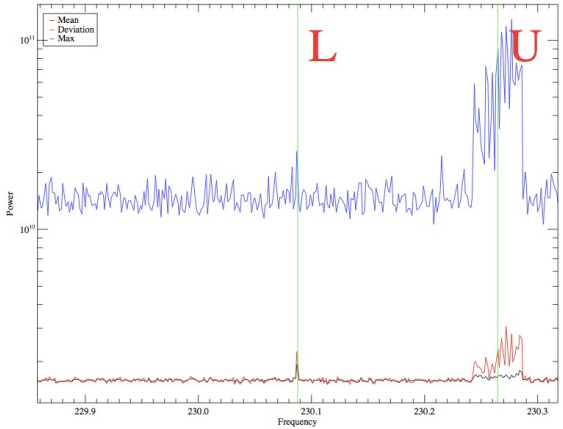
Stacking Search for Faint Pulsars and Approach to Binary Pulsar Searches

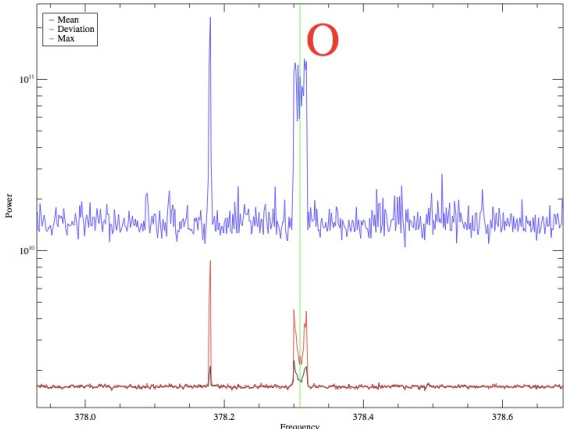


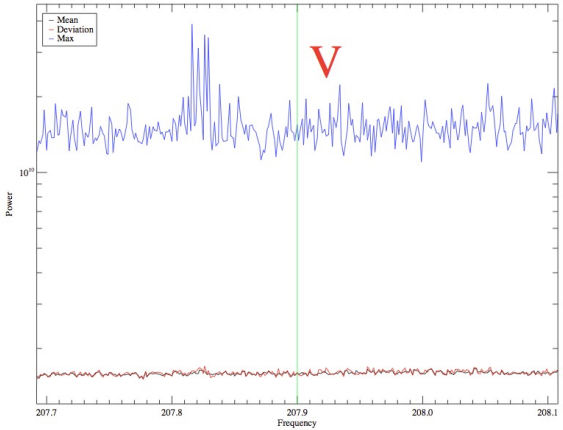
Zhichen Pan(BI1MAX), Bo Peng,
Lei Qian(BI1NBN), Yinfeng Dai(BI1WQF) et al.

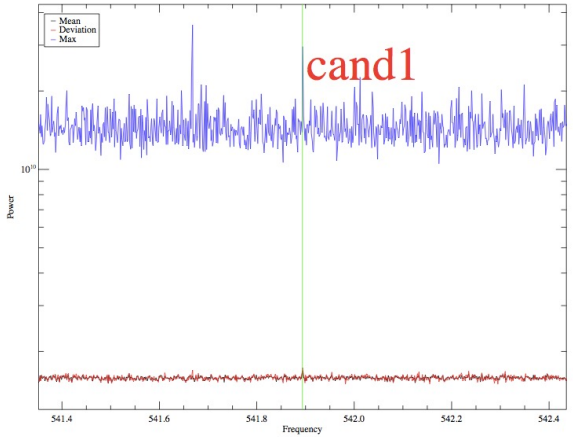
2025.7.6

Since the Discovery of 47 Tuc aa and ab









- UL： 47 Tuc L (iso.) & U (bin.)
- UR： 47 Tuc O (bin.)
- LL： 47 Tuc V (bin. missed)
- LR： 47 Tuc aa (iso)

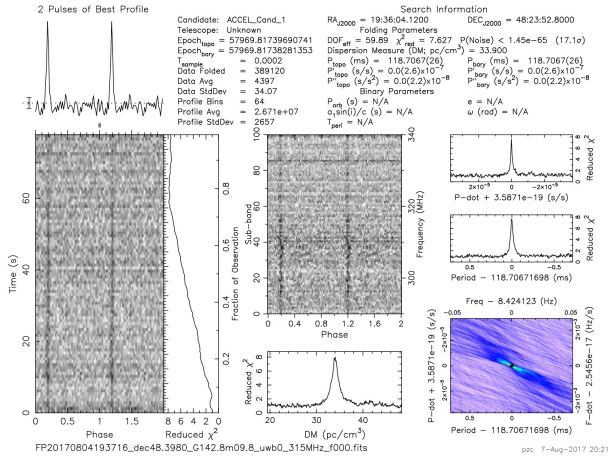
In 47 Tuc, till 2015, PSR C to Z
Stacking >1000 hr Parkes data
Pan et al. 2016, aa & ab
Missing： P/R/V/W

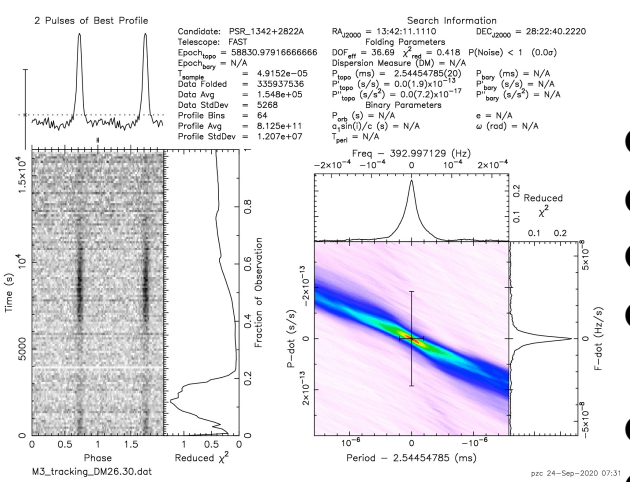
Pulsars in 47 Tuc scintillating aa & ab with VERY low detection rates： 1-5%

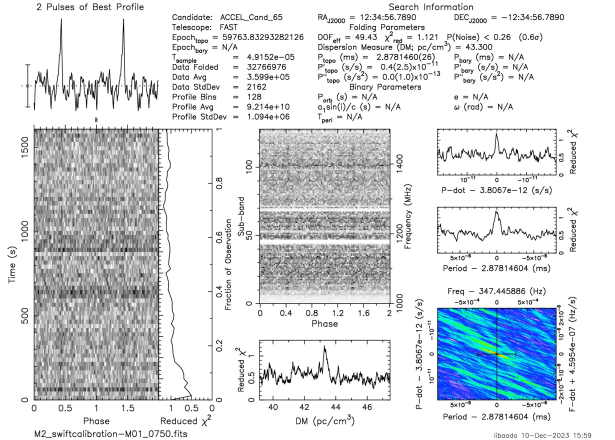
Spectra stacking useful ?
Noises are white noise ?

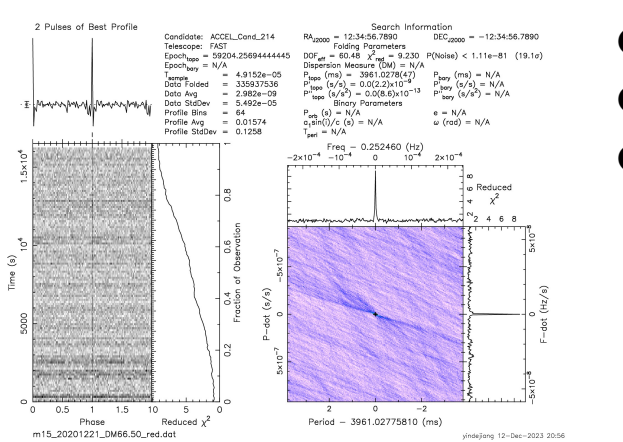
DM range of 47 Tuc: 23.6-24.9 pc cm-3; only use 24.5 pc cm^{-3} Pan et al. 2016

Thinkings in FAST Pulsar Discovery Era





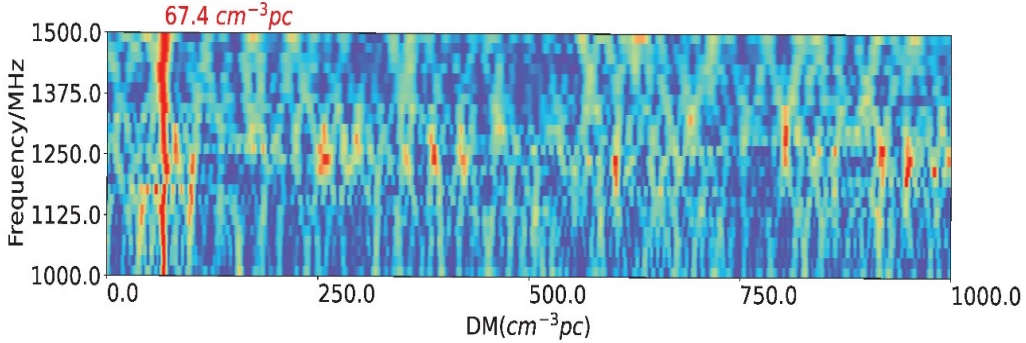




- UL：FAST 1st PSR, Qian+
- UR：M3A Li+ 2024
- LL：M2H Li+ in prep
- LR：M15L Wu+ 2024

- Need multiple observations
- Scintillations
- Harmonics adding
- Long period？Binary？
- Acceleration search？

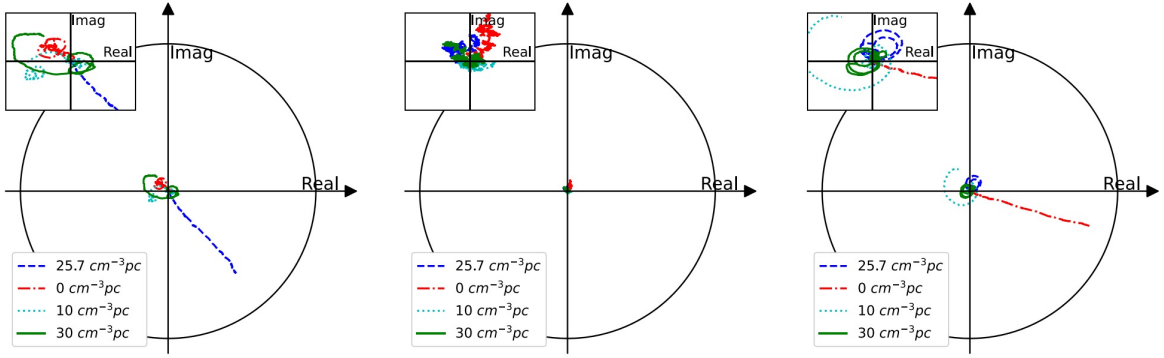
Inspired by Frequency Domain Dedispersion





- FFT for each channel
- Stacking and periodic signal search
- Solving the DM

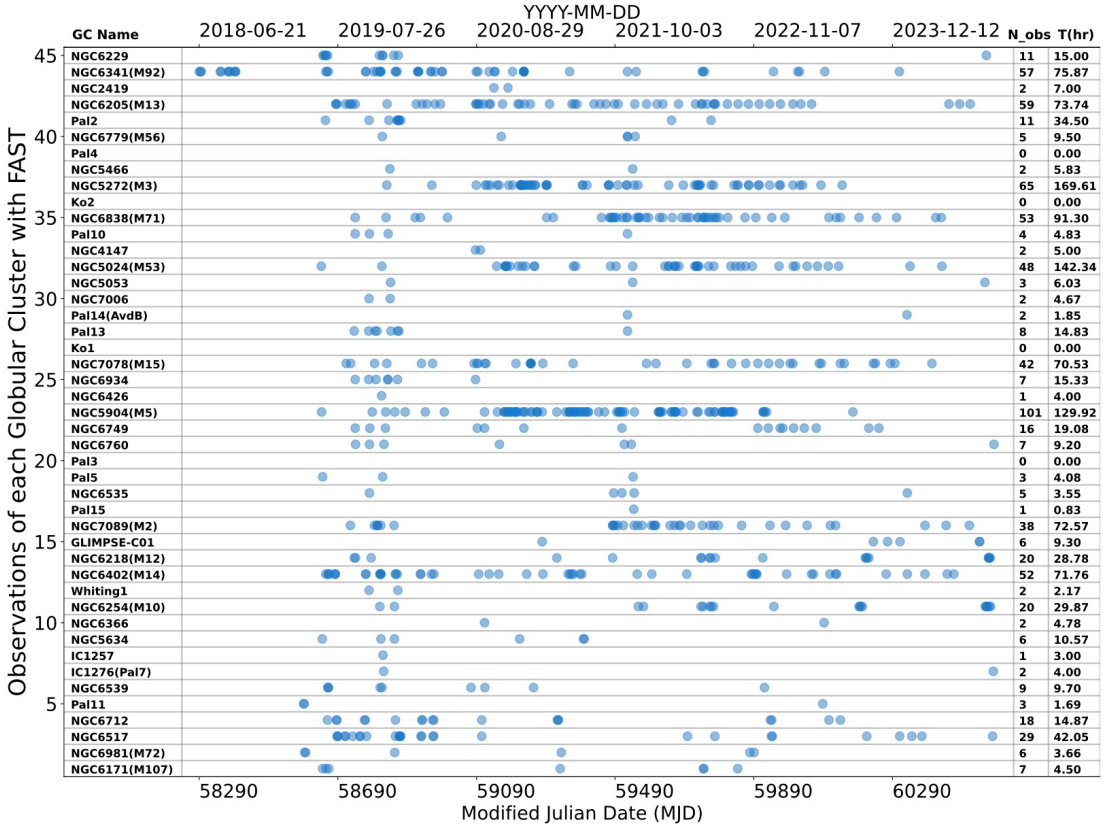
For any DM range, calculations are similar?
Stacking multiple observations?
Binary searches?

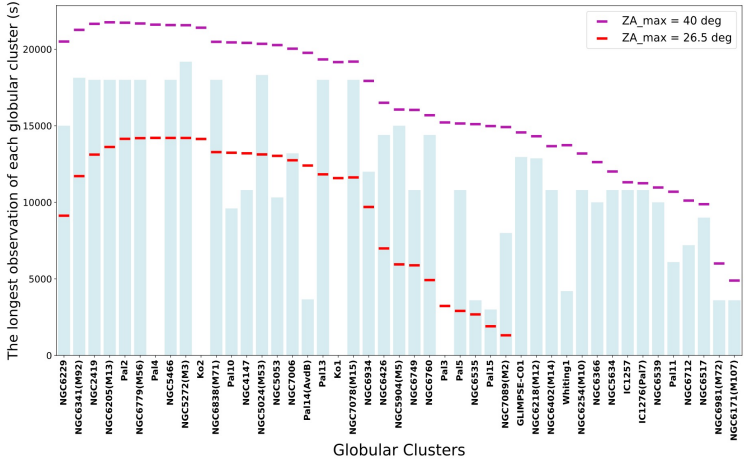


(a) PSR J1905+0400, 264.2423 Hz (b) 200 Hz (c) 150.1046 Hz

Peng et al. 2023

GC FANS = Globular Cluster with FAST – a Neutron Star Survey

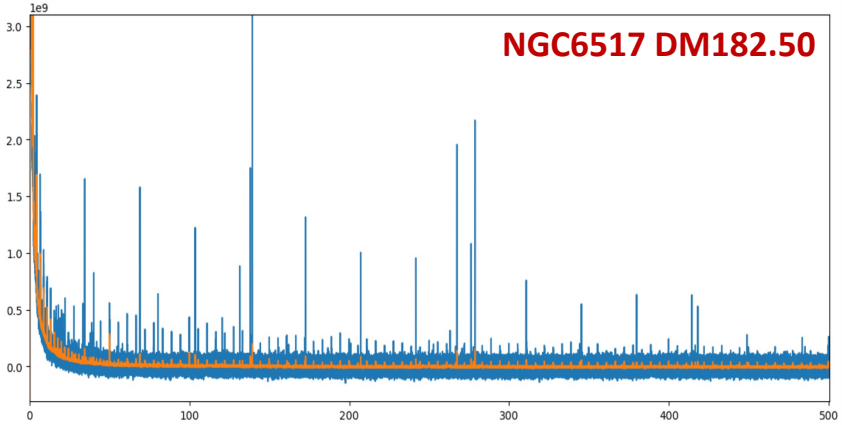


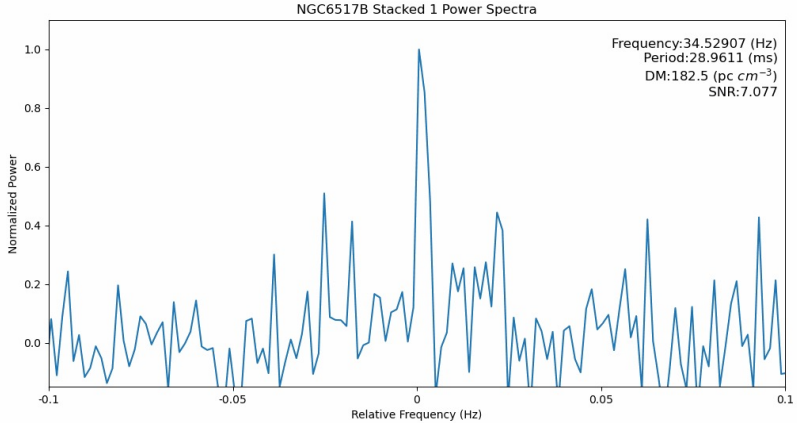


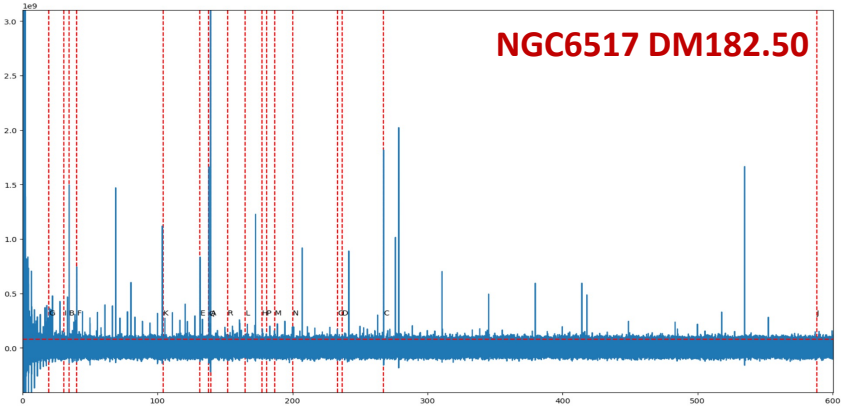
- With multiple observations
- Single observation long enough
- GCs host exotic pulsars

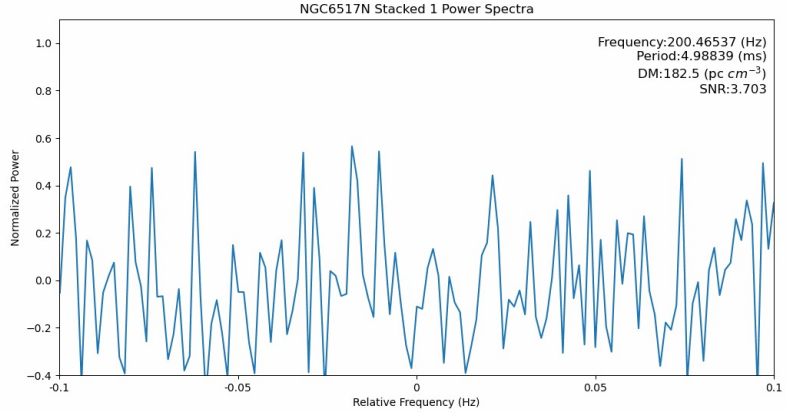
Lian et al. accepted

Stacking FAST Data





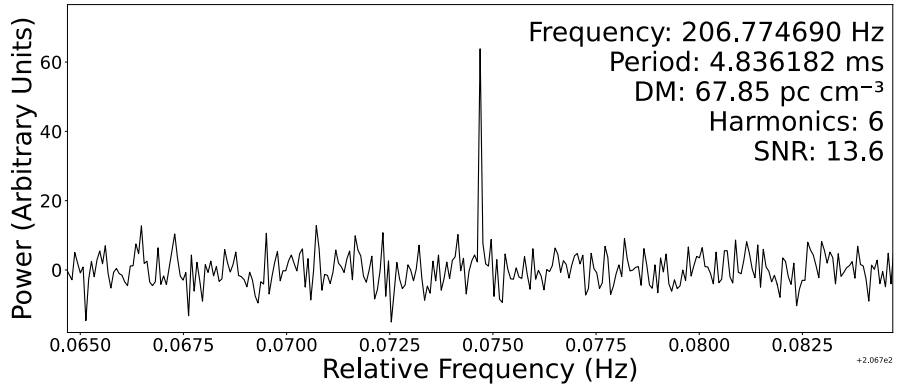


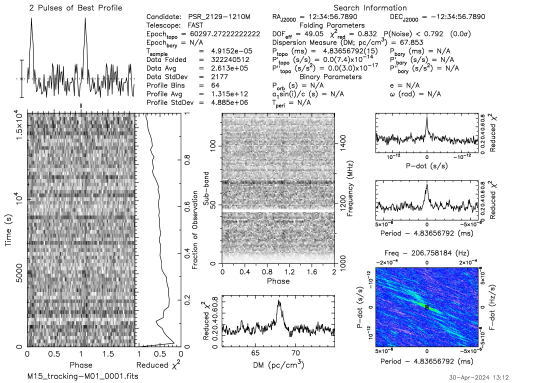


NGC 6517B & NGC 6517N

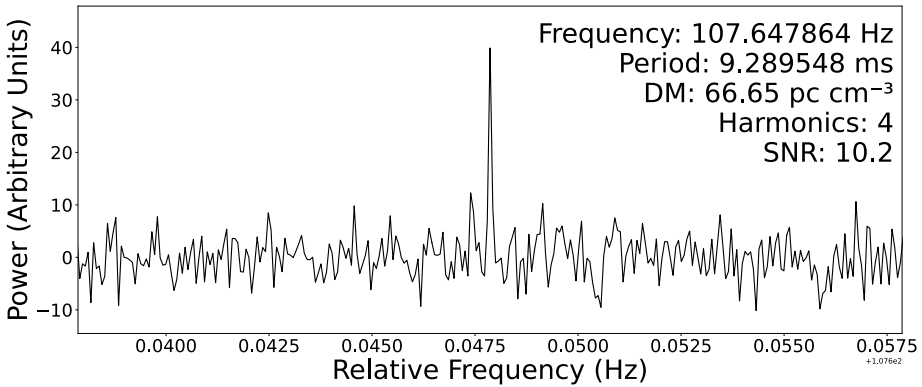
M15M & N

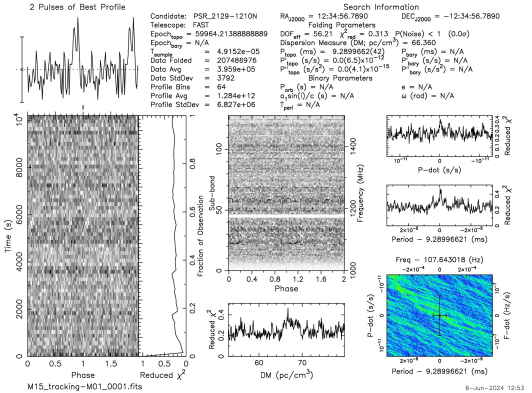
M15M





M15N

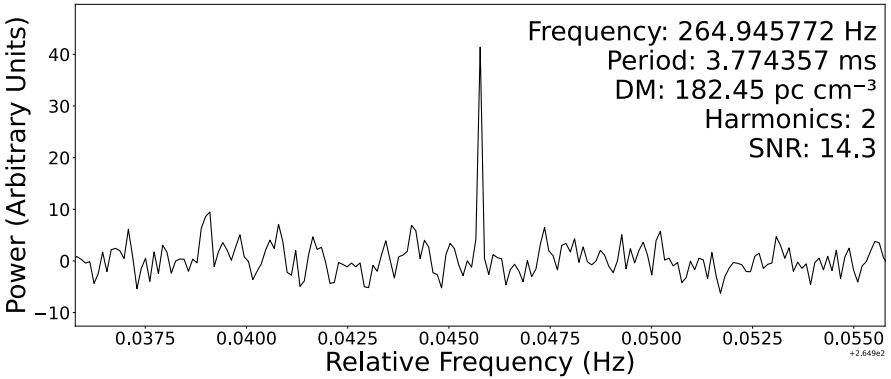




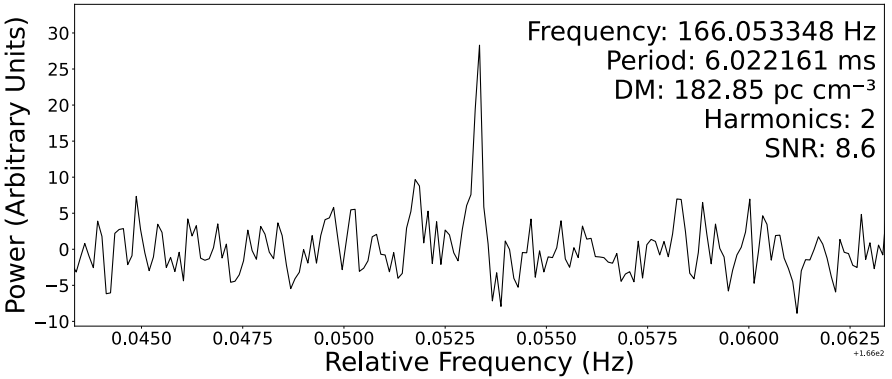
Dai et al. in prep

NGC6517S/T/U/V

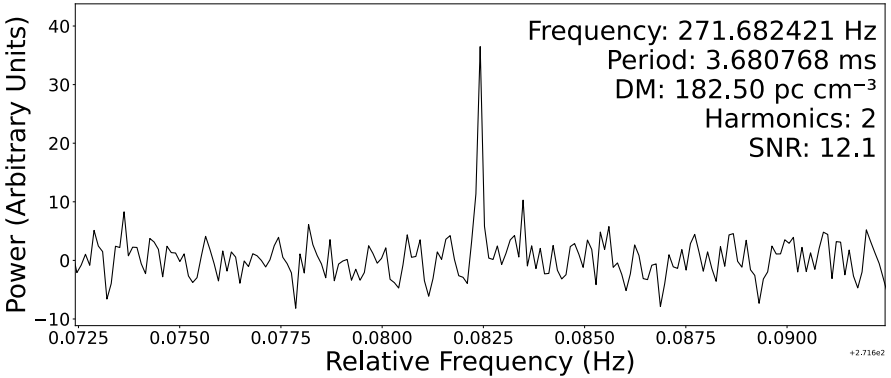
NGC6517S



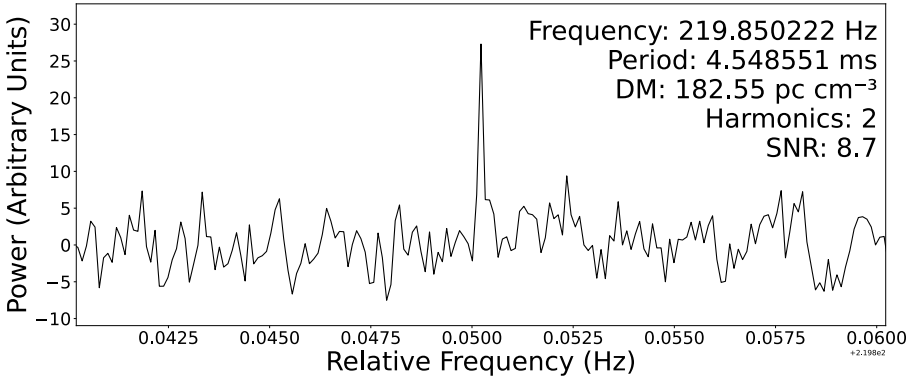
NGC6517U



NGC6517T

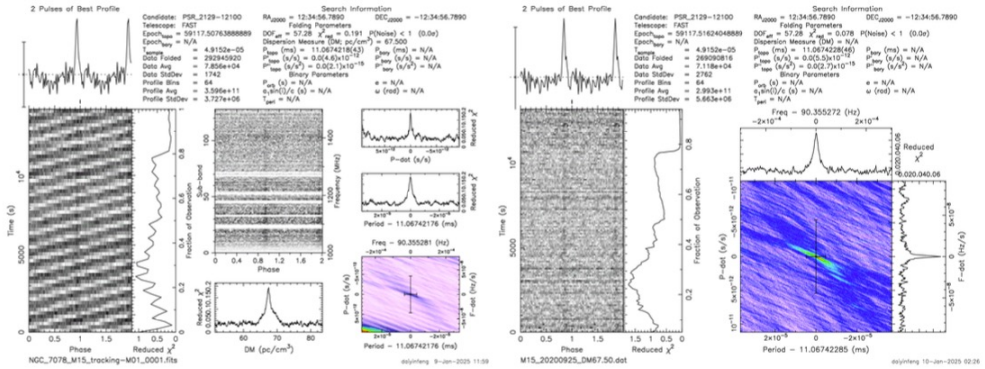


NGC6517V

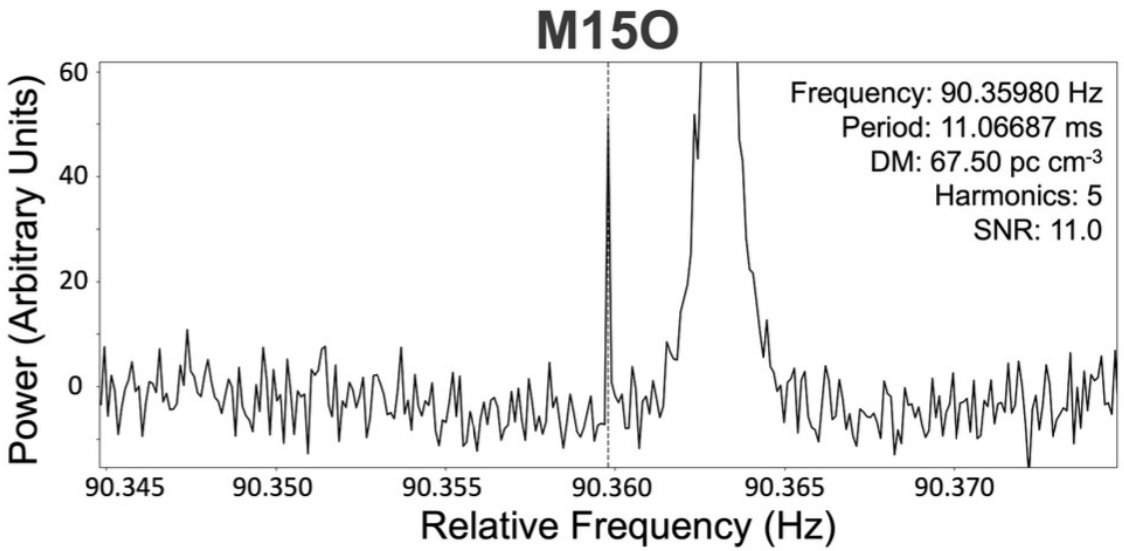


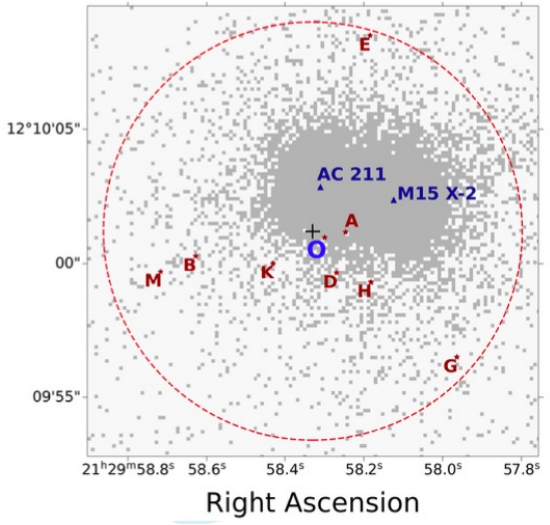
Dai et al. in prep

M15O



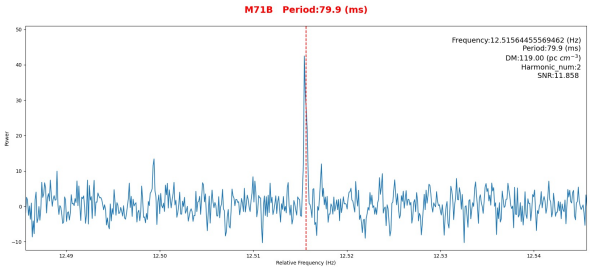
- M15O， P0 = 11.07 ms
- Very close to the harmonic of M15A
- Position and F1 are different
- F1/F2 larger than typical MSP
- Need more timing to explain F1/F2

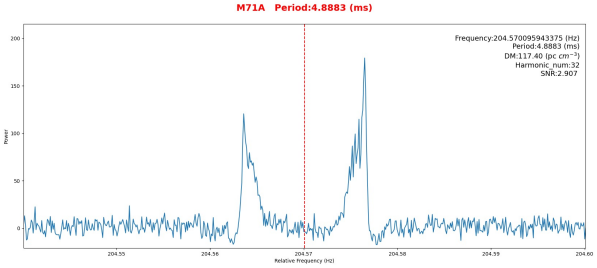


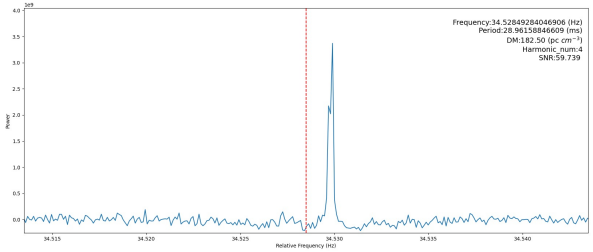


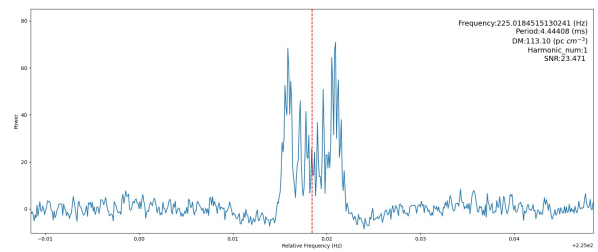
Dai et al. 2025

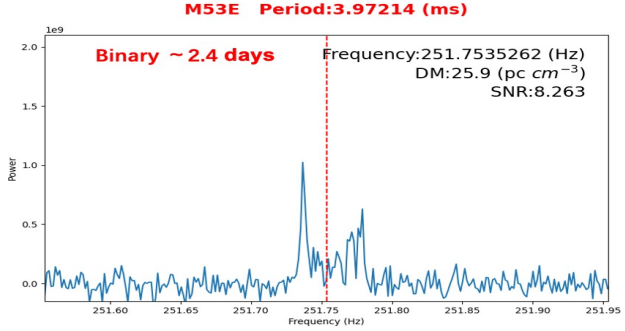
Some Consideration about Binary Pulsar Search

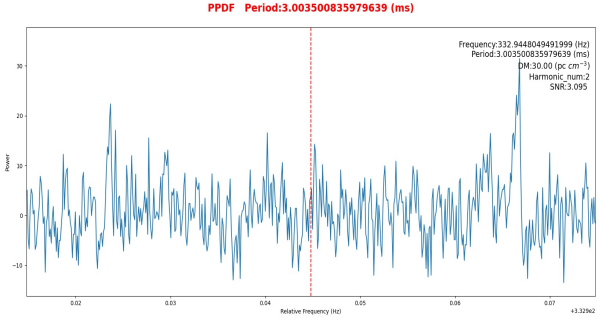






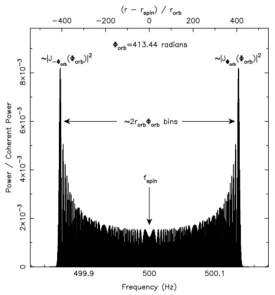


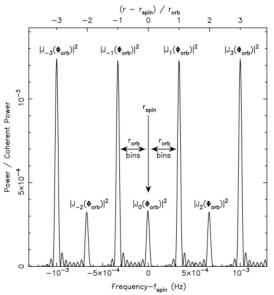




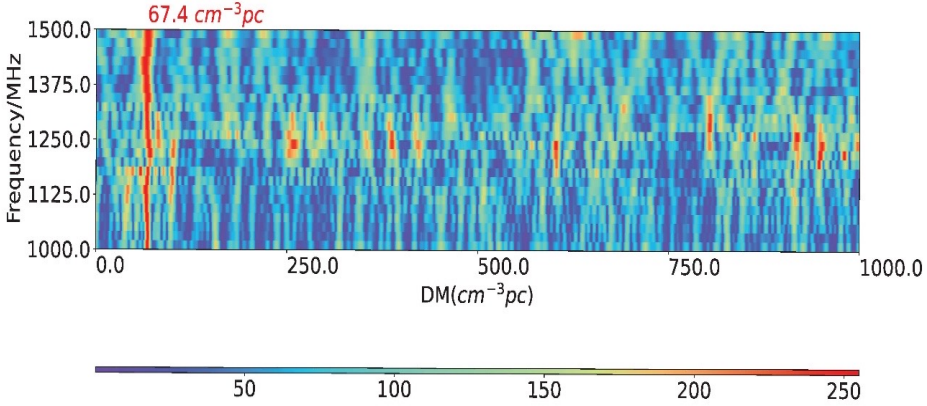
Upper to lower, left to right：
M71B (467 days)
NGC6517B (29 days)
M53E (2.4 days)
M71A (0.18 day)
M71E (0.037 day)
M3F (1.4 days)

- PB coverage：<3 day
- Scintillation?
- Faint signals?
- Multi-systems?



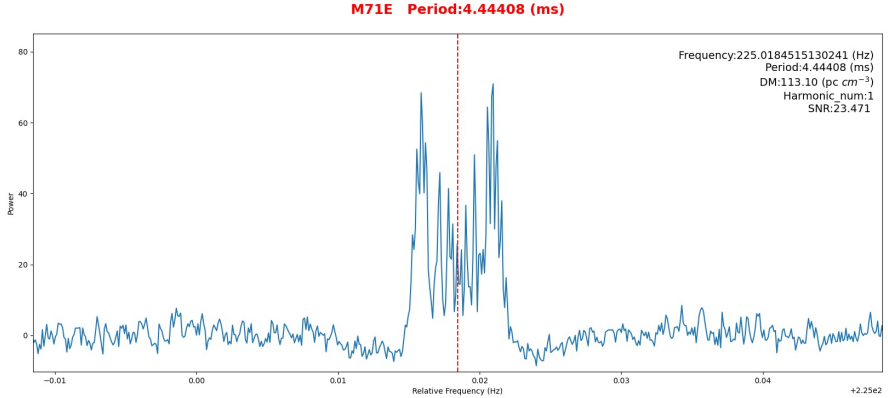


Some Crazy Ideas in Pulsar Search Pipeline



Search time cost depends on DM range

- FFT each channel first
- Adding/stacking
- Solving the DM when find the signal
- **How about FFA?**



Selection effect on binary pulsar search

- Multiple observations to sources
- Spectra stacking
- Spectra shape to orbital parameters
- **More observations are better**
- **triple？ Multi-components？**

Stacking Search for Faint Pulsars and Approach to Binary Pulsar Searches



Thank You!

Zhichen Pan(BI1MAX), Bo Peng,
Lei Qian(BI1NBN), Yinfeng Dai(BI1WQF) et al.
2025.7.6

Photo Credit: Zach and Shana