Pulsar Search and Timing in Globular Cluster M15

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- FPS 14•Qingdao
- July 4, 2025

Outline

- Background
- Search methods
- M15M & M15N
- M15C & M15K & M15L
- Summary

Background

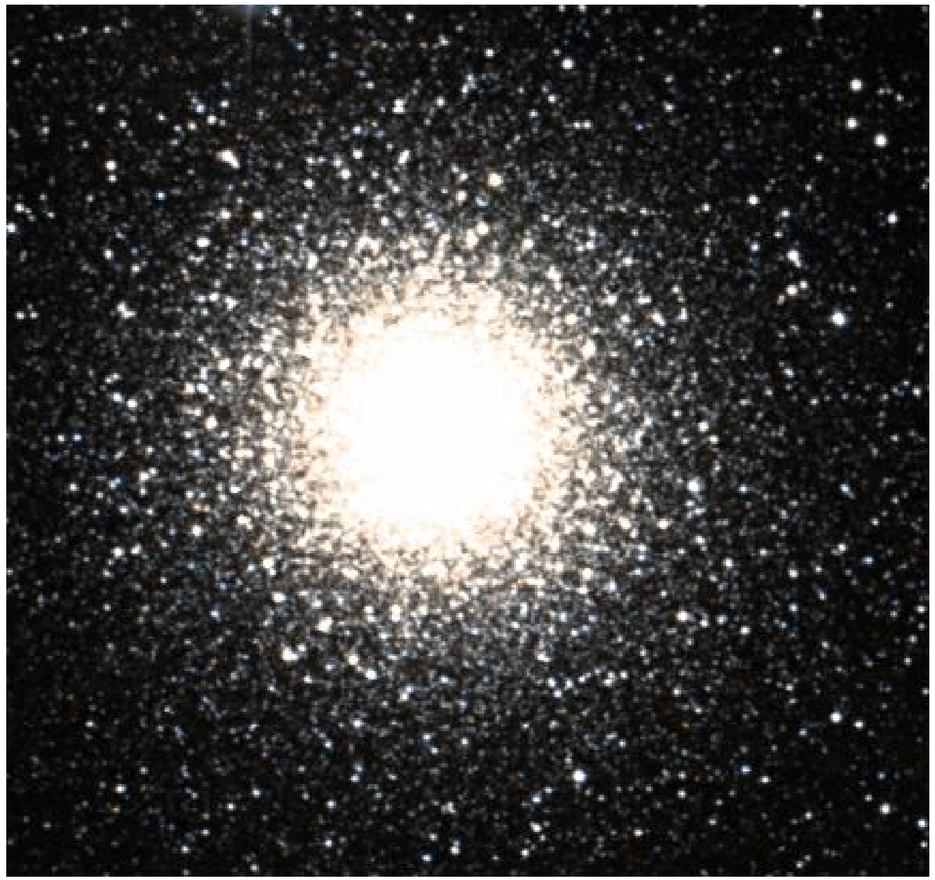


Fig. 1: Optical image of M15. The image is sourced from the website https://aladin.cds.unistra.fr/AladinLite

M15

Core-collapsed Globular Cluster

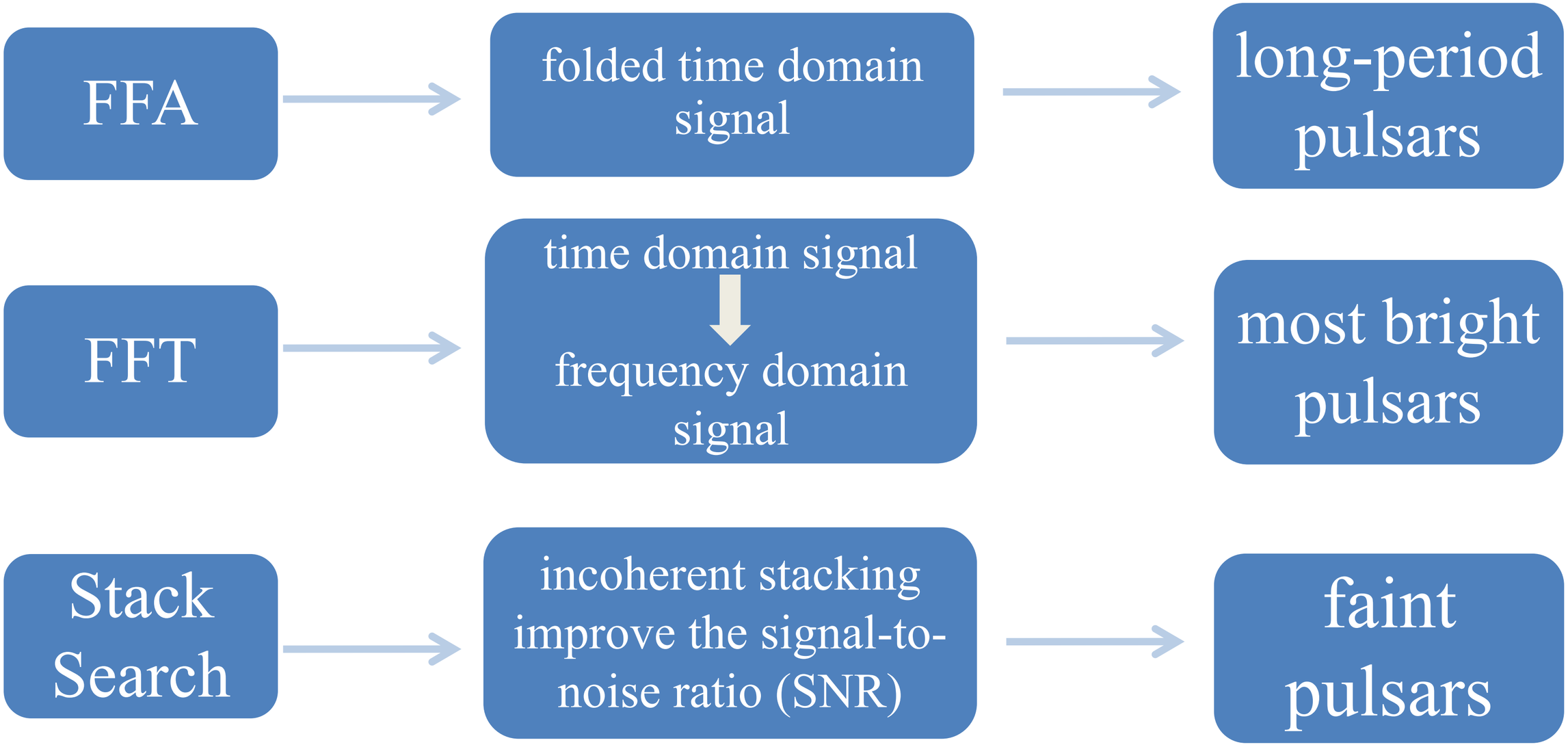
RA:21:29:58.33 DEC:12:10:01.2 (DE200/J2000)

15 pulsars were discovered in it (7 in recent years!)

DM range: 66.40 cm^{-3} pc to 67.73 cm^{-3} pc

R_sun: 10.4 kpc

Search methods



Discovery of M15J by using the FFA

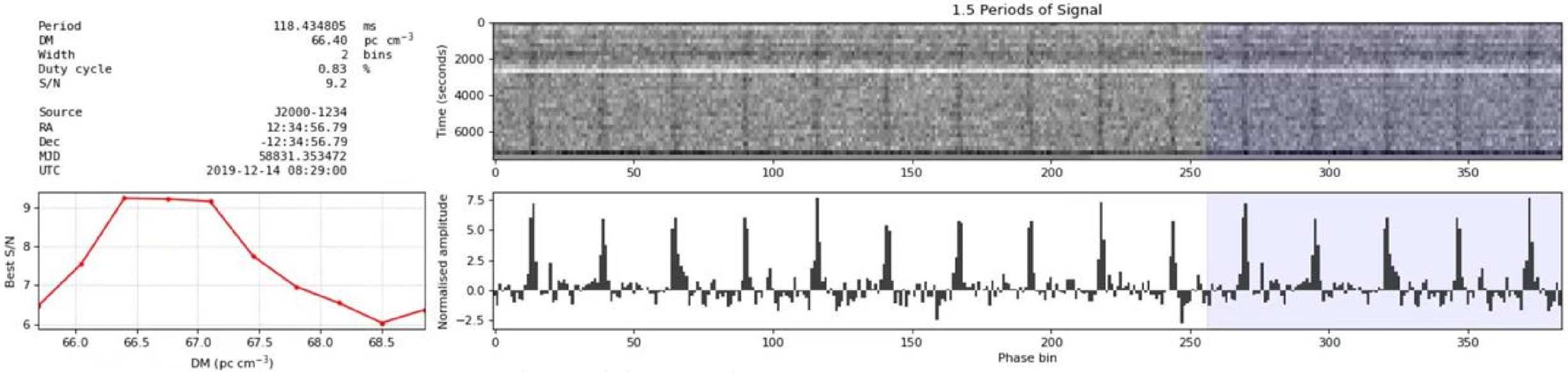


Fig. 2-1 : Riptide-FFA folding plots of M15J (Wu et al. 2024)

$F1_{M15J}$:-1×10^{-15} Hz s^{-1}

Discovery of M15I by using the FFT

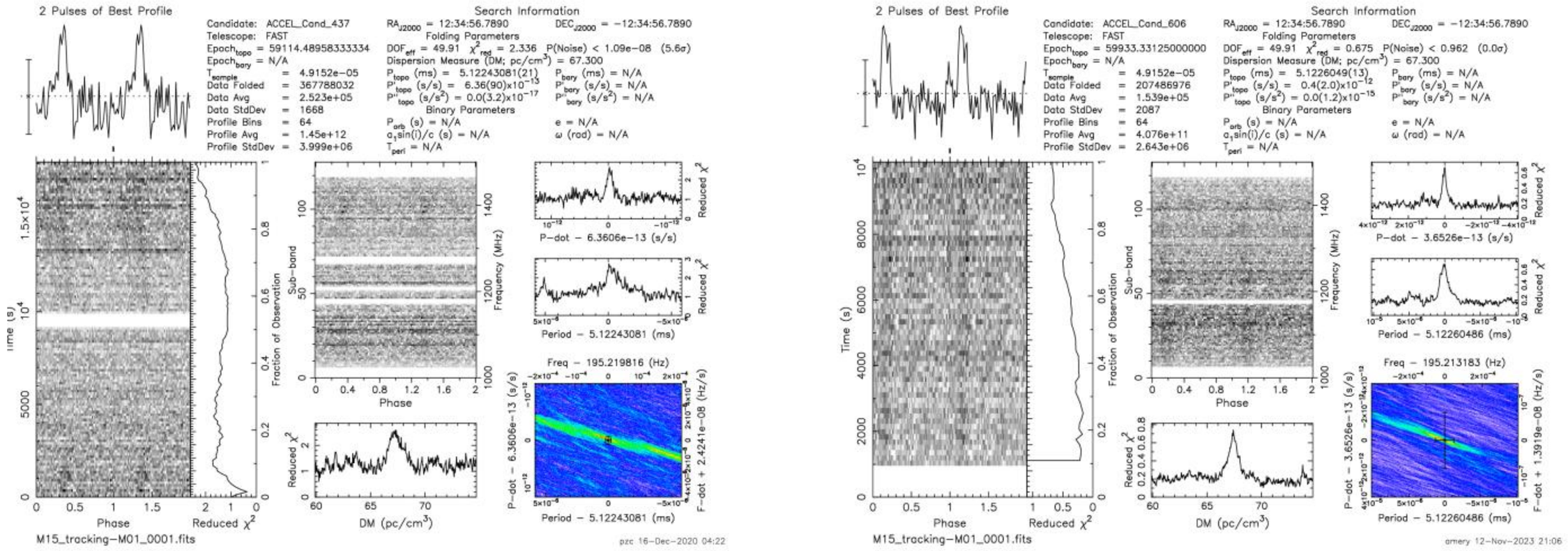


Fig. 2-2 : PRESTO folding plot of M15I (Pan et al. 2021) (Wu et al. 2024)

$F1_{M15I}$: -2×10^{-13} Hz s^{-1} $F2_{M15I}$: $1\times10^{-22} \sim 1\times10^{-21}$ Hz s^{-2}

The M15I identified in a single observation

Discovery of M15O by using the Stack Search

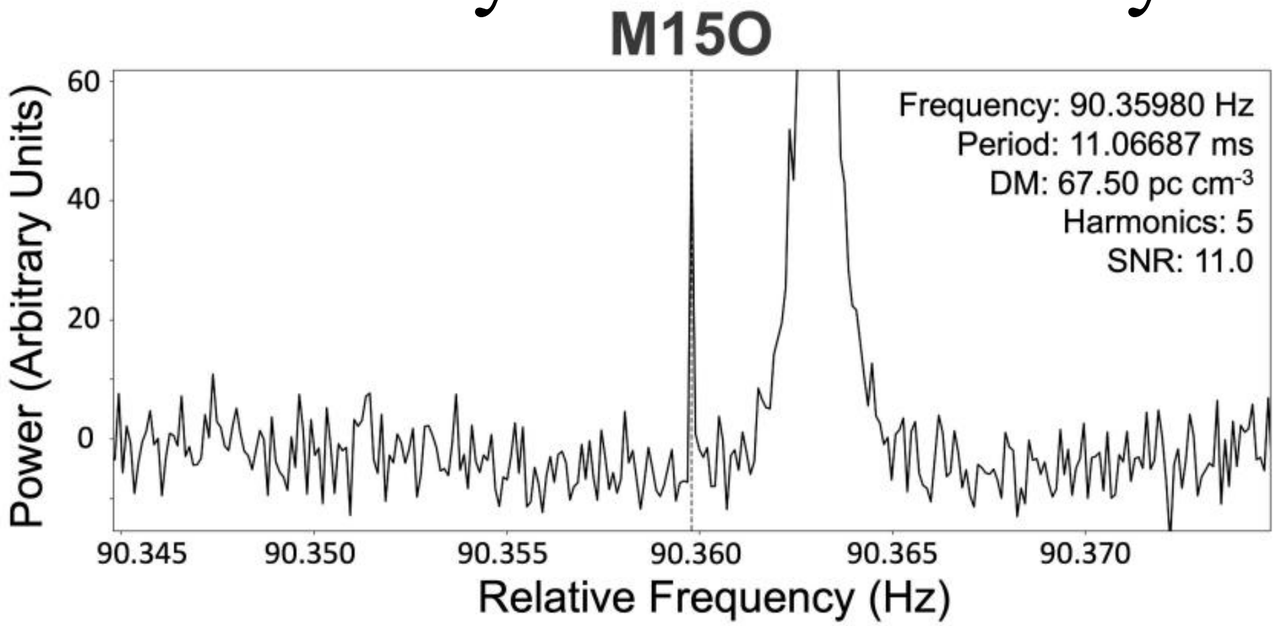


Fig. 2-3 : Power spectrum stacked folding plots of M15O (Dai et al. 2025)

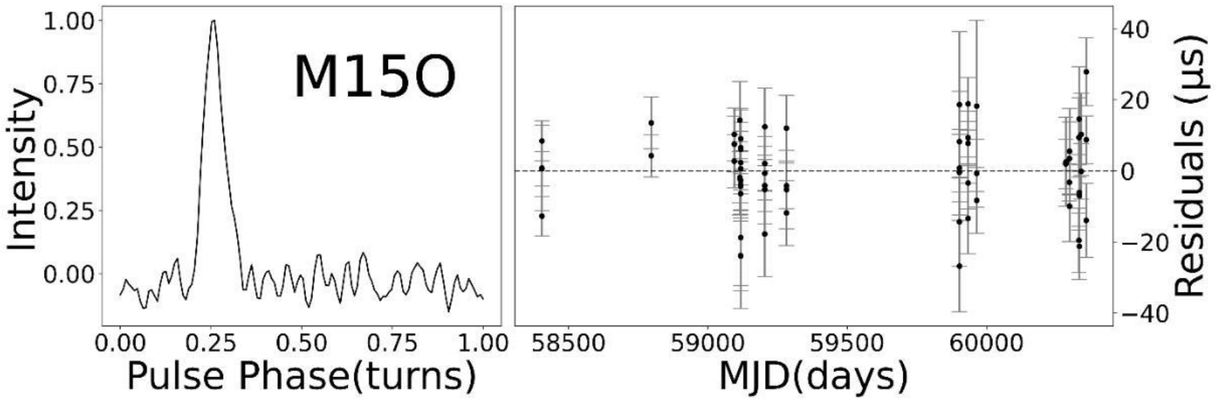


Fig. 2-5: Power spectrum stacked folding plots of M15O (Dai et al. 2025)

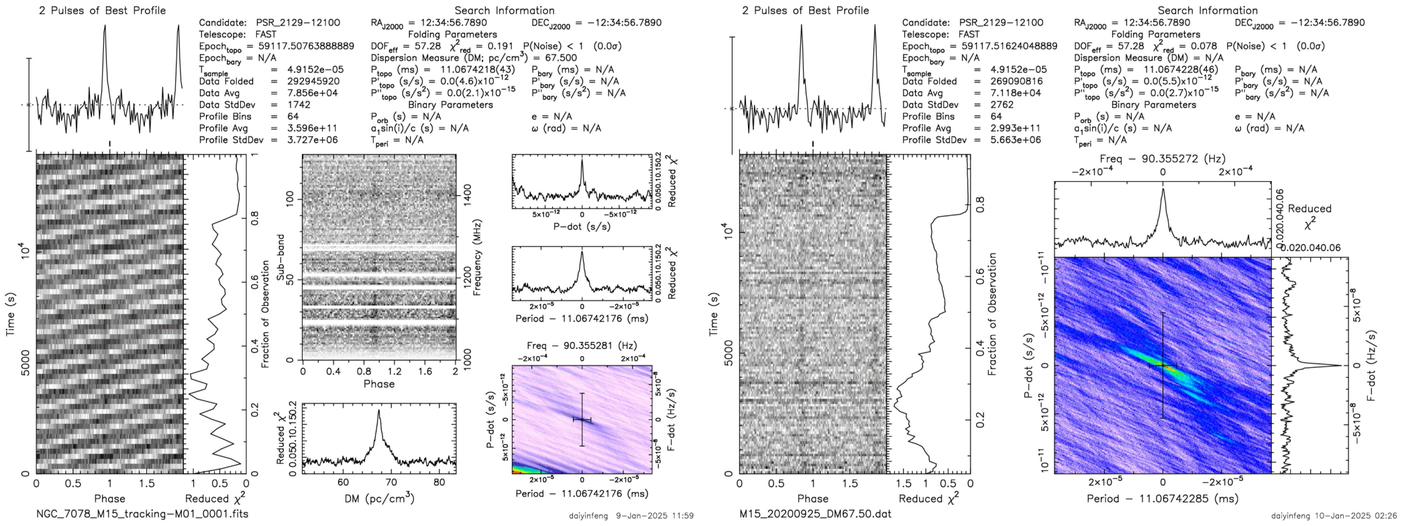


Fig. 2-4 : PRESTO folding plot of M15O (Dai et al.2025)

The 10th harmonic period of M15A： 11.06647ms

$F1_{M15O}$: 1×10^{-14} Hz s^{-1}

$F2_{M15O}$: 3×10^{-23} Hz s^{-2}

Positions

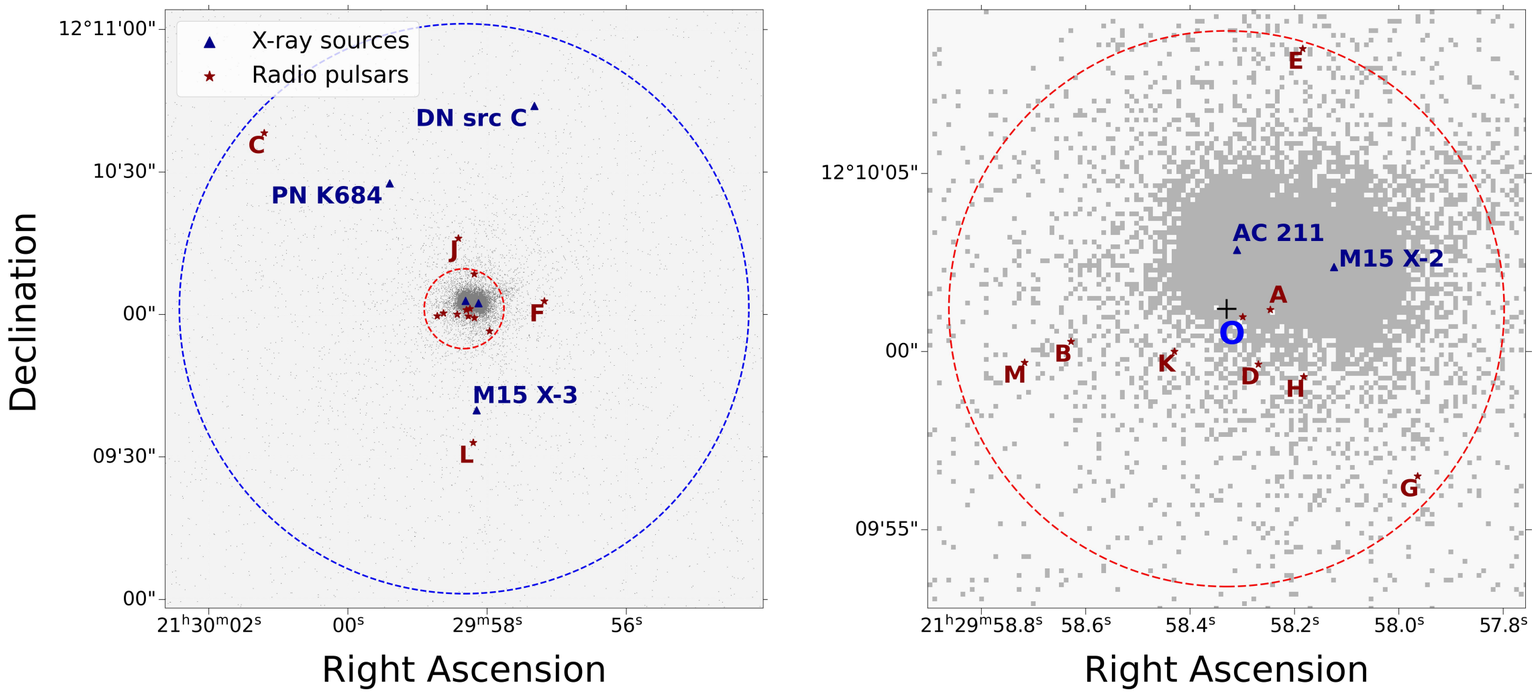
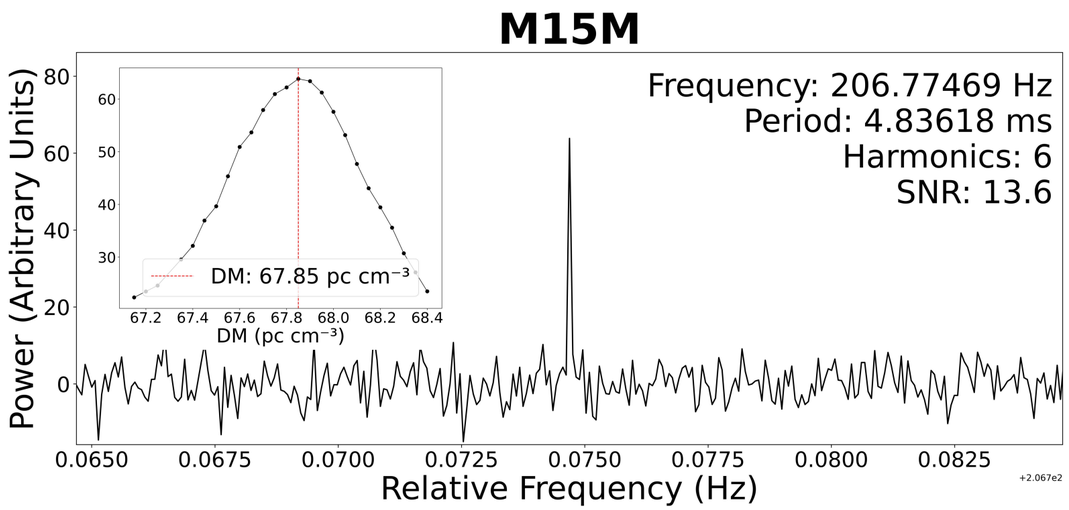


Fig. 2-6 : Positions of pulsars and X-ray sources in the globular cluster M15 (Dai et al. 2025)

None of the pulsars has a X-ray counterpart

M15O is only 0.37 arcseconds away from the center.

M15M&N



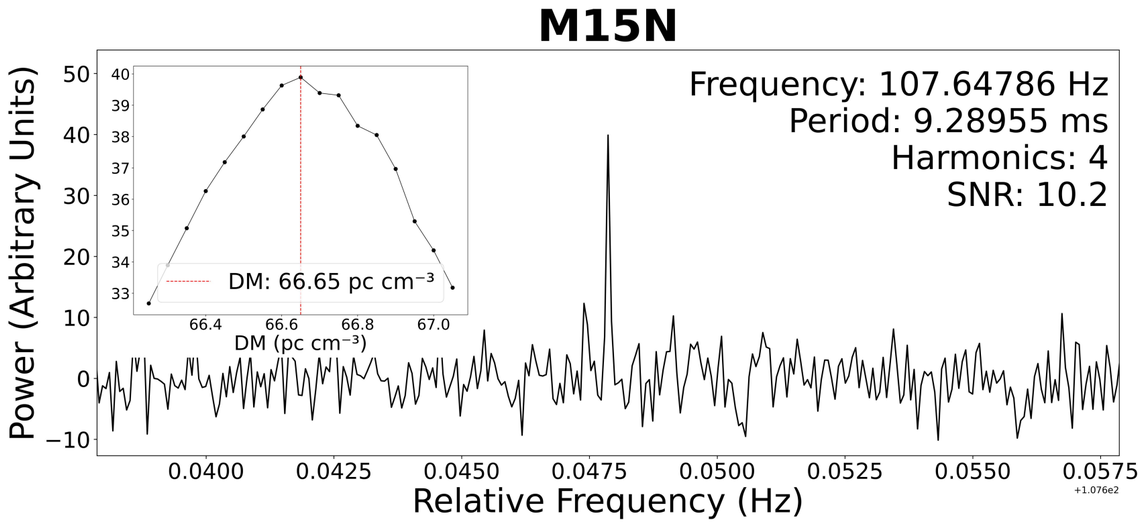
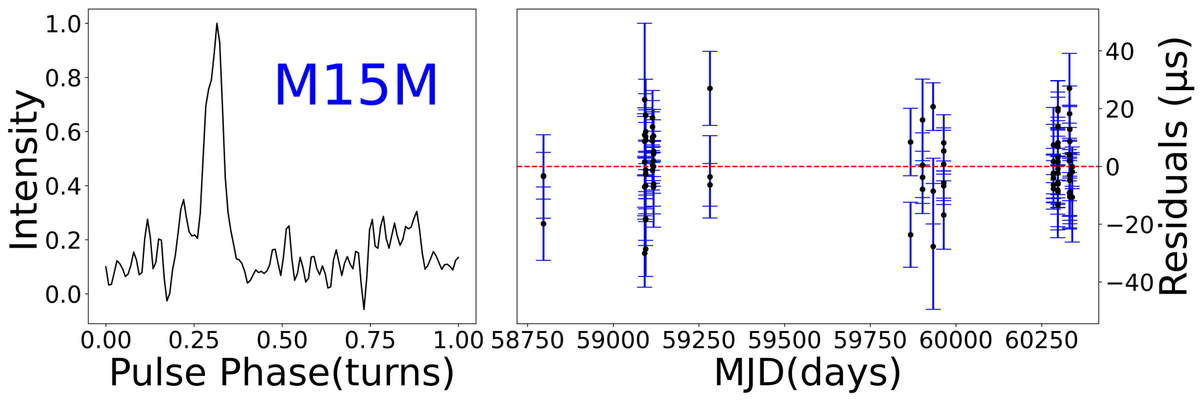


Fig. 3-1: Power spectrum stacked folding plots of M15M&N (Dai et al. 2025)



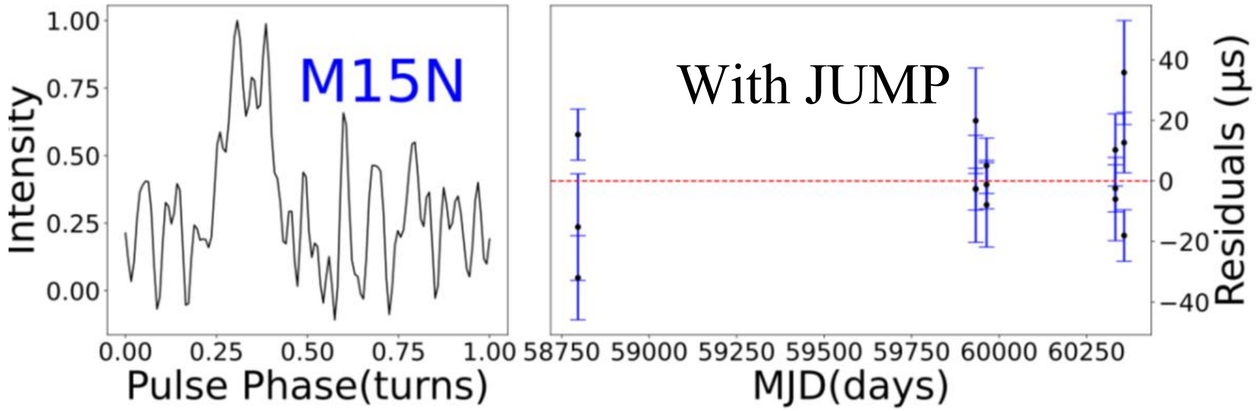
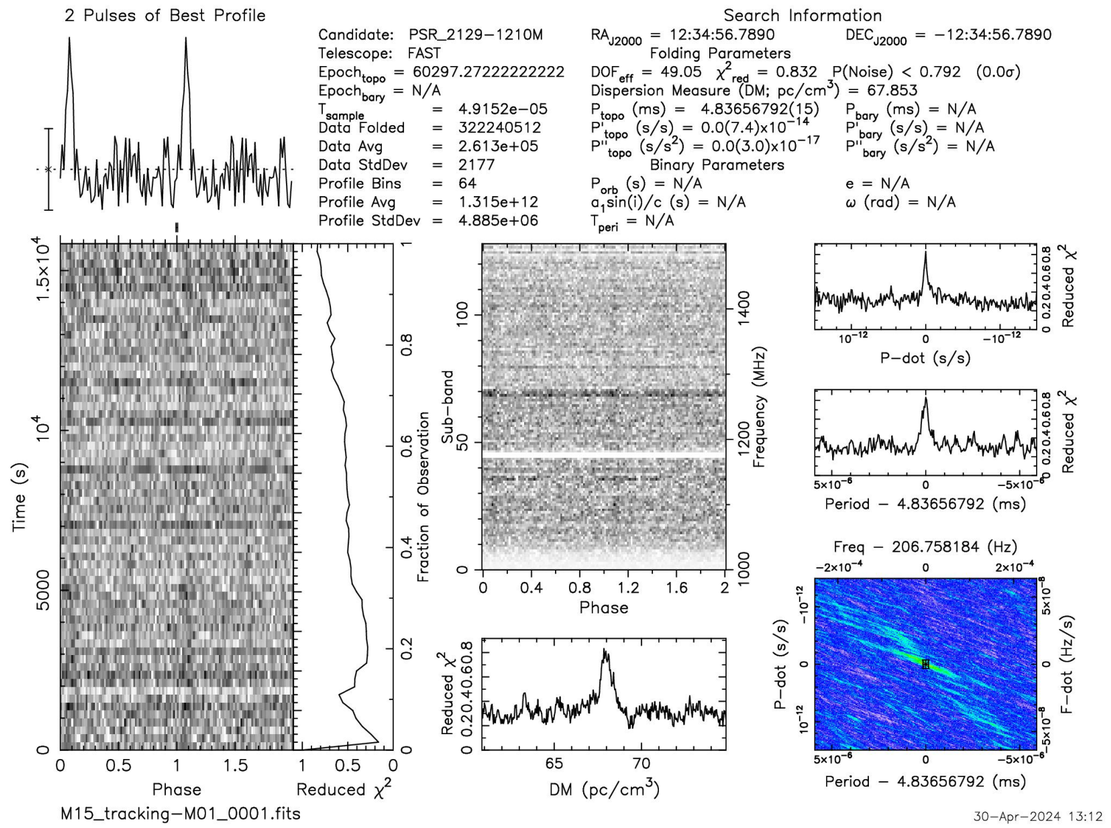


Fig.3-2 : Average pulse profiles (left) and timing residual plots (right) of M15M&N (Dai et al. 2025)

M15M&N



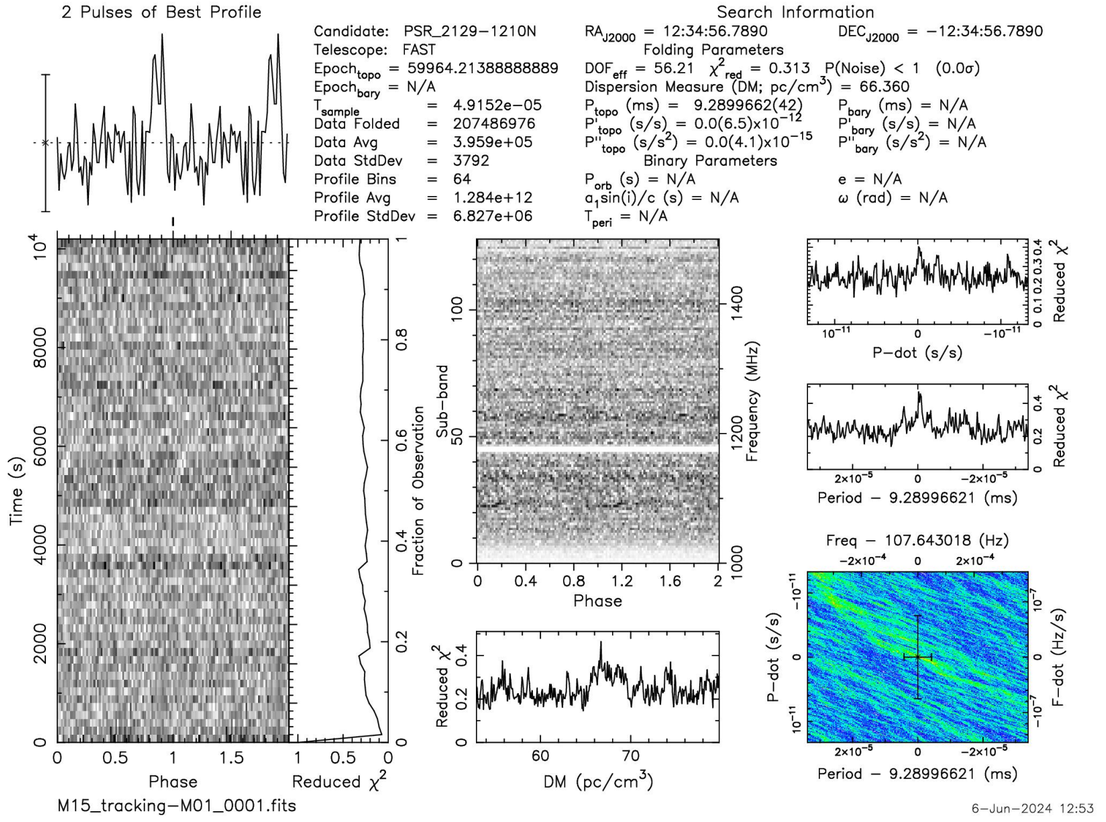


Fig. 3-3 : PRESTO folding plot of M15M&N (Dai et al.2025)

M15C&K&L

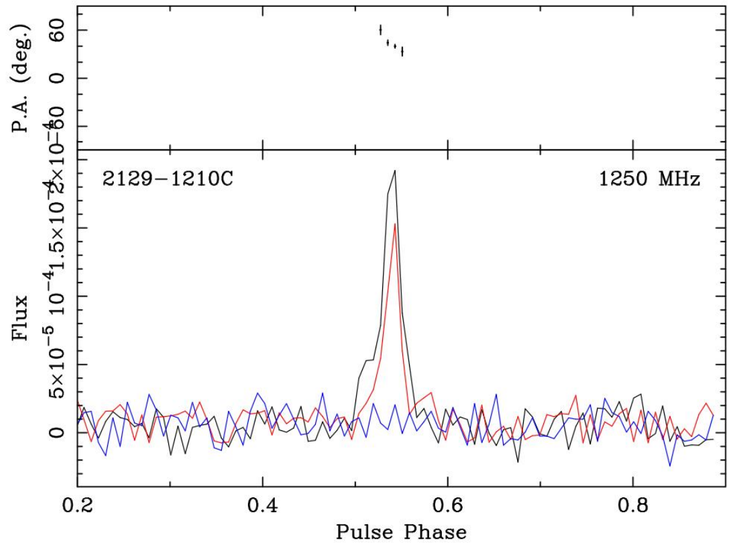


Fig.4-1: M15C has a high degree of linear polarization (Wu et al. 2024)

P_{M15K}=1928.60ms

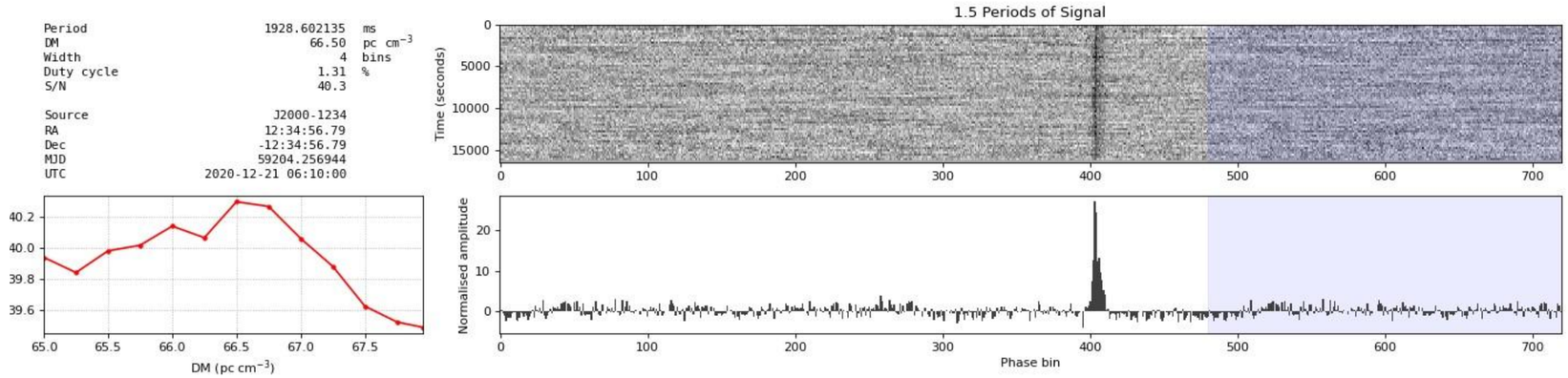


Fig. 4-2 : Riptide-FFA folding plots of M15K (Wu et al. 2024)

Obs. date	T_{obs} (h)	Flux Density (mJy)
2018.10.13	1.0	0.0025
2018.11.17	1.1	0.0067
2019.04.25	0.7	0.0030
2019.08.18	0.3	0.0057
2019.11.09	1.3	0.0025
2019.12.14	2.0	0.0034
2020.08.30	0.7	0.0027
2020.09.02	3.0	0.0016
2020.09.22	2.5	0.0026
2020.09.25	4.0	0.0026
2020.12.21	4.5	0.0022
2021.03.09	2.4	NO DETECTION
2022.01.02	0.5	NO DETECTION
2022.07.07	0.9	NO DETECTION
2022.11.19	1.8	NO DETECTION
2022.12.20	2.8	0.0015
2023.01.20	2.8	NO DETECTION
2023.02.20	0.7	NO DETECTION

Table 1 : M15C estimated flux density shows a significant decline (Wu et al. 2024)

P_{M15L}=3961.02ms

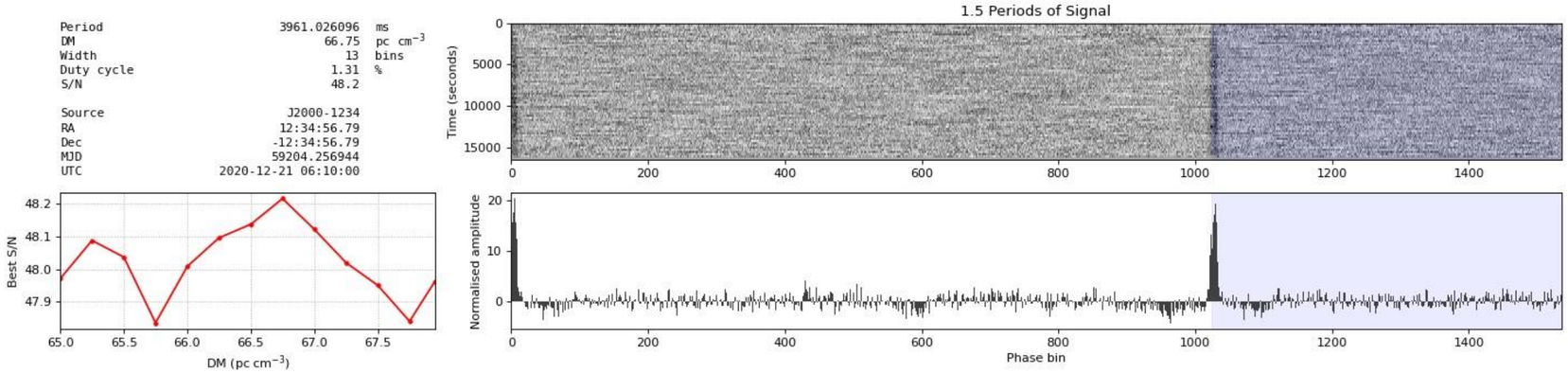


Fig. 4-3 : Riptide-FFA folding plots of M15L (Wu et al. 2024)

Summary

1.Seven new isolated pulsars are discovered in M15.

2.M15C has a high degree of linear polarization, and its estimated flux density shows a significant decline.

3.Continue to monitor M15I and M15N.

4.Hidden M15O in M15A was found through power spectrum stacking.

Thank you!