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The periodic variability of the 6.7 GHz methanol masers of massive protostars.

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AfAS African Astronomical Society

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Presentation outline

- Introduction
- Aims & objectives
- Methodology
- Results & Discussions
- Conclusion

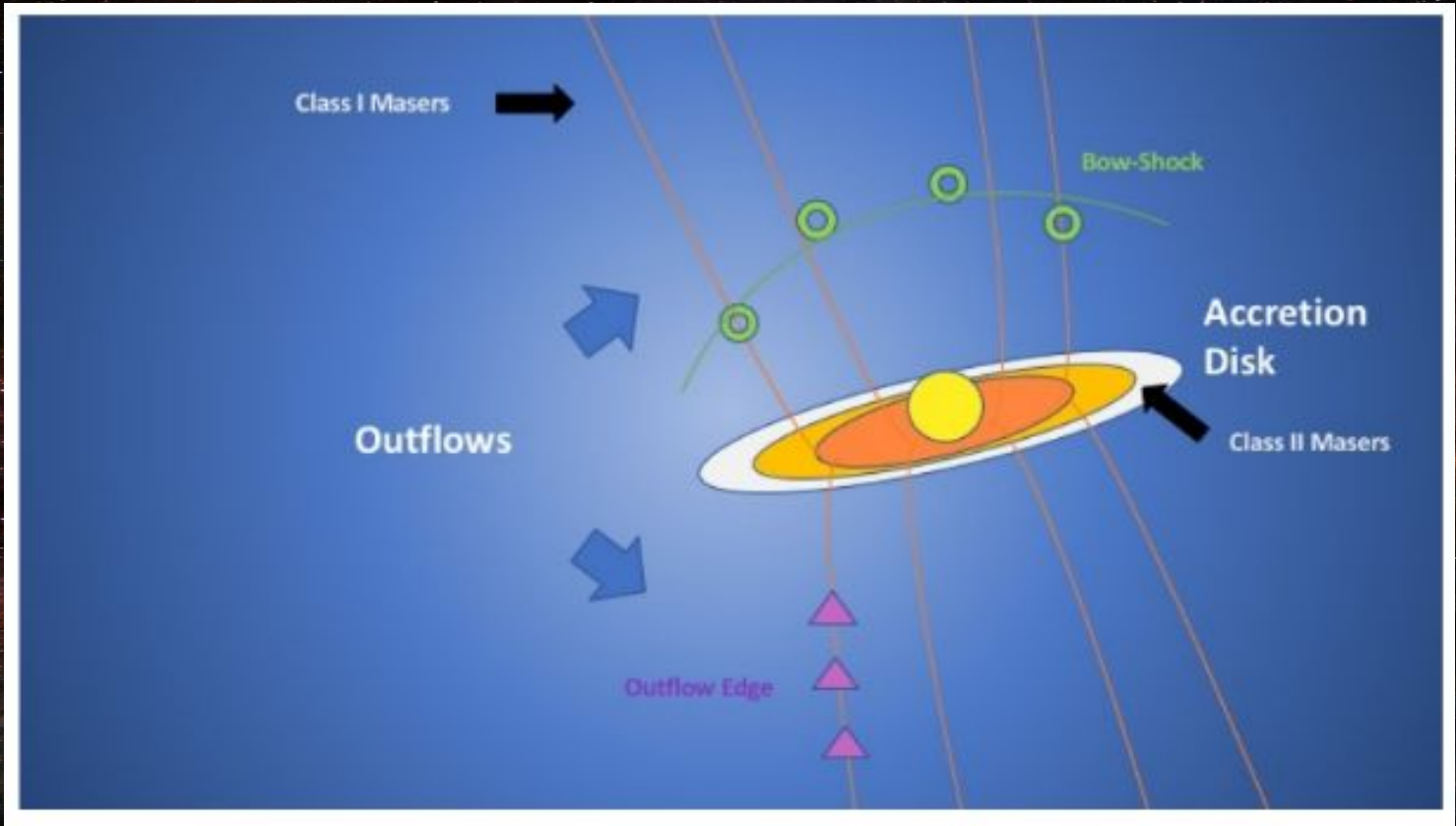
Introduction

MASERS – Microwave Amplification by Stimulated Emission of Radiation.

- Point-like sources in the sky, serving as an excellent source of information in further understanding the environment of high-mass star formation.
- Associated with star-forming regions and late type stars that lose their mass into circumstellar space.

Two classes of methanol masers:

- Class I: excited by collisions (44.1 GHz)
- Class II: excited by infrared radiation (6.7 & 12.2 GHz).



Credit: (Clarisse & Sarma, 2019)

Aim & Objectives

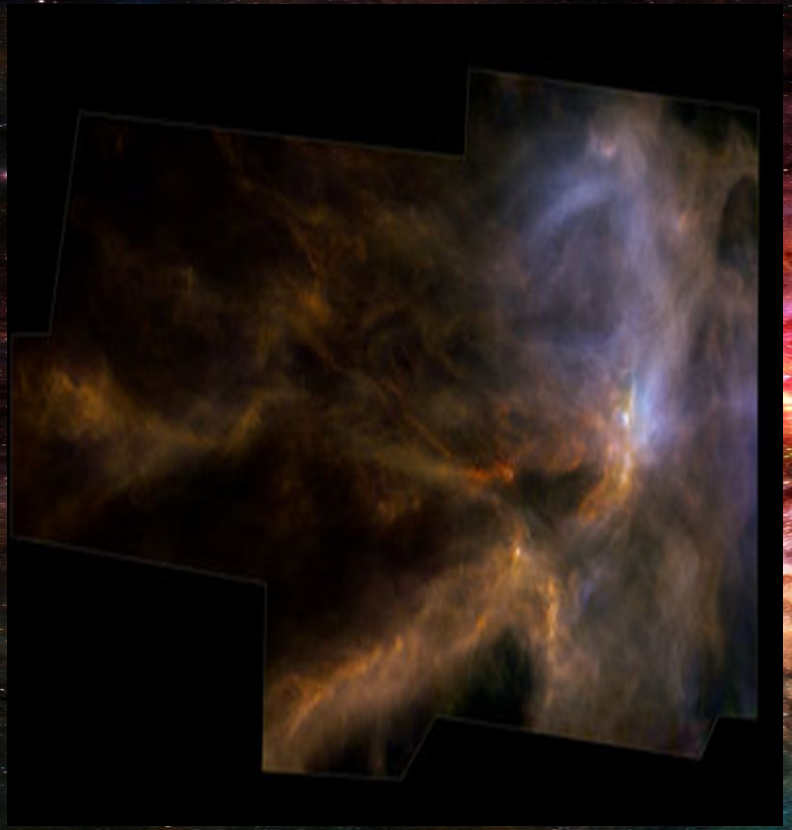
Aim:

- Study the periodic variability of the 6.7 GHz methanol masers associated with massive young stellar objects.

Objectives:

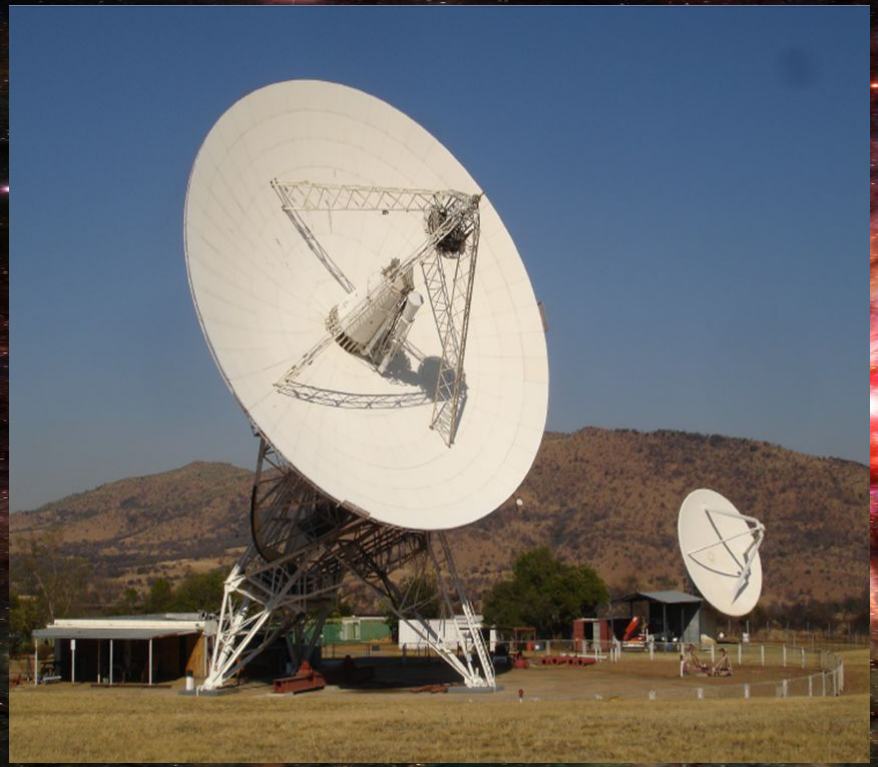
- High cadence observations of masers associated with high-mass protostars with HartRAO 26m radio telescope.
- Calibrate and derive maser spectra from each observed epoch.
- Analyse data (including fitting periodograms to the light curves).

Region of study: G174.20-0.08



- High-mass star forming region.
- Also known as AFGL5142.
- Sign post for star formation.
- Controls dynamical evolution of the stellar cluster in AFGL5142.
- Maintains growth of high-mass protostars.
- Rich in maser activity, accretion processes & bipolar outflows.

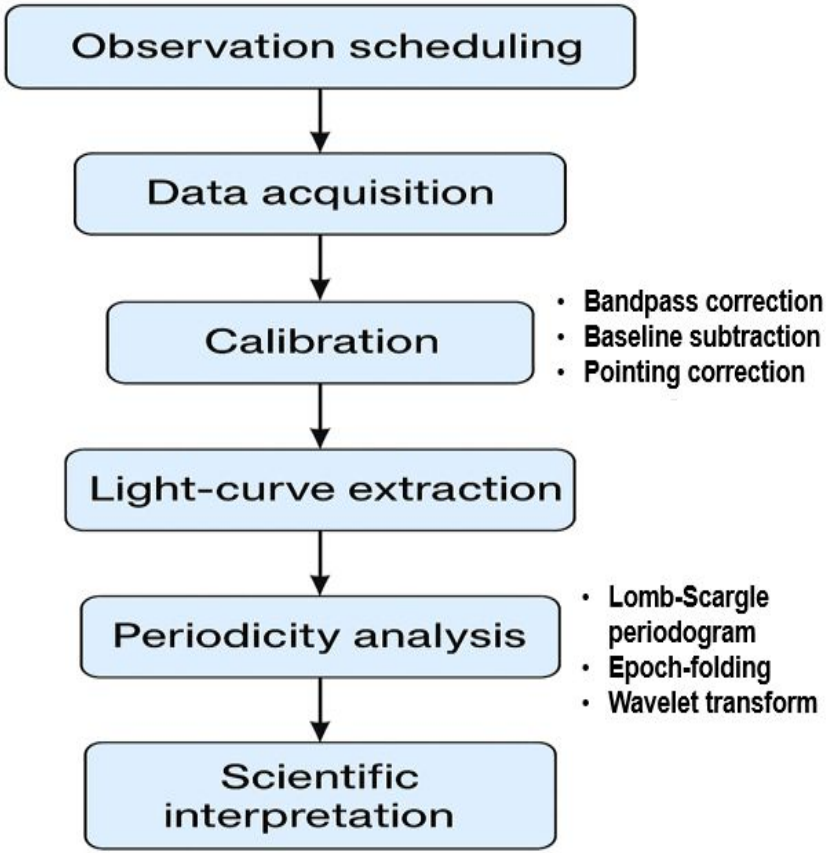
HartRAO 26-m telescope



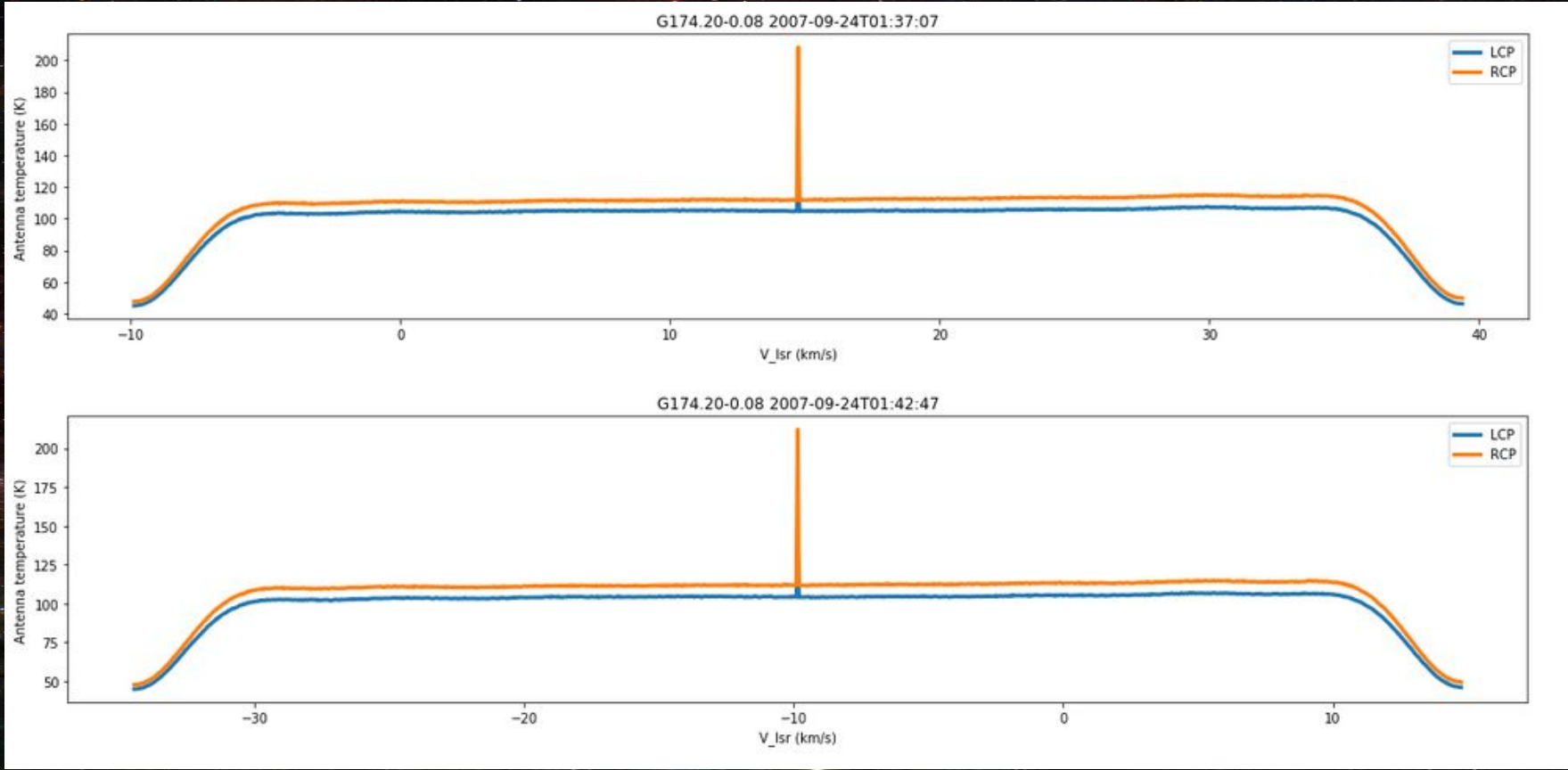
Credit: http://www.hartrao.ac.za/gallery/

- Hartebeesthoek Radio Astronomy Observatory (HartRAO)
- Located in the valley of the Witwatersrand mountain range 65 km from JHB.
- Equipped with a 15-m diameter azimuth-elevation mounted telescope.
- 26-m equatorial mounted cassegrain-type radio telescope.
- Built by Blaw Knox in 1961.
- This study is only limited to the 26-m telescope.

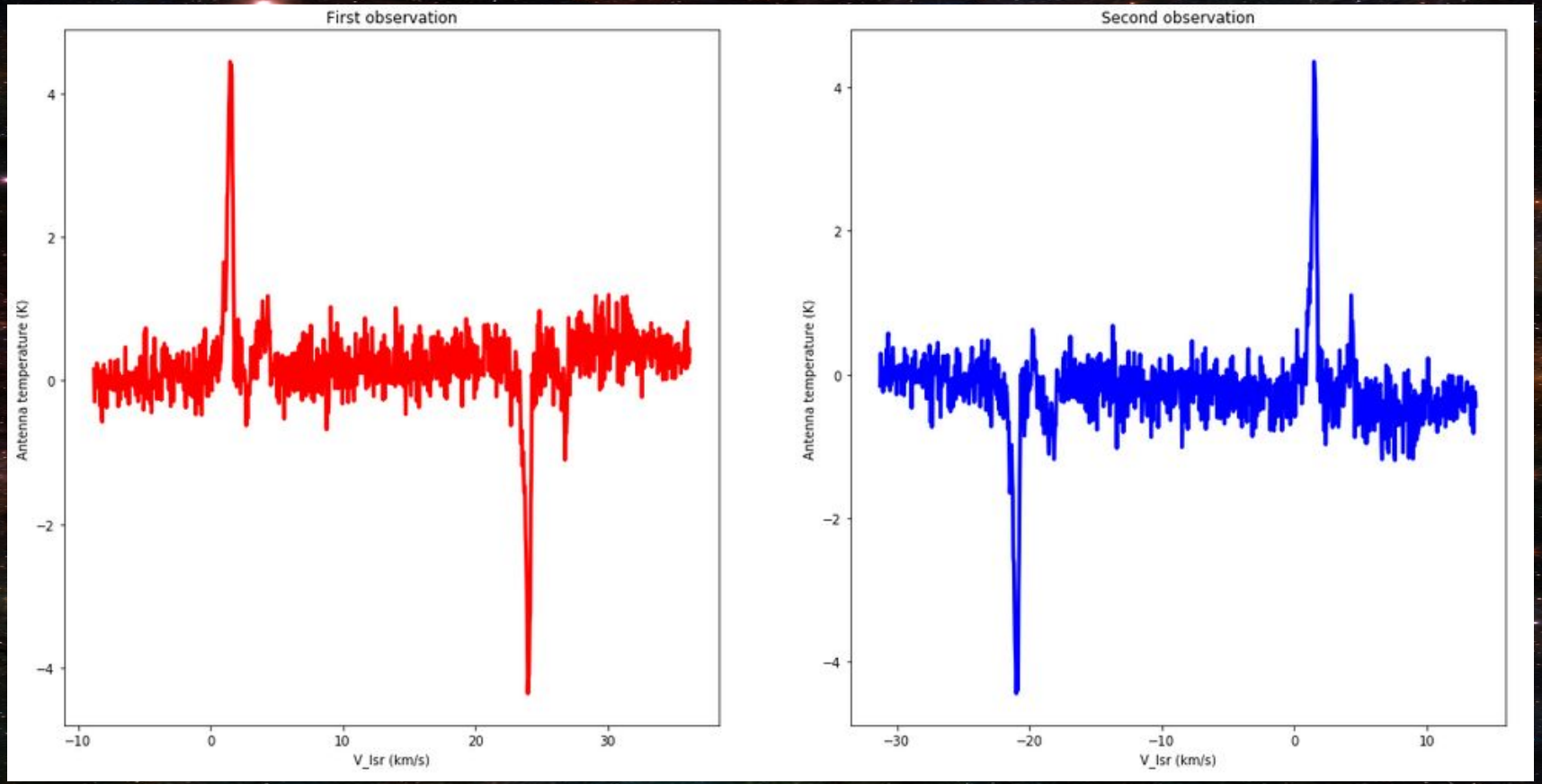
High-cadence Maser Monitoring

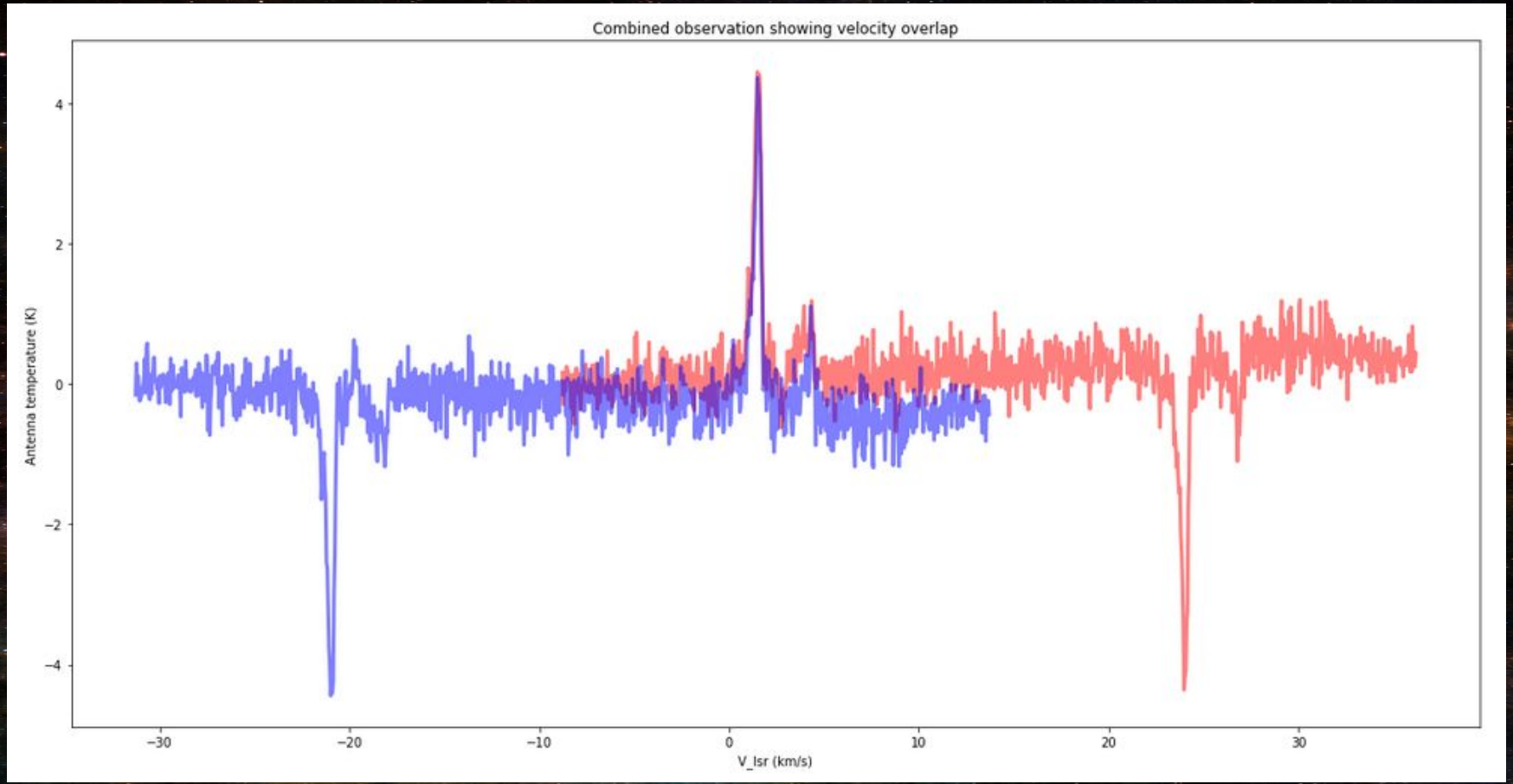


Frequency switching

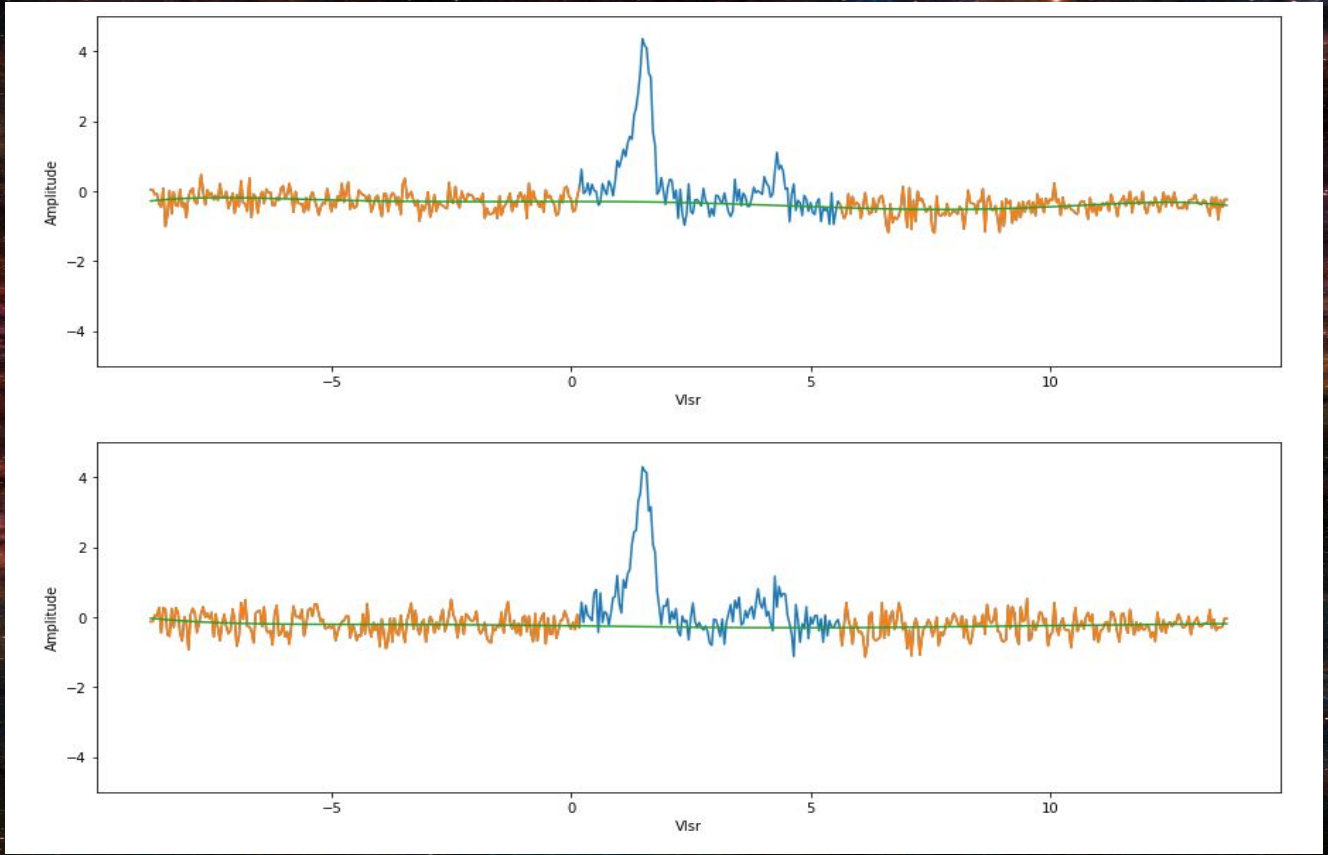


Velocity overlap

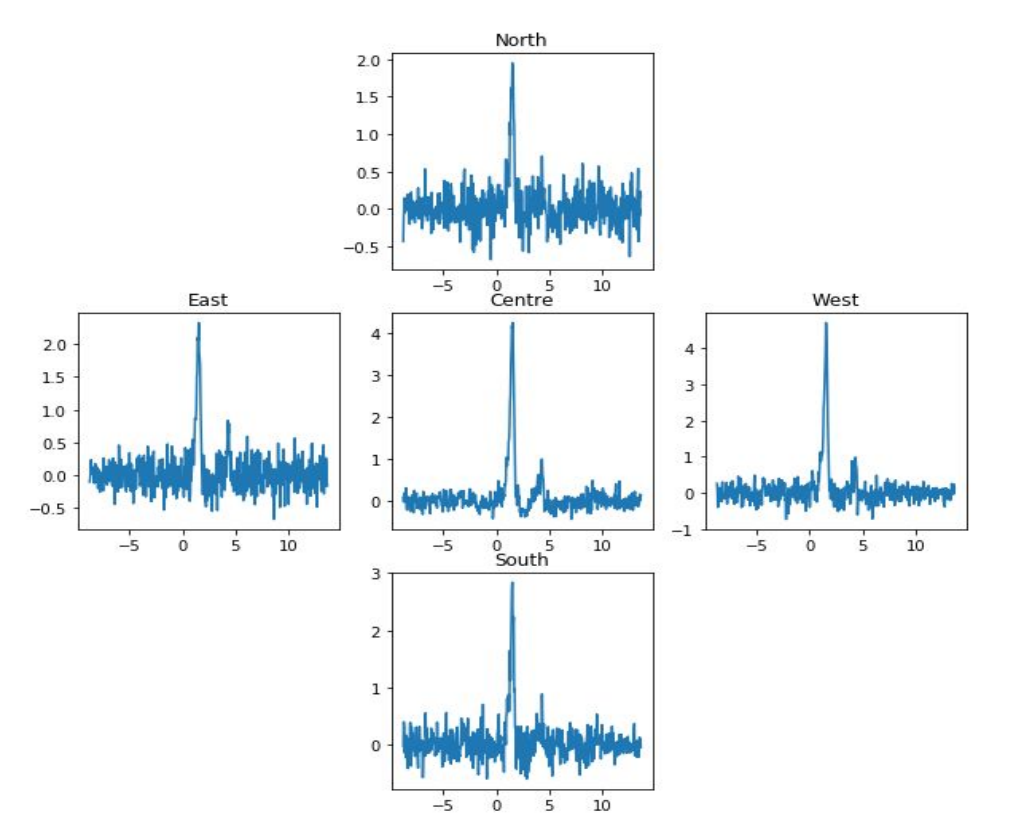



Combined observation showing velocity overlap
Antenna temperature (K)
4
2
0
−2
−4
−30
−20
−10
0
10
20
30
V_lsr (km/s)

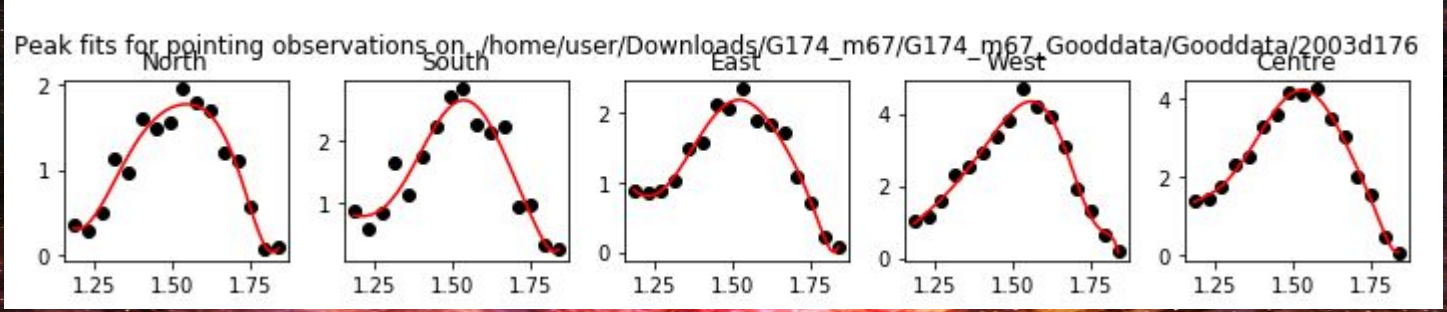
Baseline fitting

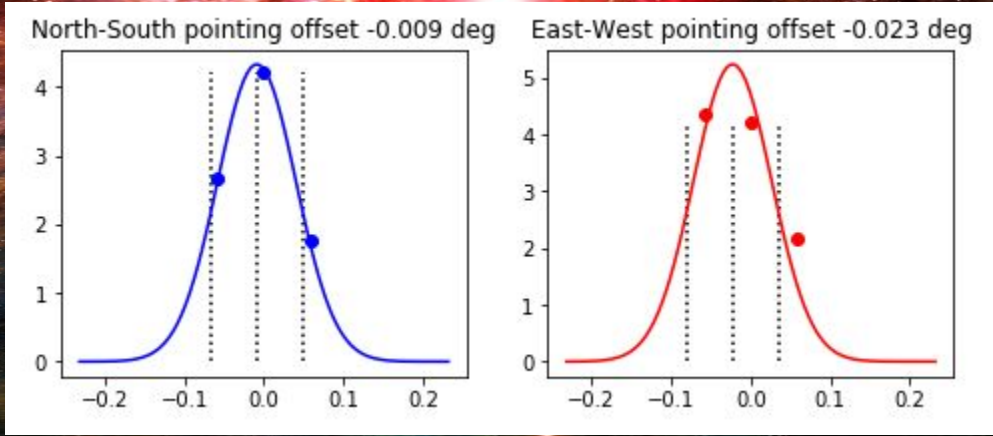


Pointing correction

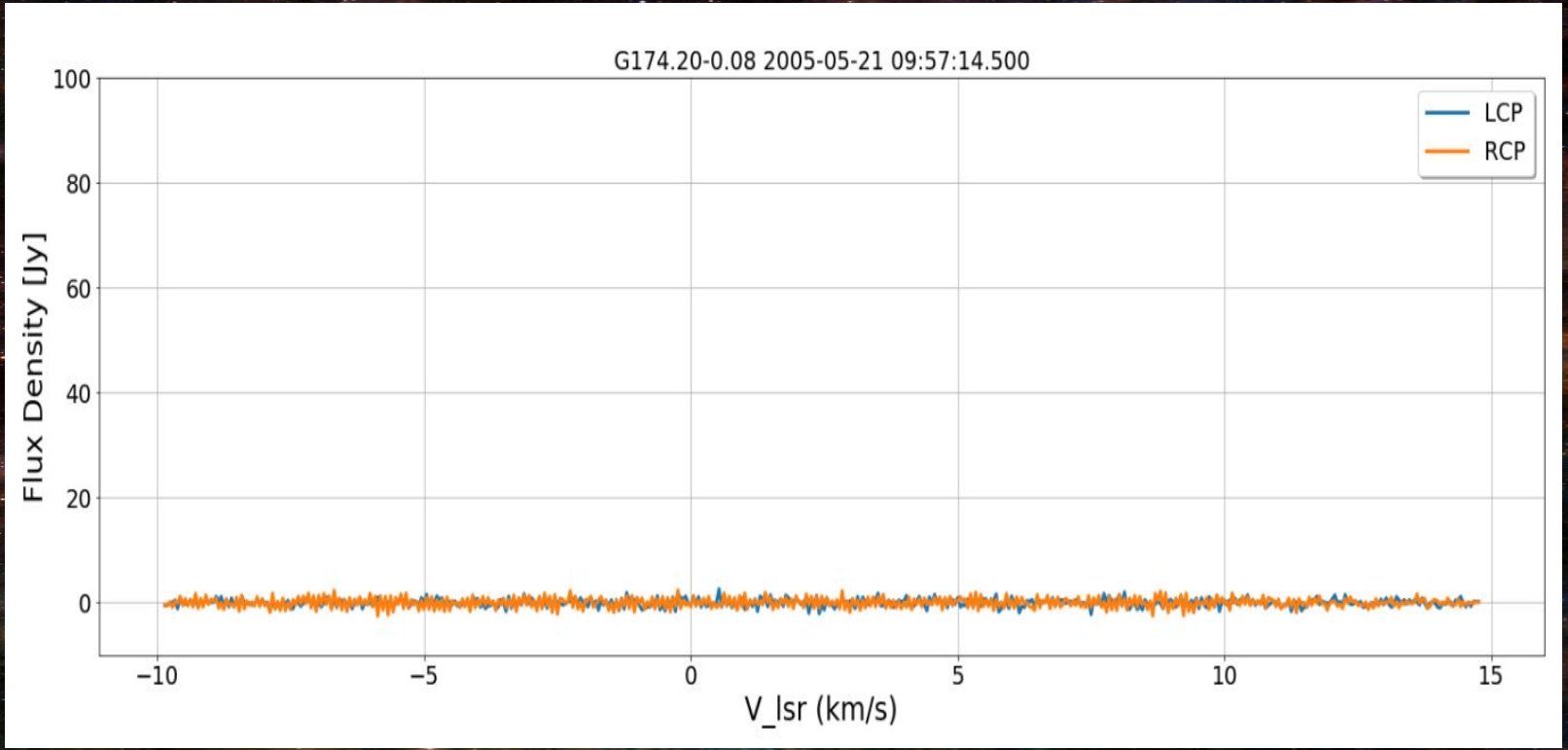


Gaussian fits

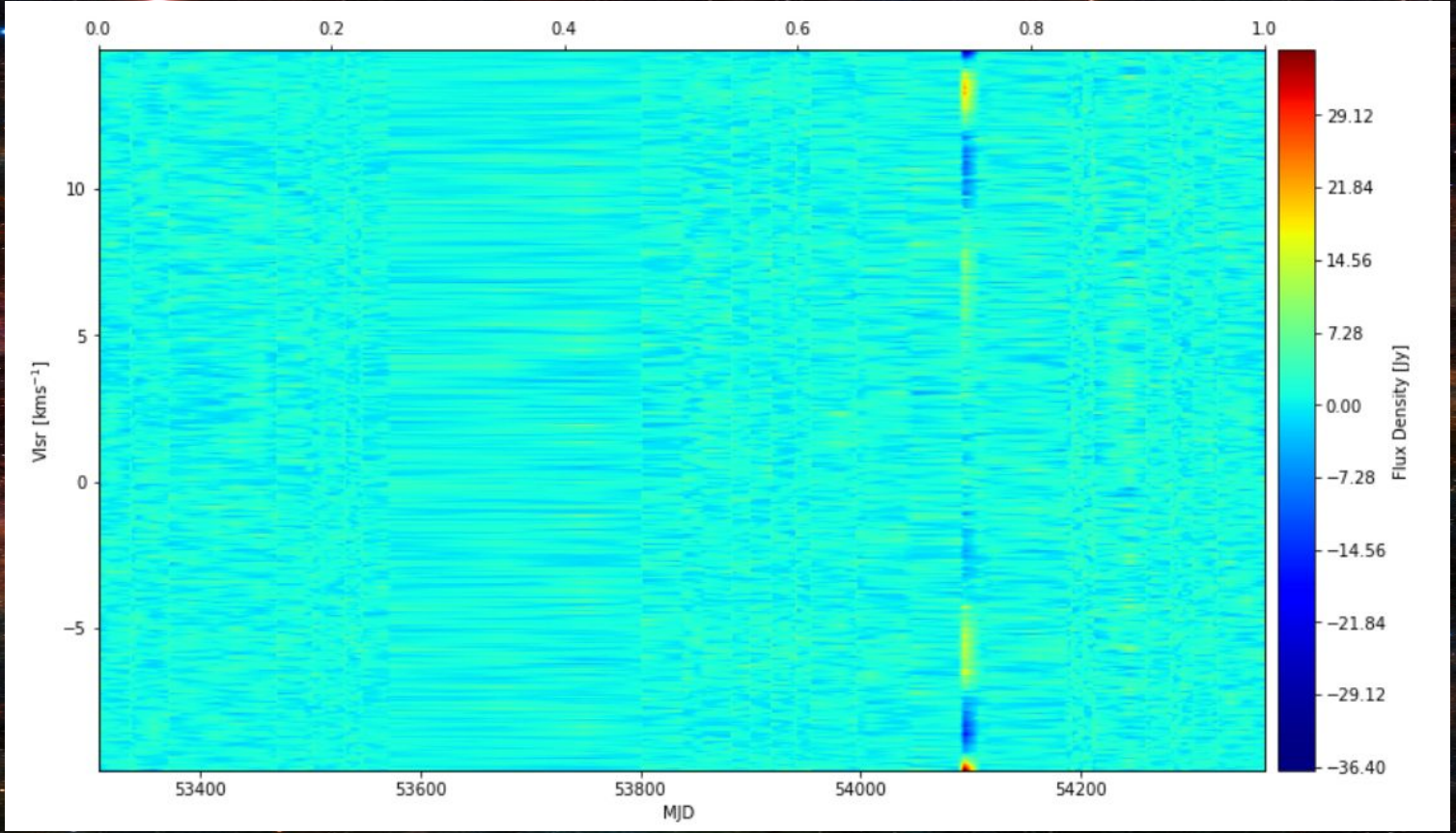




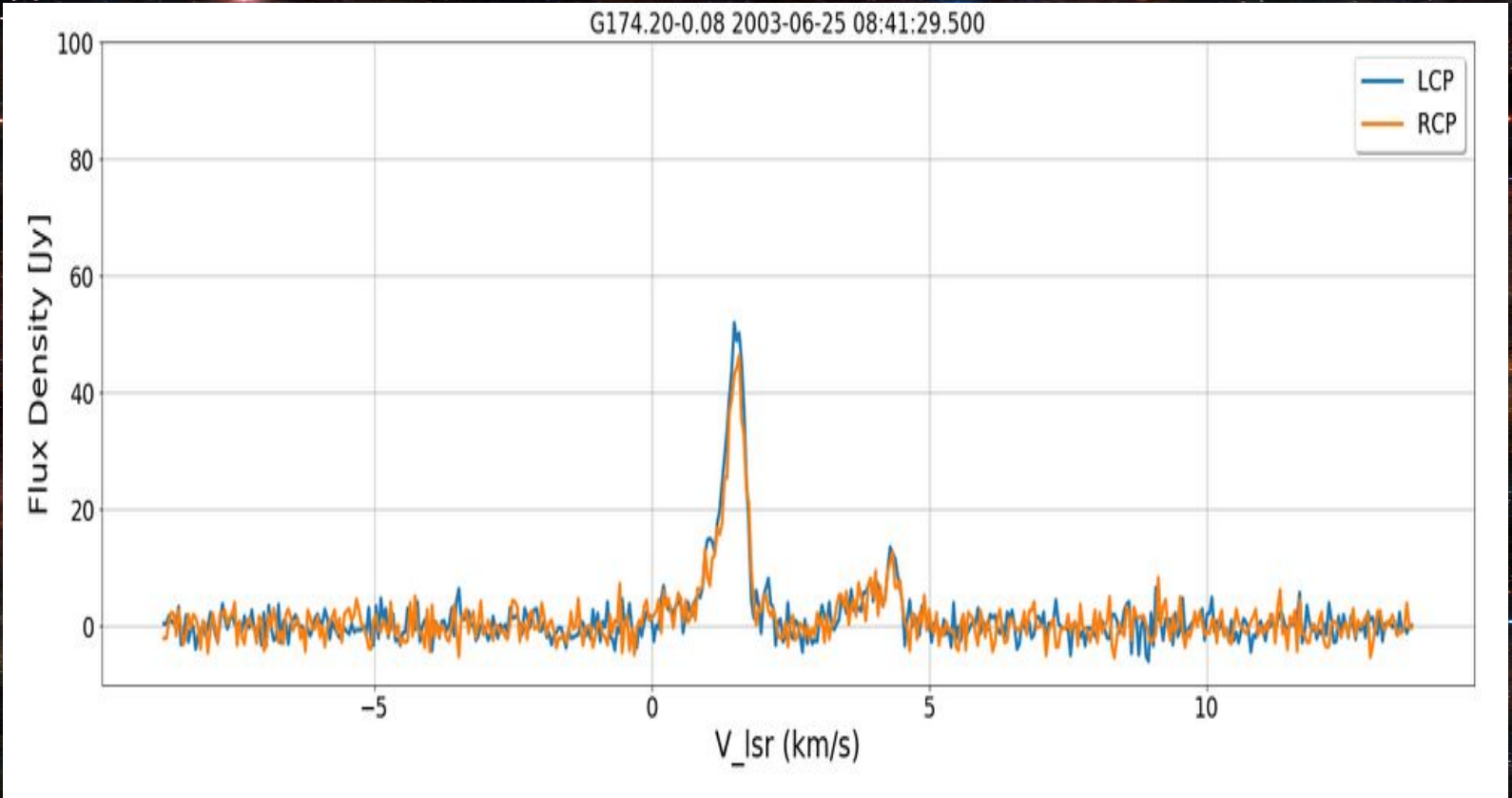
Results (12.2 GHz)

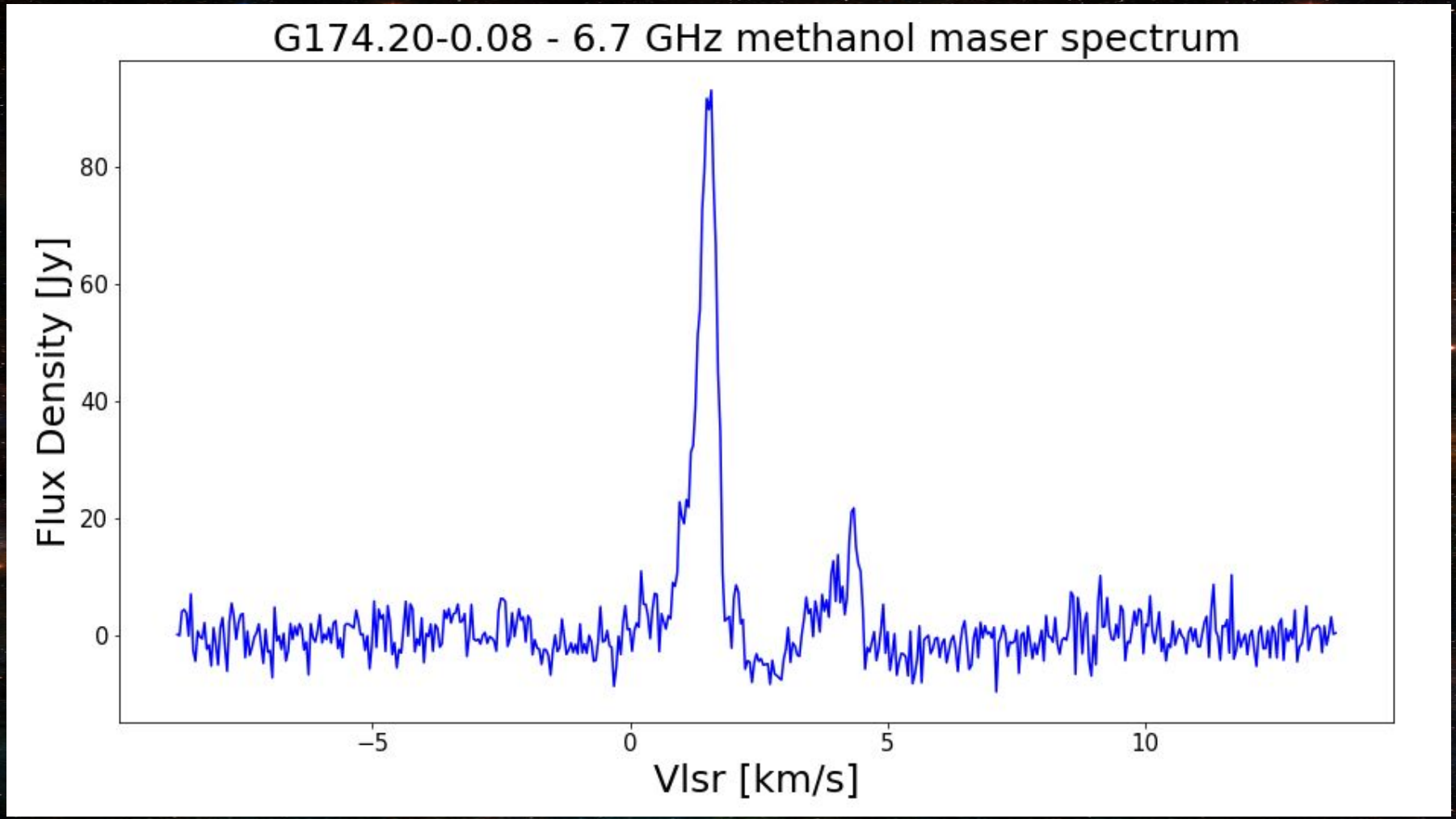


12.2 GHz Dynamic spectrum

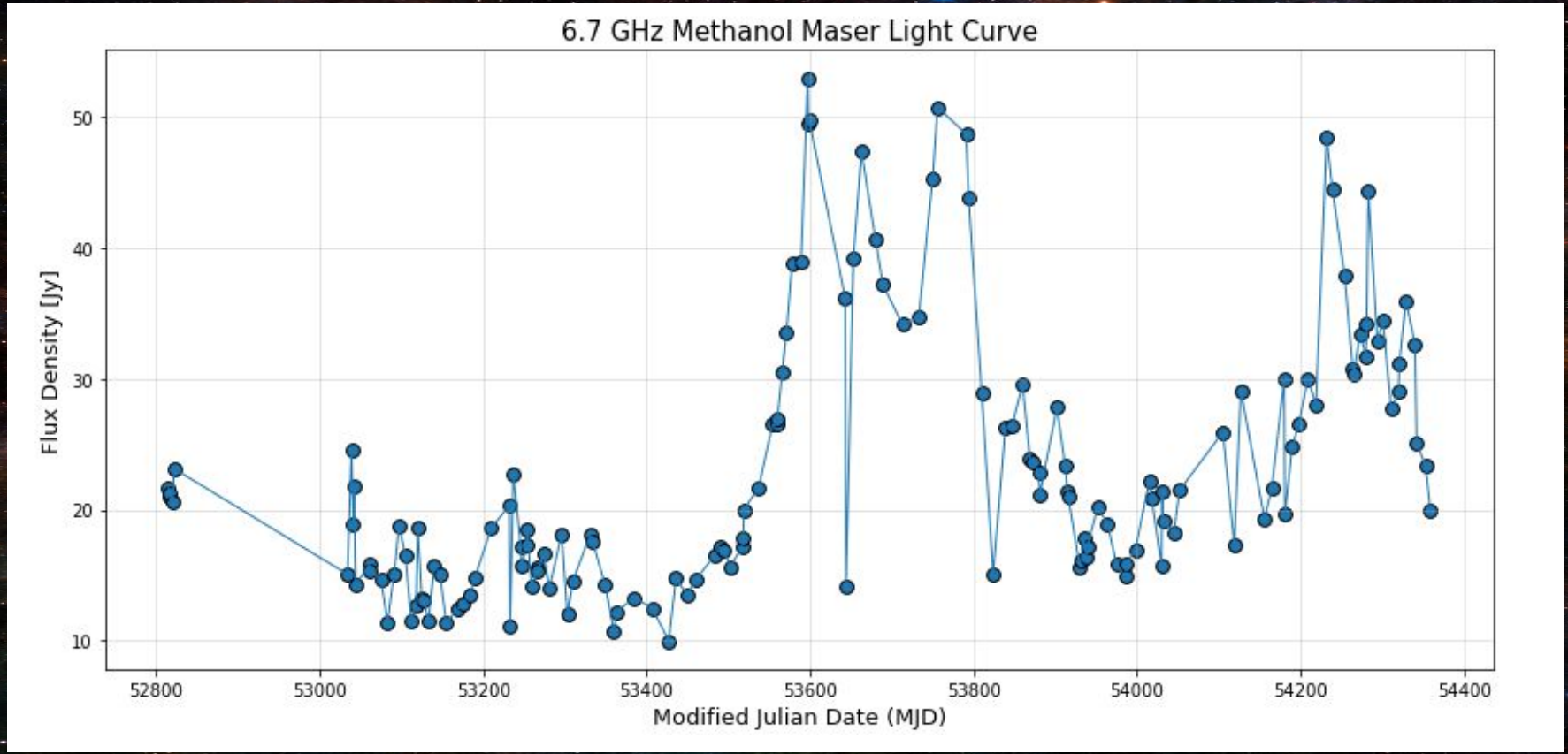


6.7 GHz results

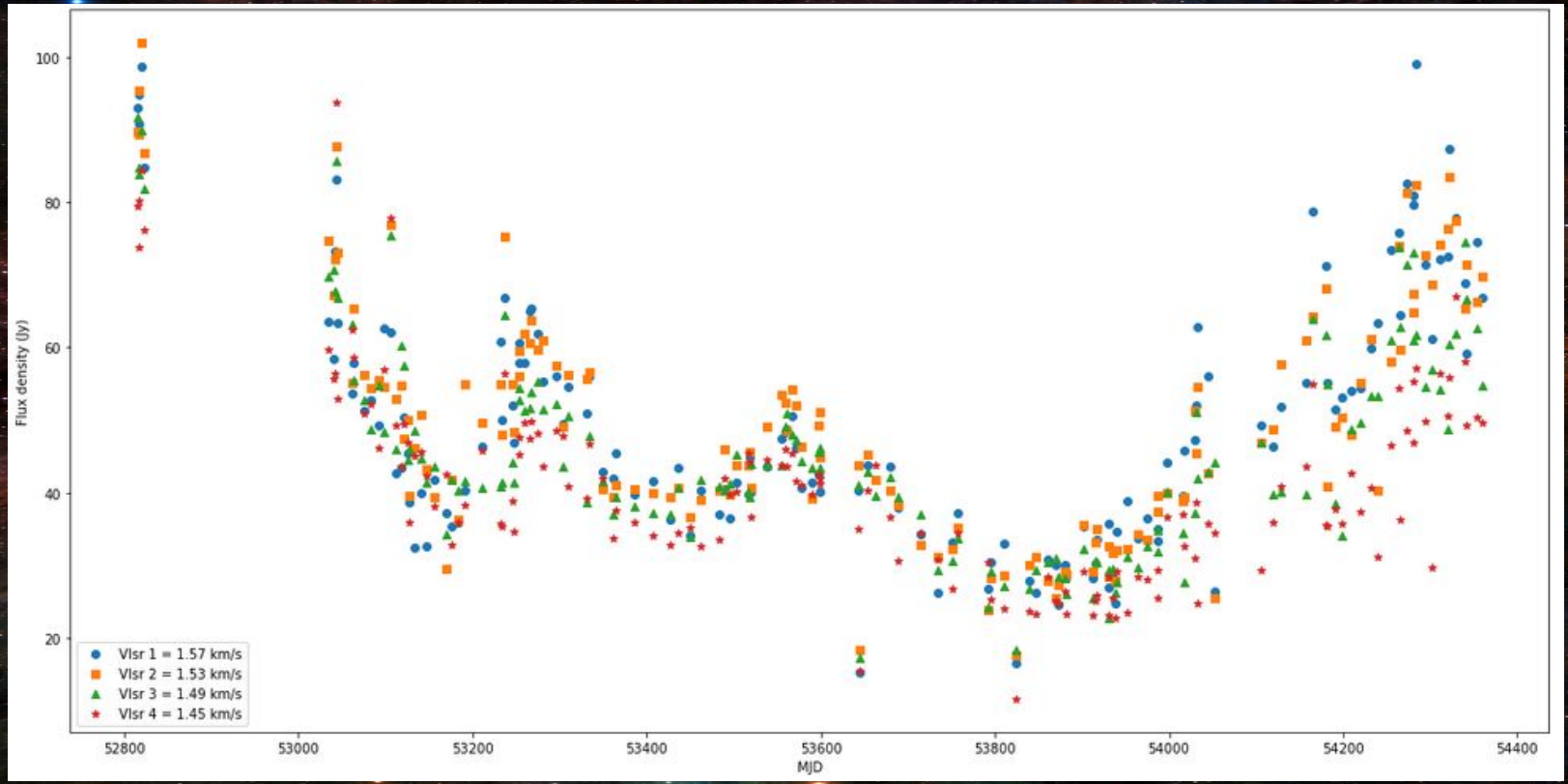



G174.20-0.08 - 6.7 GHz methanol maser spectrum
Flux Density [Jy]
80
60
40
20
0
−5
0
5
10
Vlsr [km/s]

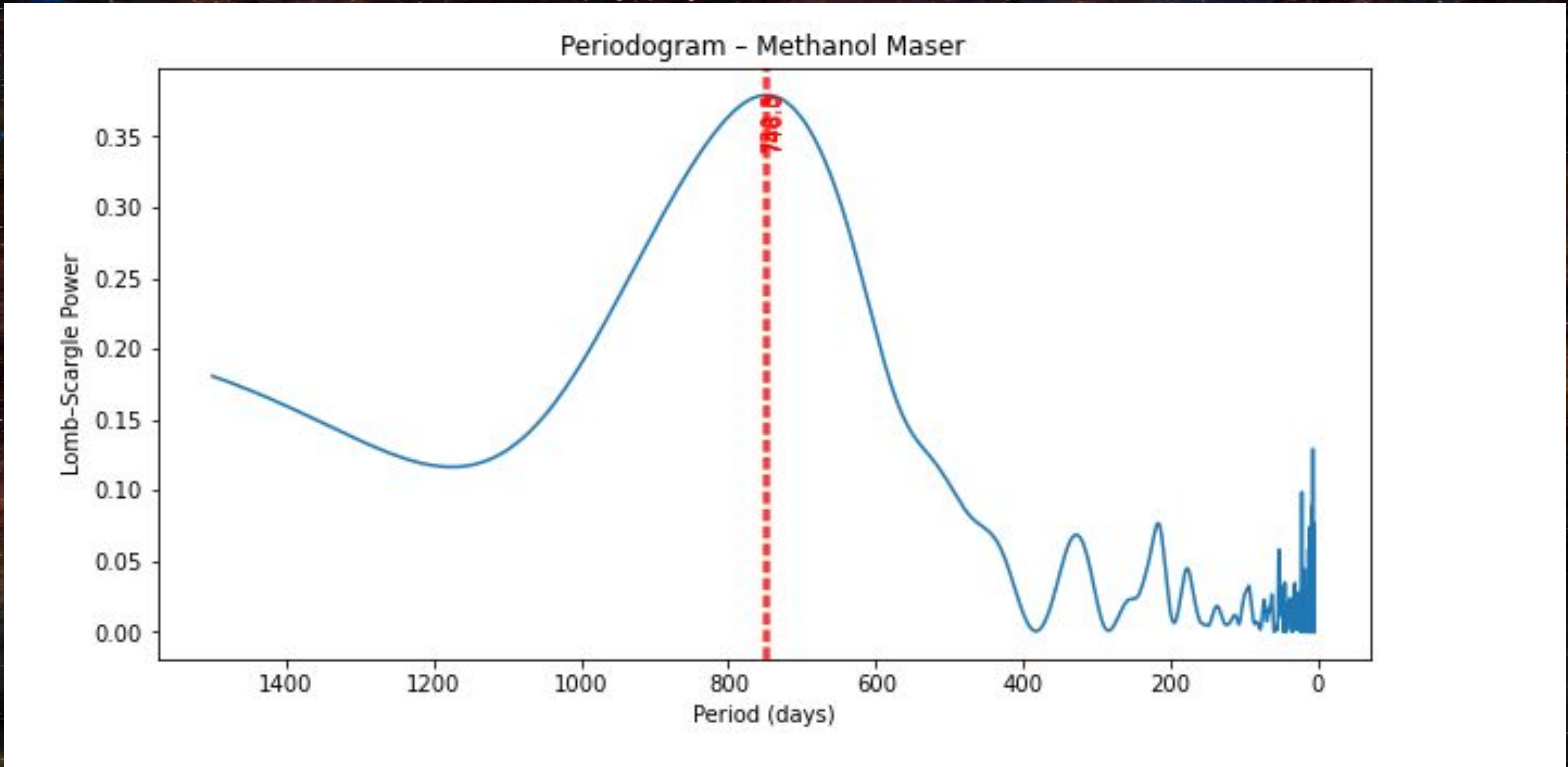
Light curve


6.7 GHz Methanol Maser Light Curve
Flux Density [Jy]
Modified Julian Date (MJD)
10
20
30
40
50
52800
53000
53200
53400
53600
53800
54000
54200
54400

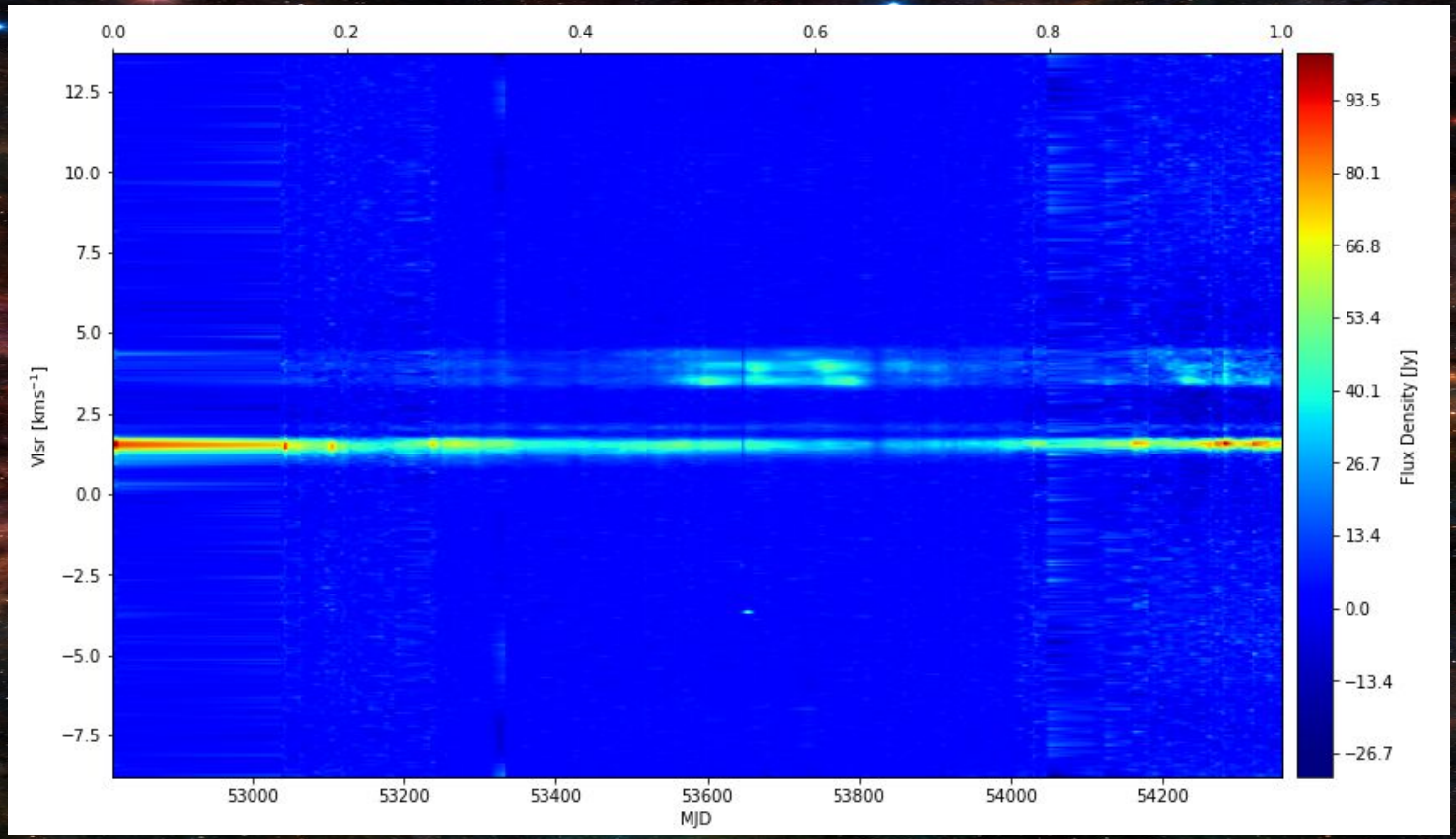
Times series analysis



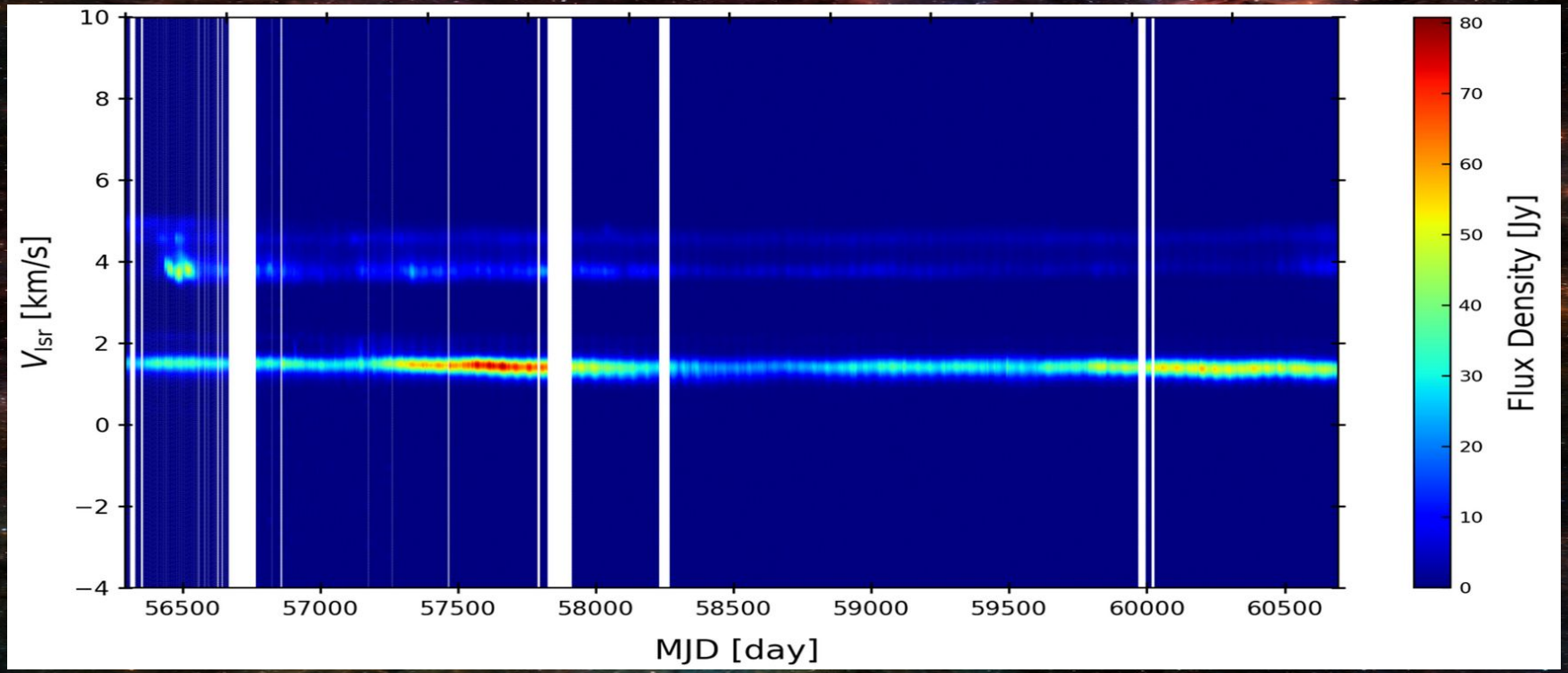
Lomb-Scargle periodogram



6.7 GHz Dynamic spectrum



Ibaraki Dynamic spectrum



Conclusion

- No periodic variability in the 12.2 GHz methanol masers.
- There is a velocity overlap at Vlsr 1.5 km/s on the Ibaraki and HartRAO results.
- Strongest peak flux of ~ 85 Jy that was observed by Gaylard and MacLeod (1993) is also present in these results.
- Lomb-Scargle periodogram showed a period of approximately 748 days.
- False alarm probability (FAP) of 0.003 confirming statistical significance of periodicity.
- Mechanisms that explain periodic maser variability include: periodic radiative pumping, colliding-wind binaries and period accretion bursts.
- The velocity-resolved time-series study of G174.20-0.08 shows strong evidence for coherent, radiatively driven periodic maser variability.


Thank
you!