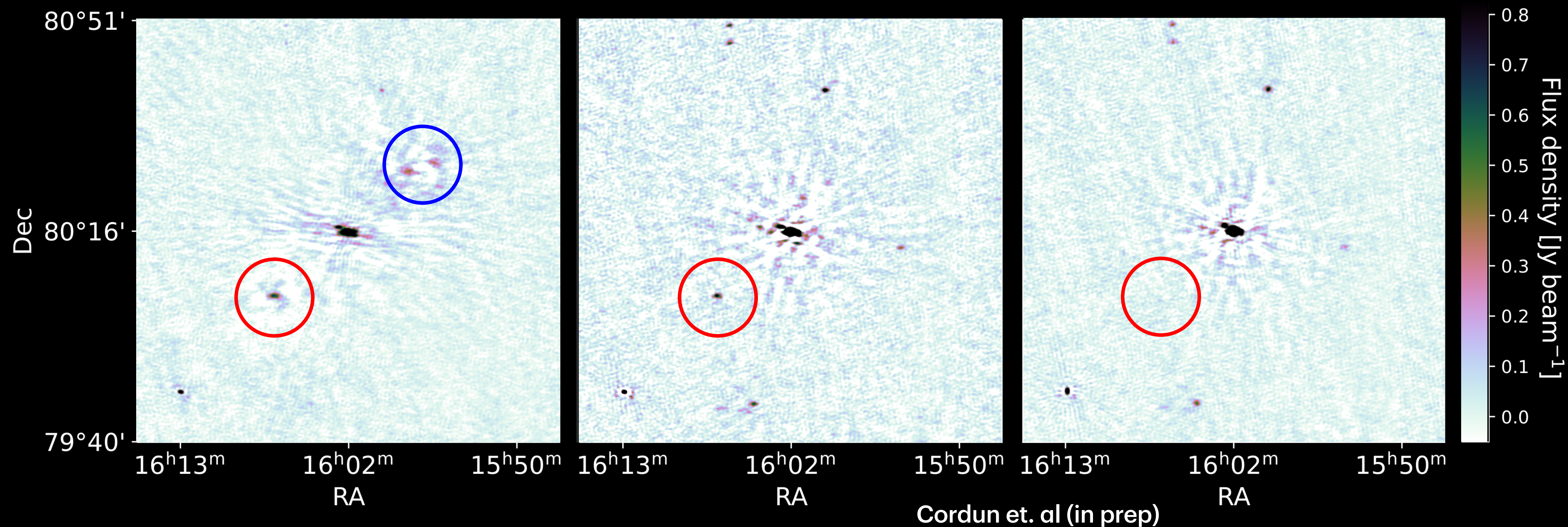
Lower = harder

LoTSS - 144 MHz -> LoLSS - 54 MHz -> LoDeSS - 23 MHz



Lower = harder

LoTSS - 144 MHz $\rightarrow$ LoLSS - 54 MHz $\rightarrow$ LoDeSS - 23 MHz



But we **MUST** keep on searching



Beamformed	Imaging	Live imaging
Targeted	Targeted / Untargeted	Untargeted
Known candidates Follow-ups High time resolution	Surveys Blind search Averaged data	ALL raw data Blind search Subtract images

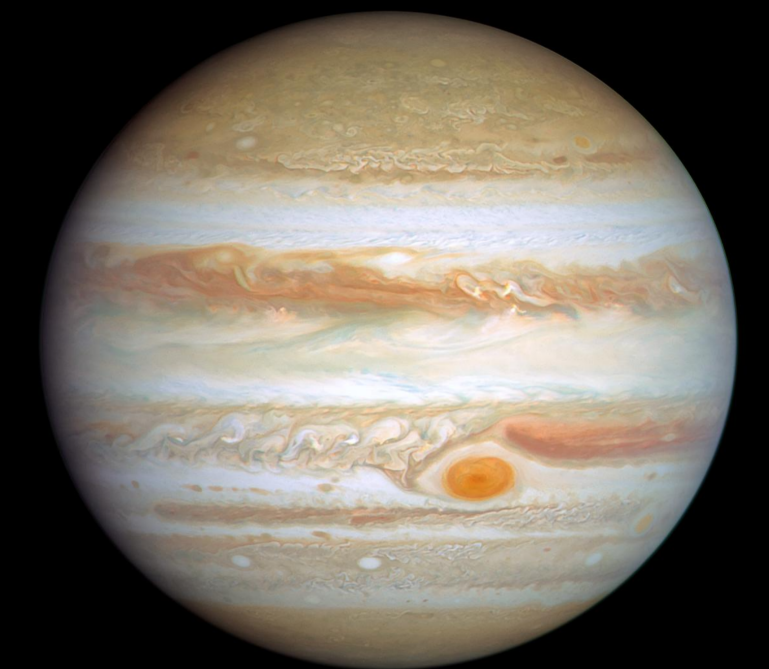
Summary

- Three types of emission:

- Sun-like => Seen in stars
- Jupiter-Io like => Not seen in radio (YET)
- **Jupiter-like** => Seen in Brown dwarfs, **not (YET) seen in planets**

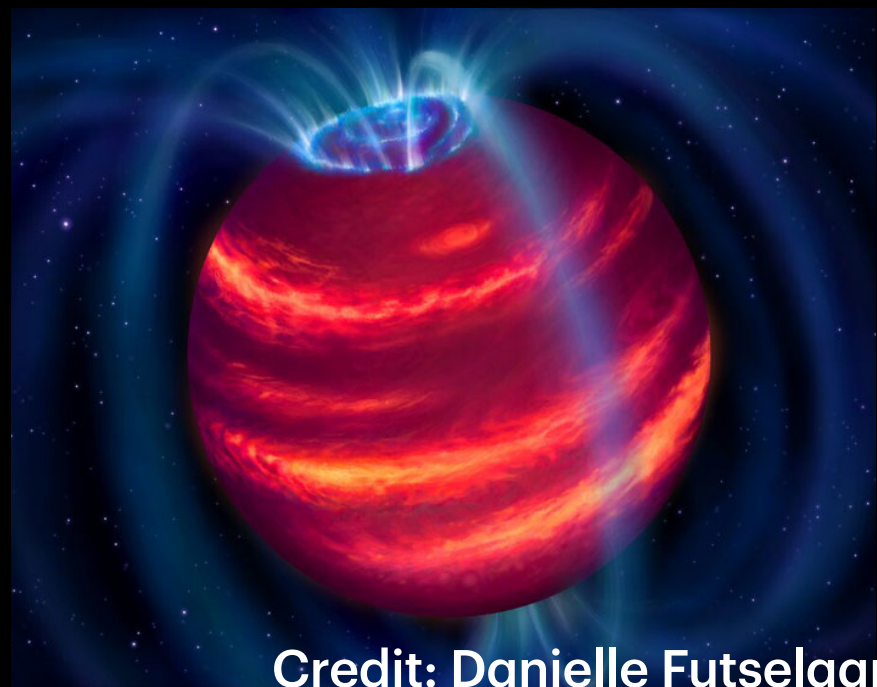


Credit: Fraiser Cain



Credit: Wiki

Lower = better, BUT lower = harder



Credit: Danielle Futselaar

Summary

- Three types of emission:

- Sun-like

=>

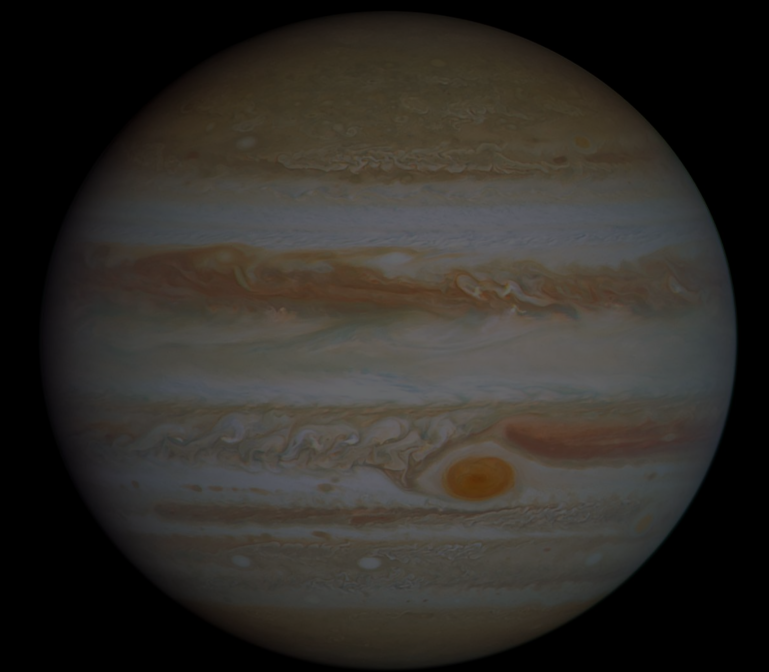
- Jupiter-like

- ,

GO LOW OR GO HOME

parts, not seen in planets

Lower = better, BUT lower = harder



Credit: Wiki