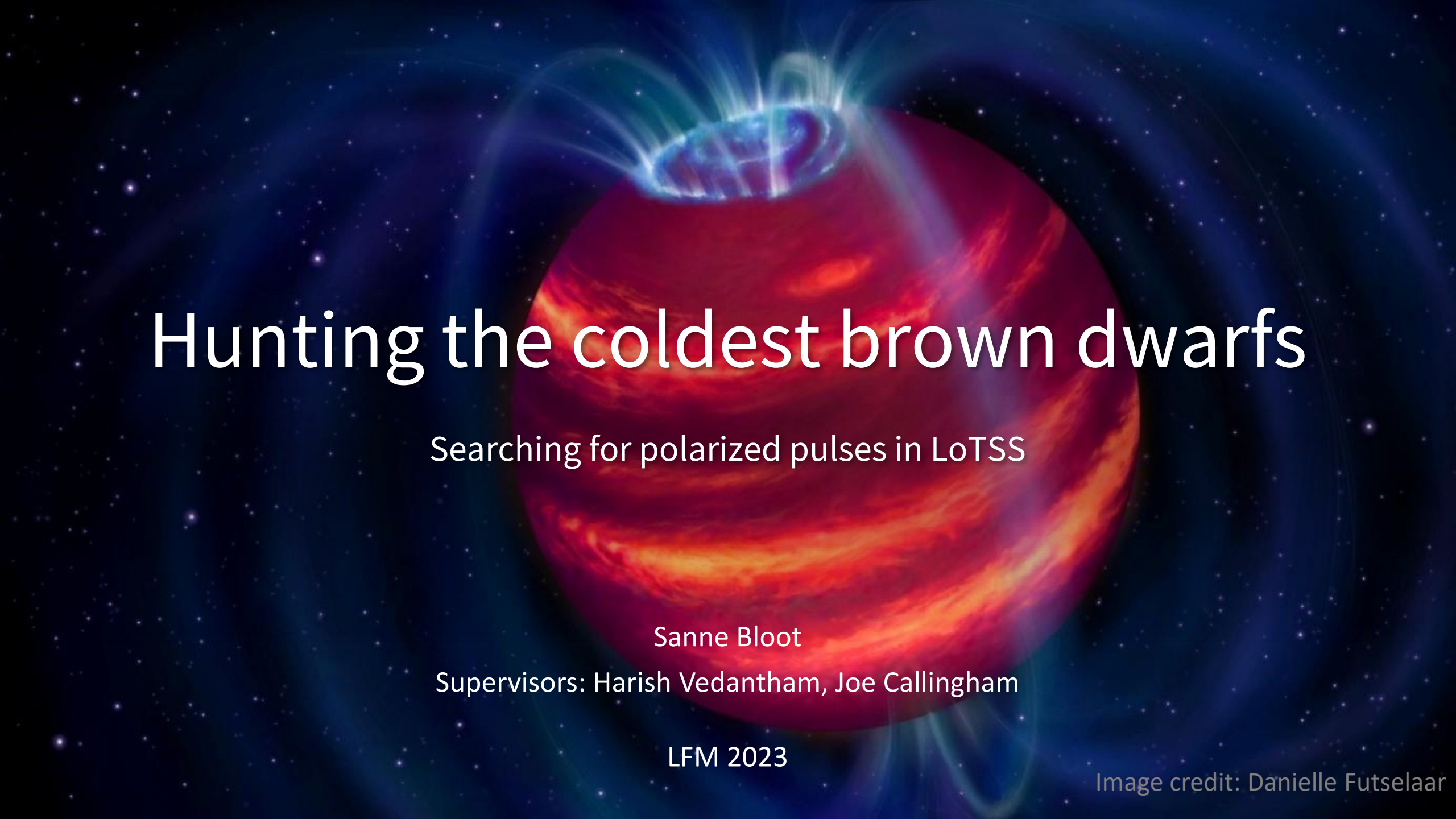




Hunting the coldest brown dwarfs

Searching for polarized pulses in LoTSS

Sanne Bloor

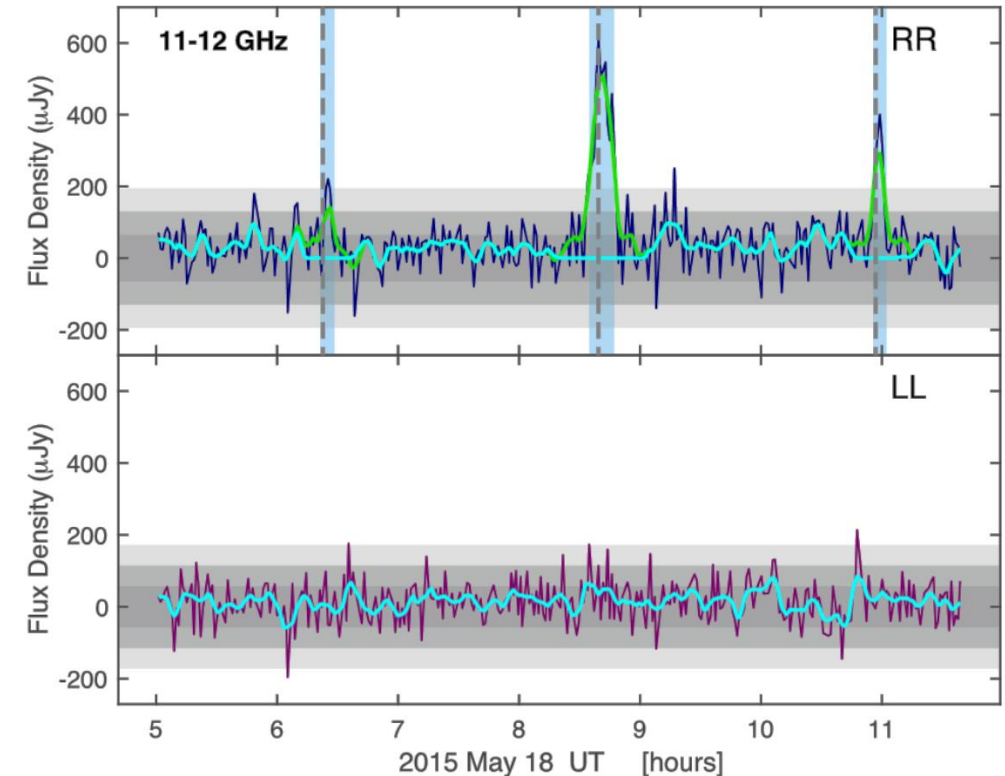
Supervisors: Harish Vedantham, Joe Callingham

LFM 2023

Image credit: Danielle Futselaar

Brown dwarfs at radio frequencies

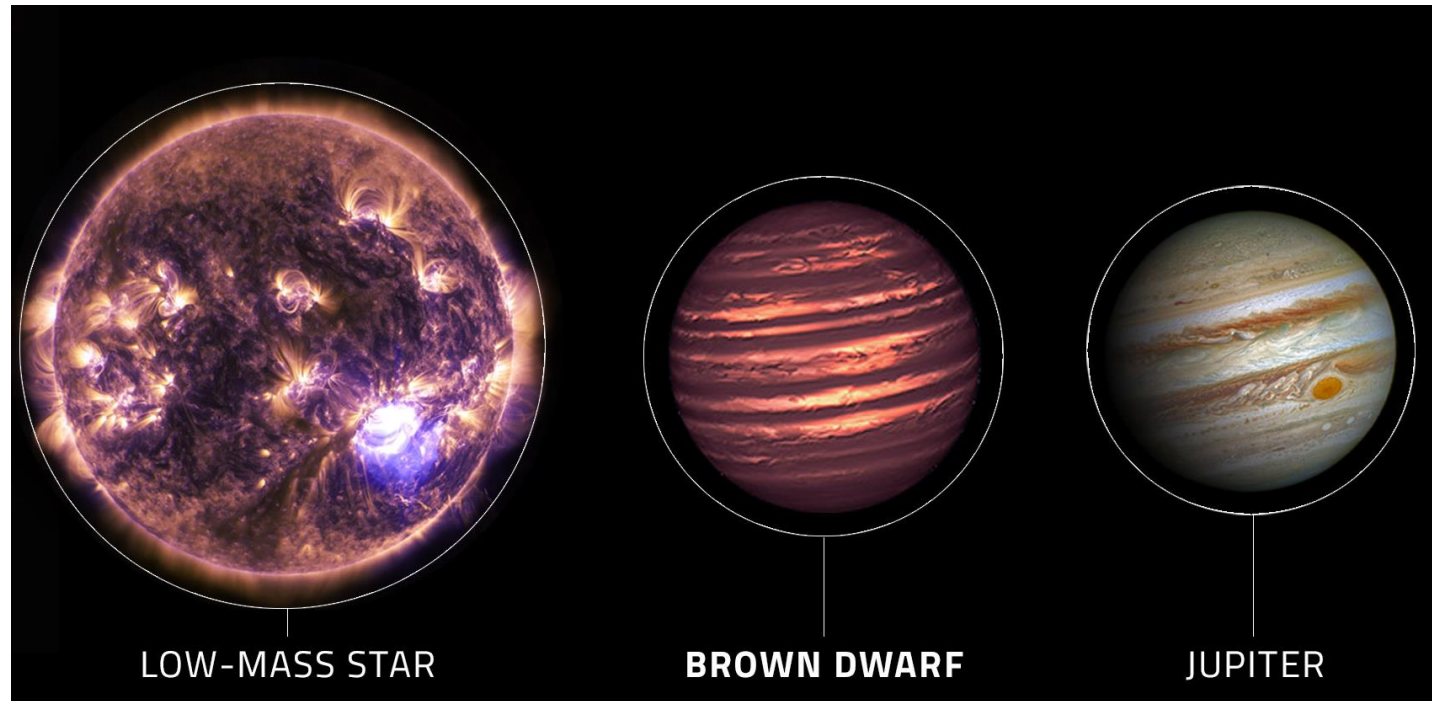
- Auroral emission
 - Pulsed
 - Breakdown of corotation
 - Potentially a companion
- Direct measurement of magnetic field strength



Kao et al. (2018)

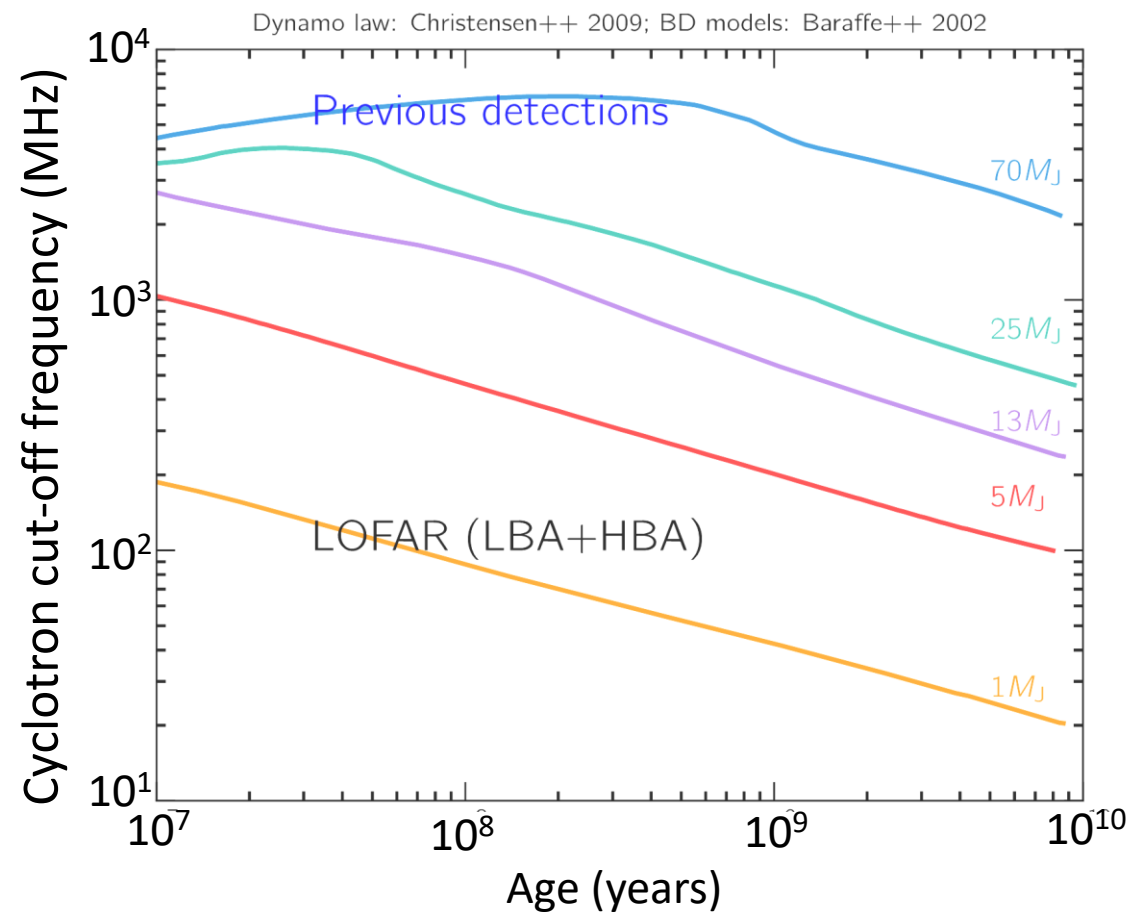
Why look for the coldest in radio?

- Similar to gas giants
- Calibrate dynamo models
- Search for free-floating exoplanets



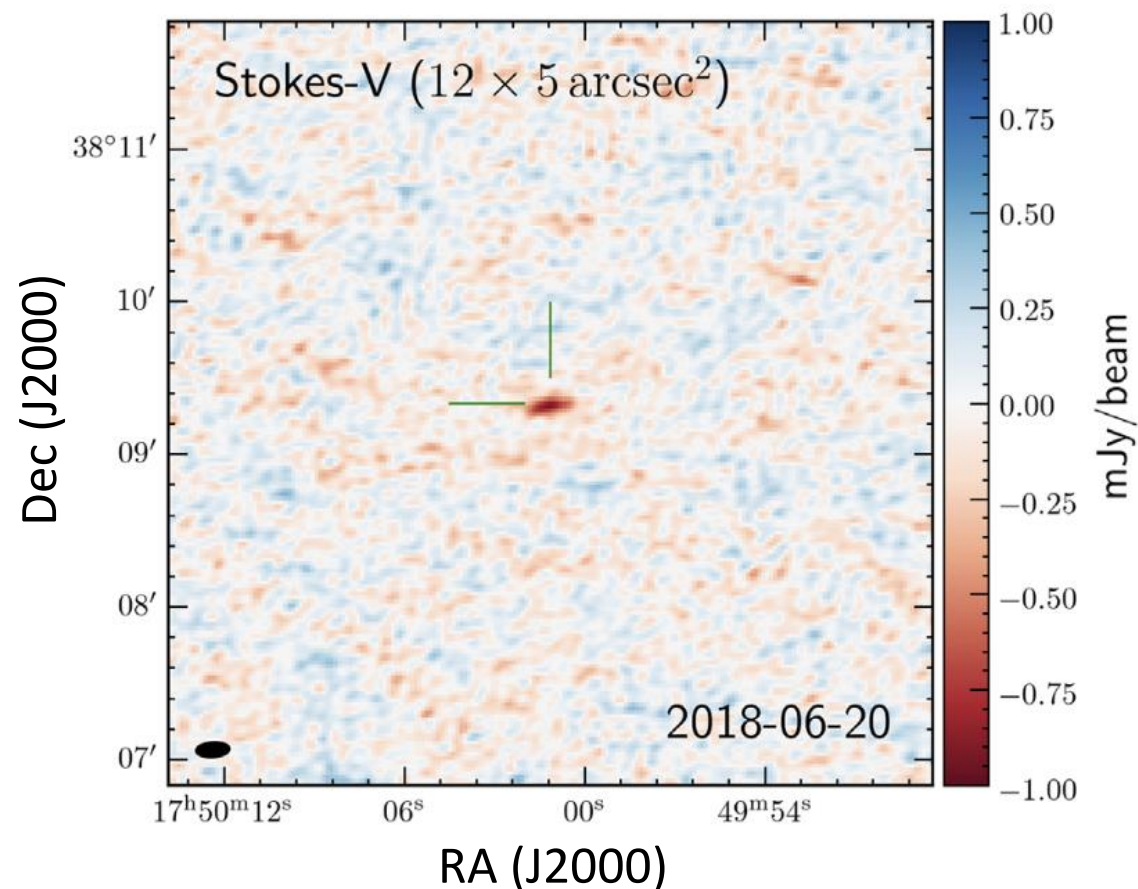
Why LOTSS?

- Blind survey
- 8 hour exposures
 - Covers a full rotation for most brown dwarfs
- Low magnetic field strengths



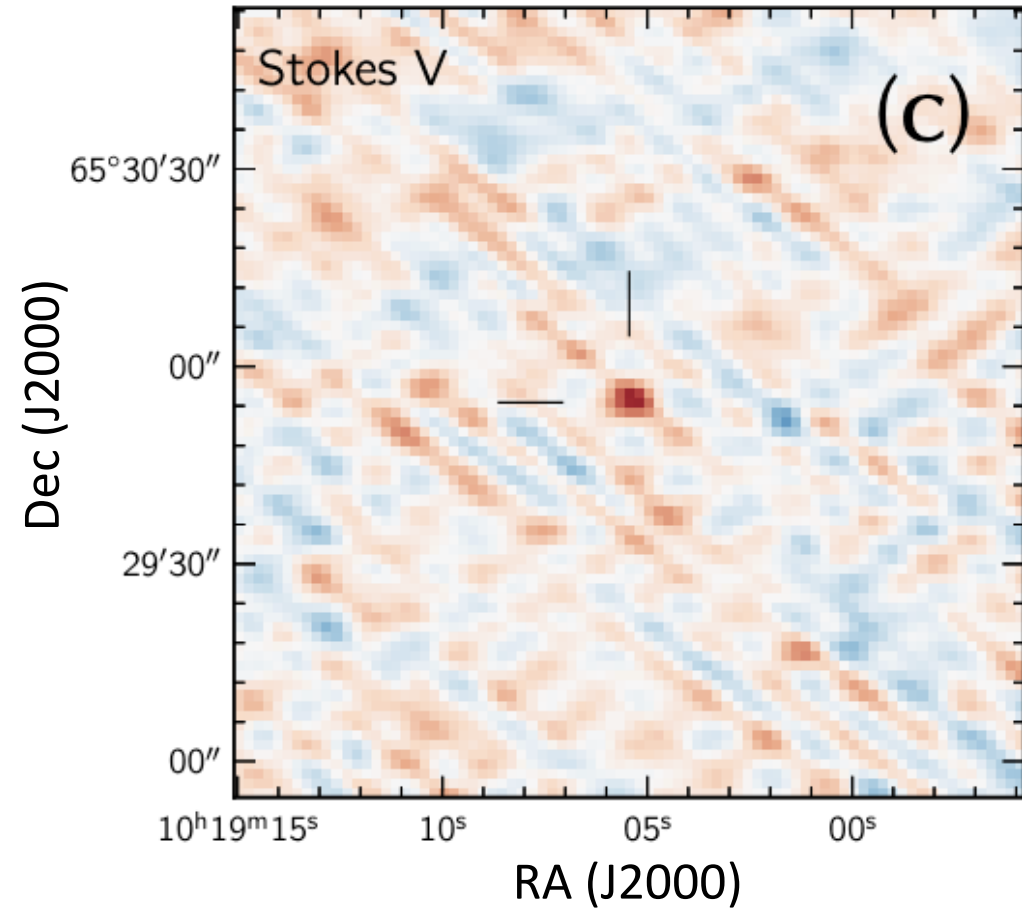
Elegast

- Vedantham et al. (2022)
- Blind survey
- 65 pc, extremely luminous
- Constant emission over 8 hours



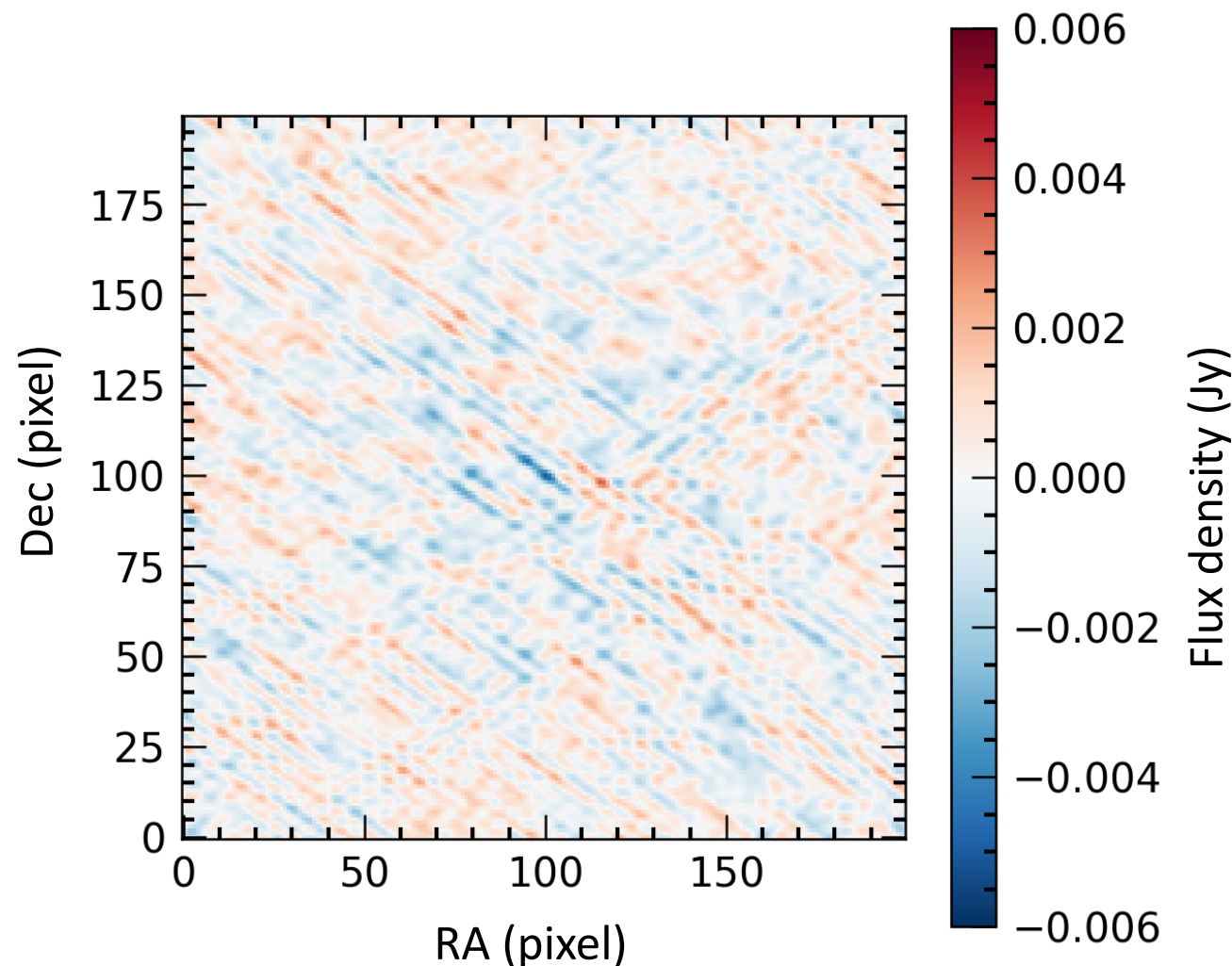
J1019+65

- Vedantham et al. (2023)
- Targeted search
- Produces pulsed emission

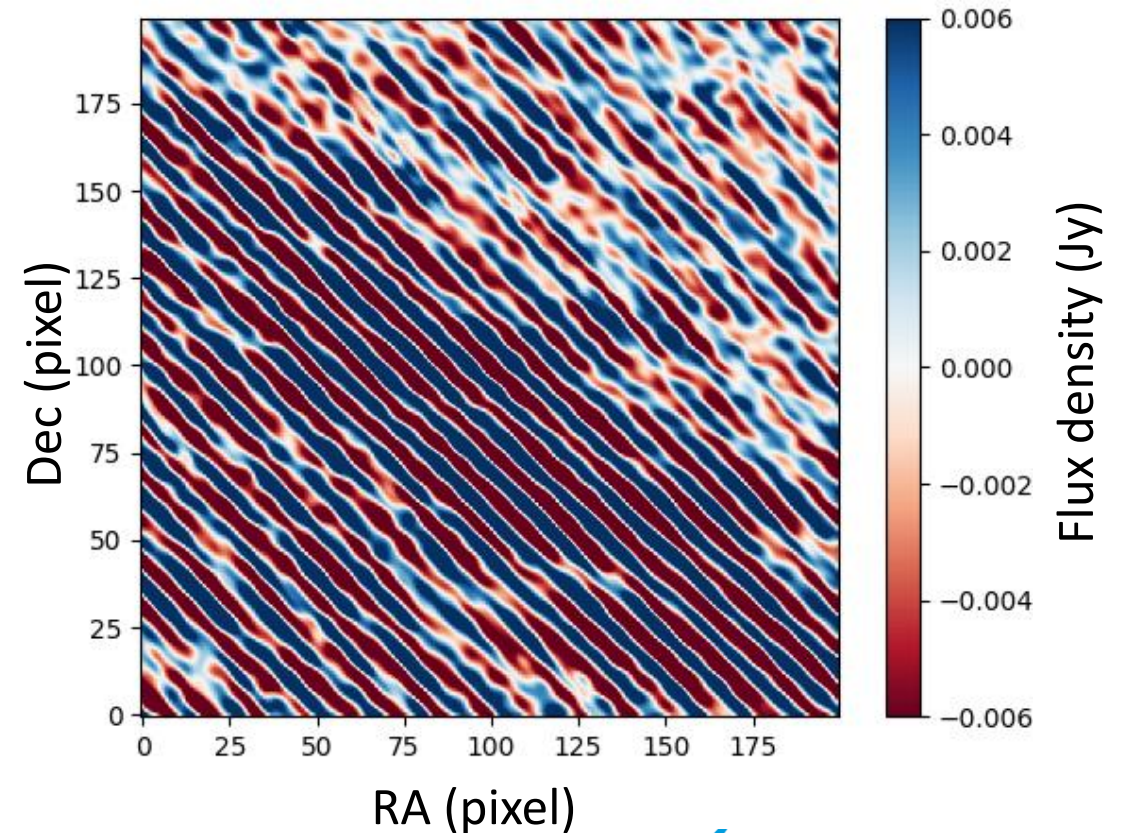
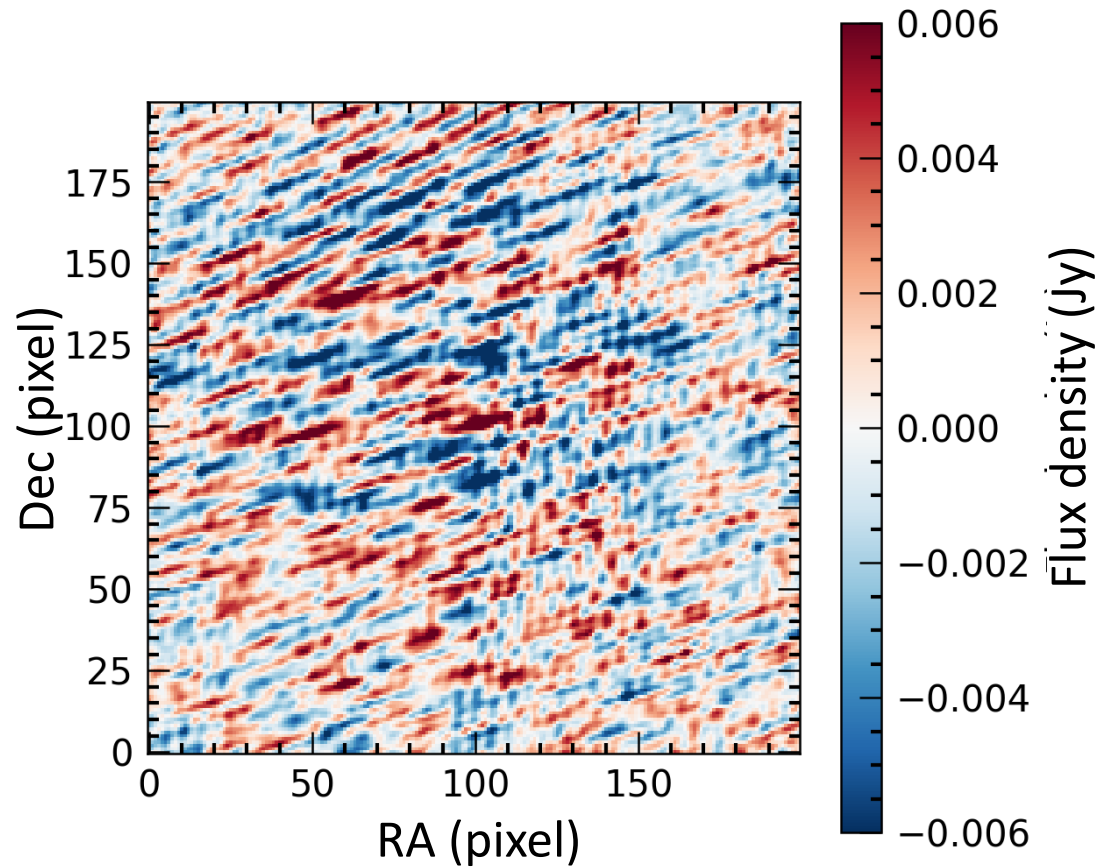


Detection method

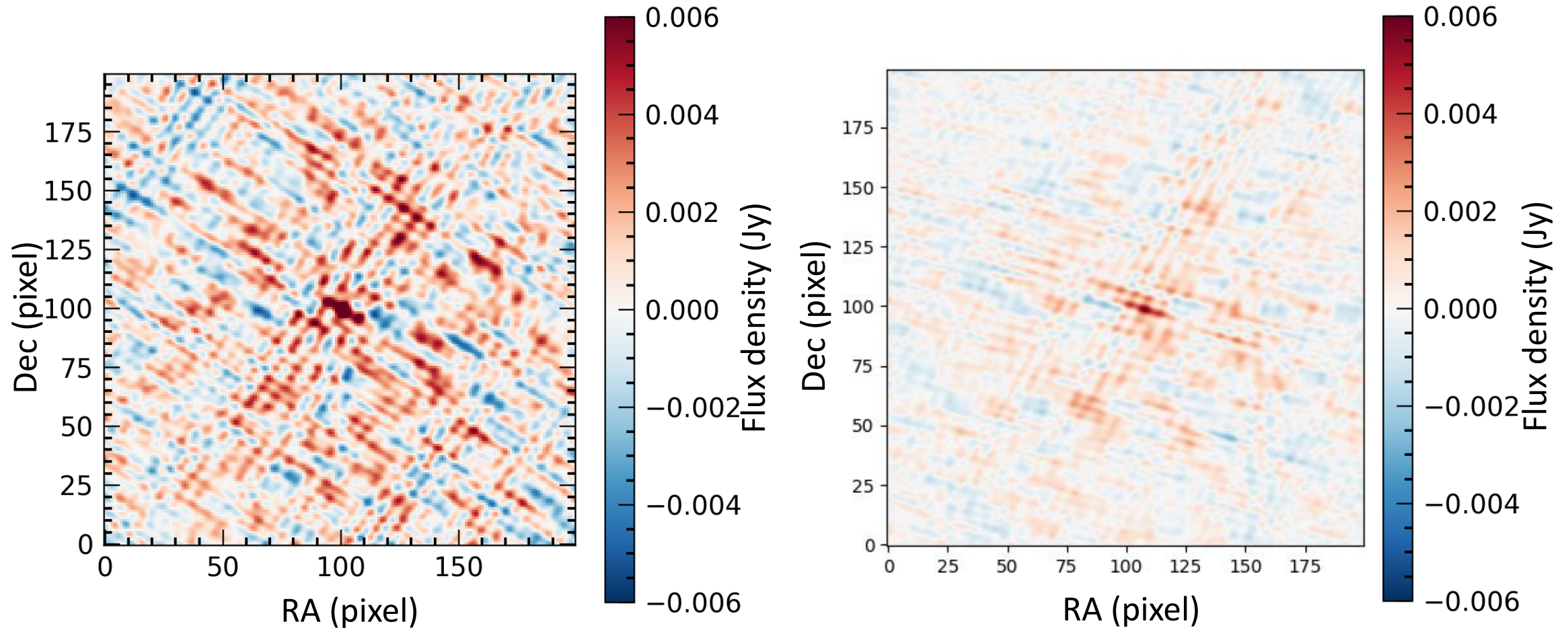
- Image 4 minute intervals
- Detect 7 sigma sources
- Remove false detections



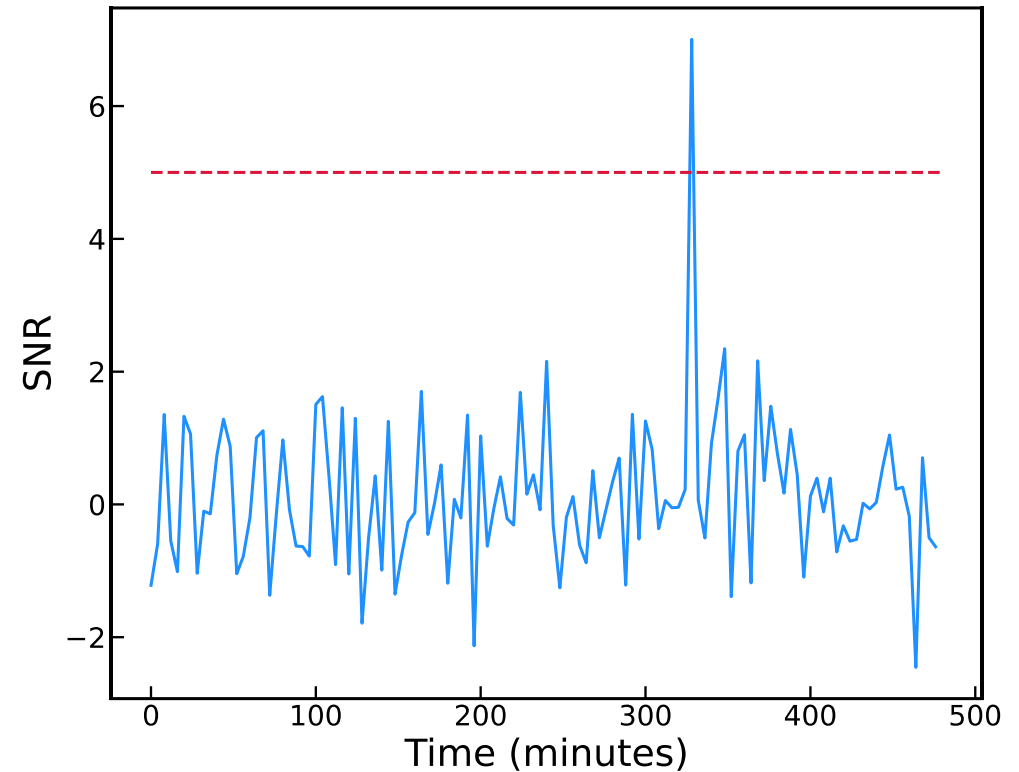
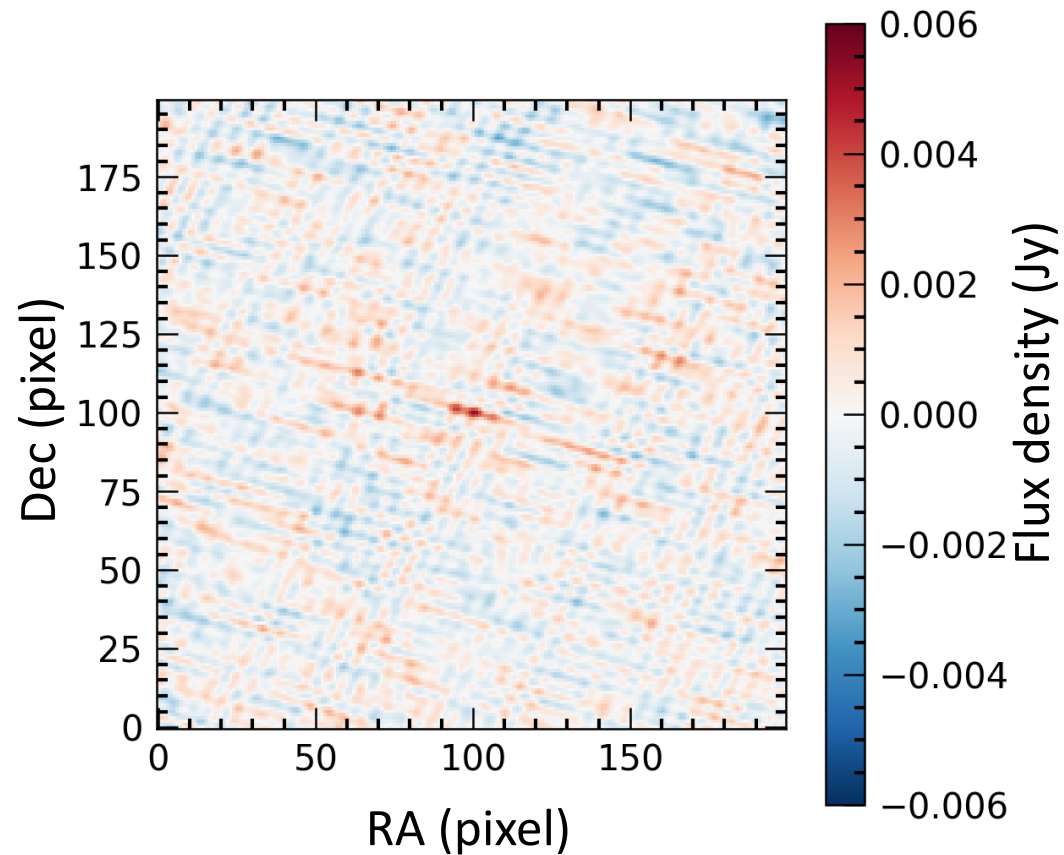
False detections



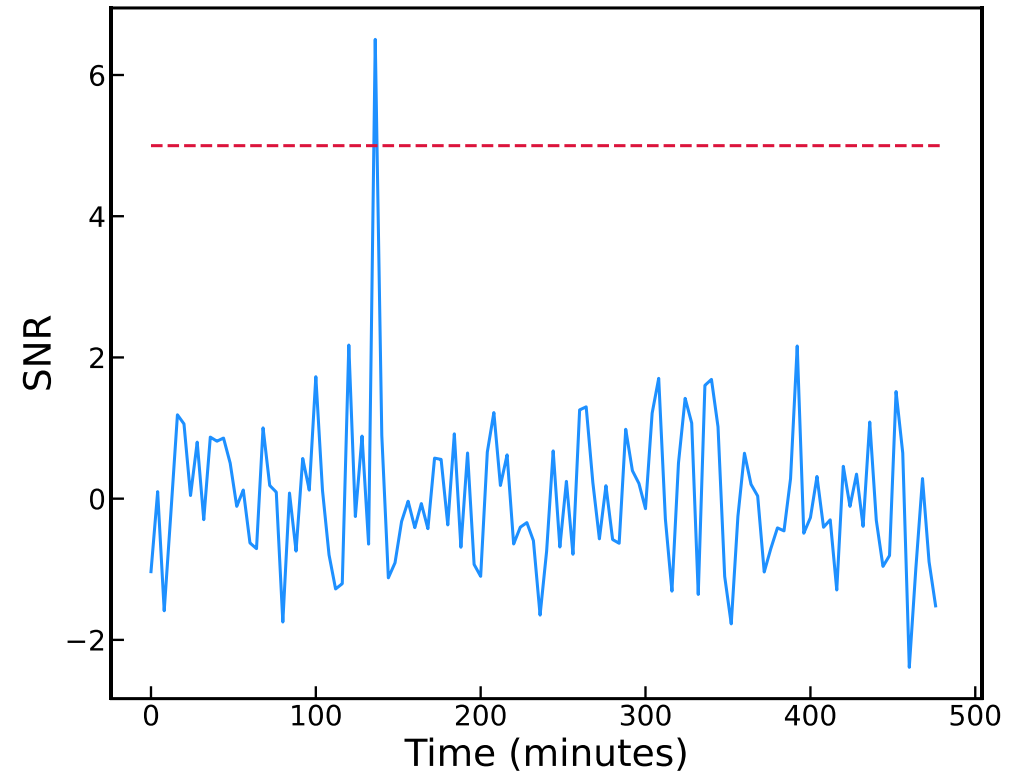
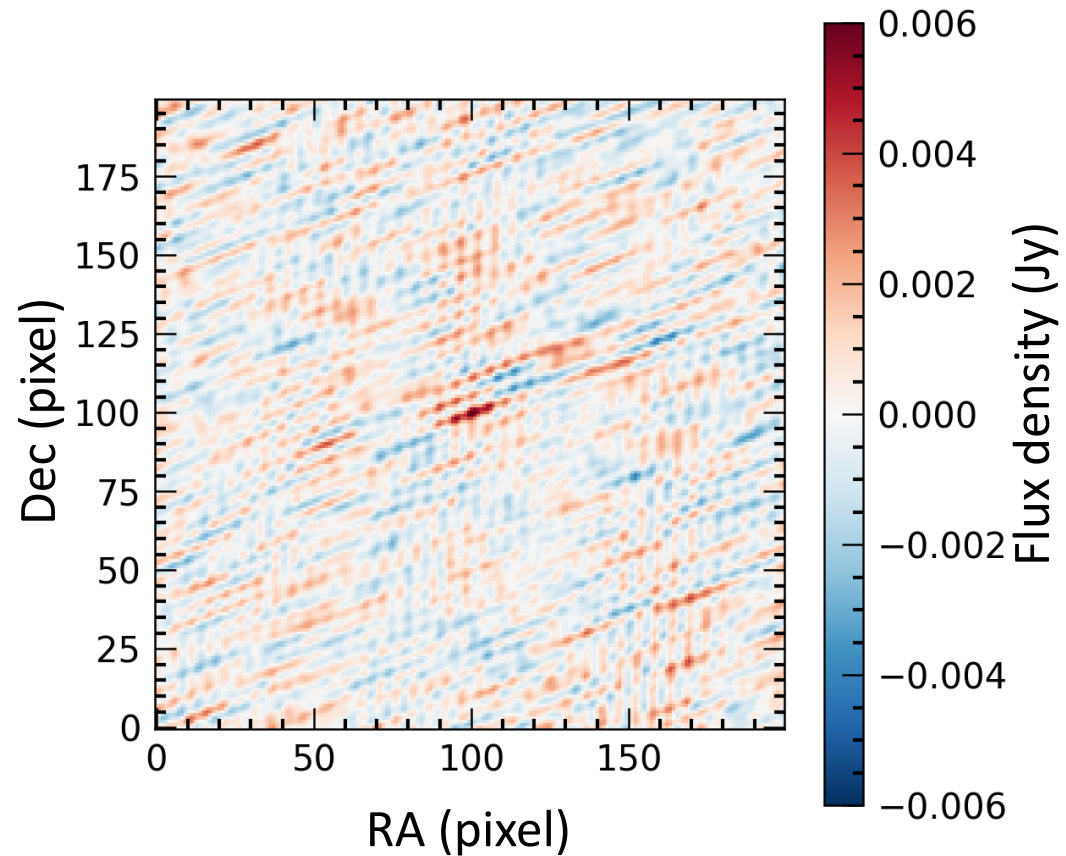
Bright V-LoTSS sources: pulsars and stars



Brown dwarf candidates

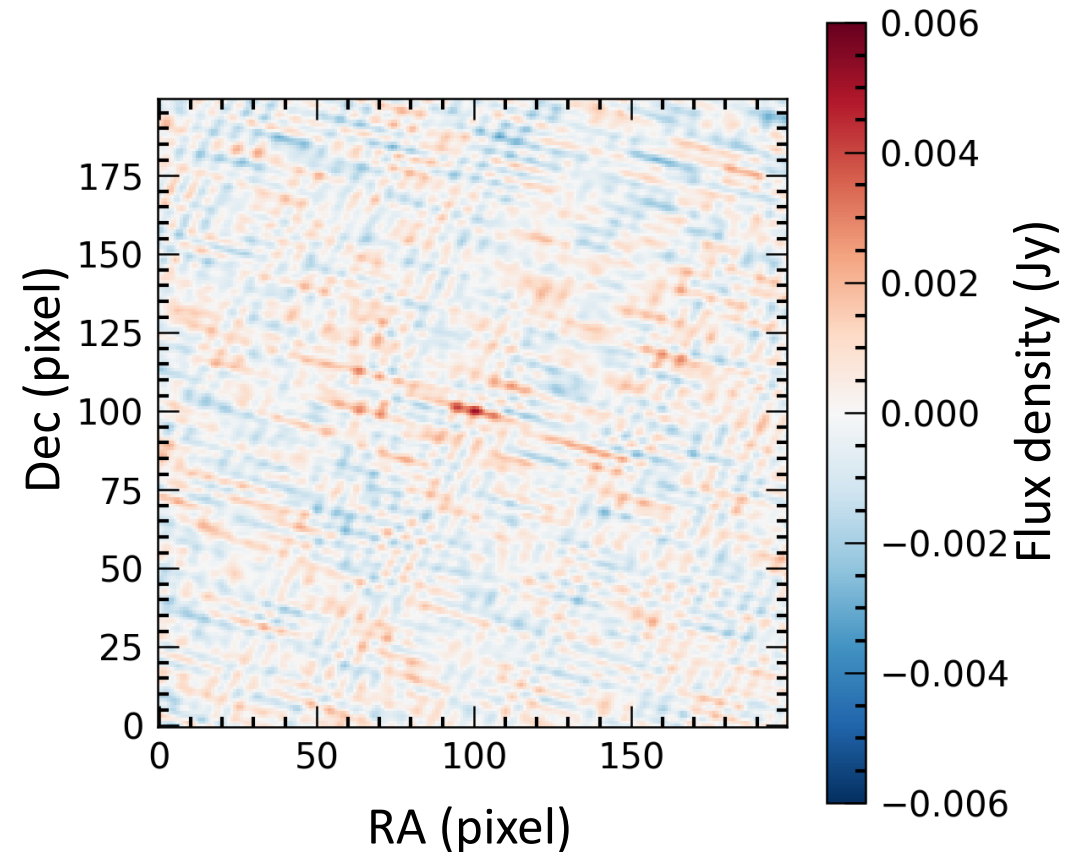


Brown dwarf candidates



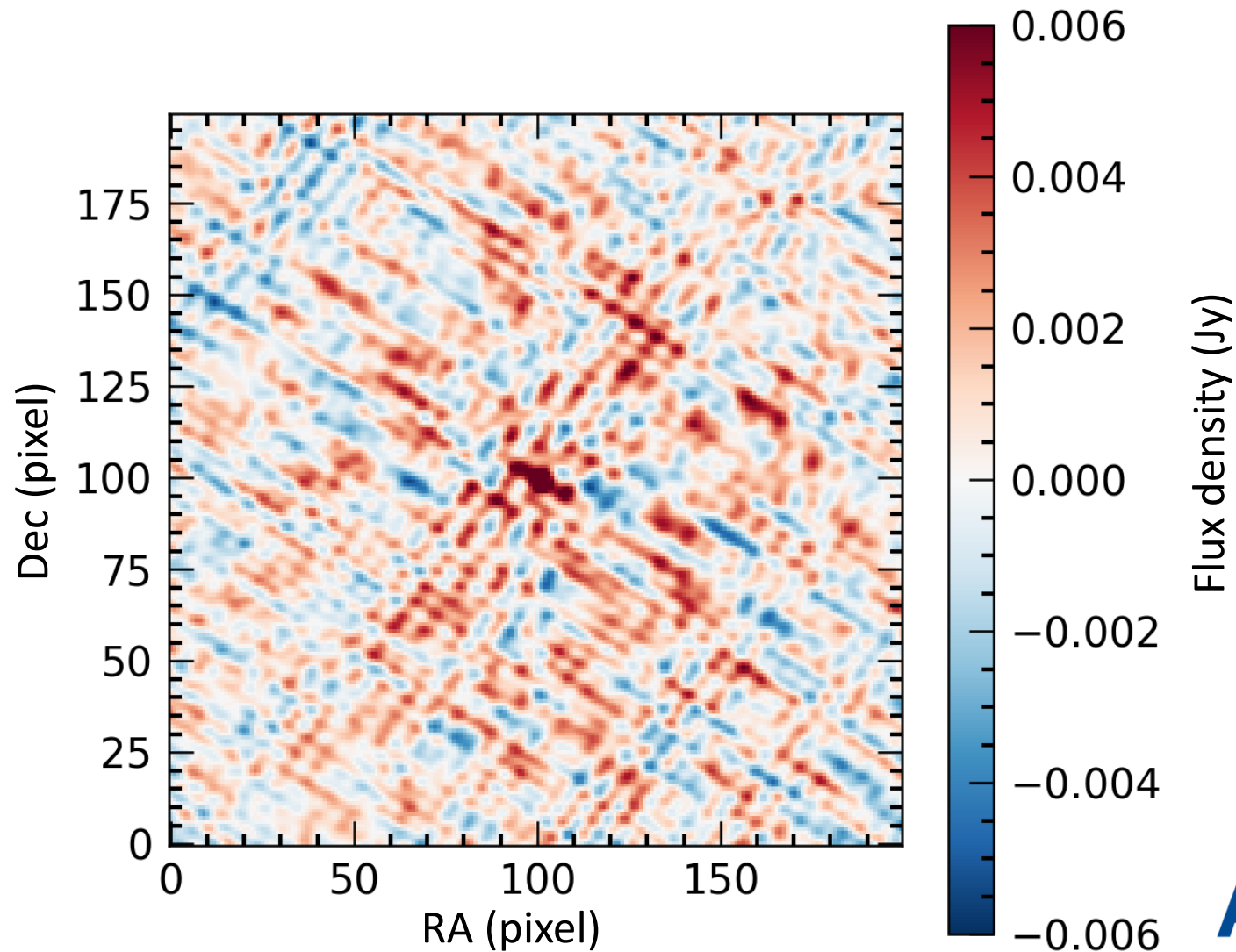
Next steps

- Process all of LoTSS DR2
- Search candidates for periodicity with LOFAR
- Follow up candidates in infrared





Bright V-LoTSS sources: pulsars



Brown dwarfs at radio frequencies

Coherent radio emission is a direct measurement of plasma properties

Measure magnetic field

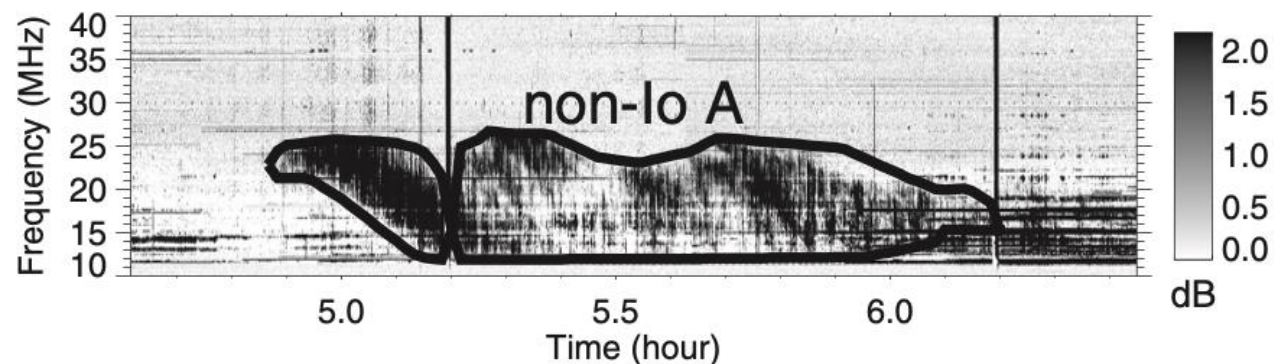
Electron cyclotron maser instability (ECMI) gives local magnetic field strength

$$\nu_B = \frac{eB}{2\pi m_e c} \approx 2.8 * 10^6 B \text{ Hz}$$

Radio emission on Jupiter

Jupiter

- ECMI
- Periodic due to beaming
- Auroral emission
- Jupiter-Io interaction



Blind surveys as the way to go

- Previous results of blind surveys?
- Many hours on 1 target
- Compared to a short time on many targets
- Cold objects – free floating