



A review of FAST pulsar study

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NATIONAL ASTRONOMICAL OBSERVATORIES, CAS

1. **FAST introduction**
2. **FAST observing program and application**
3. **FAST pulsar research**
4. **Future FAST pulsar research**

□ Five-hundred-meter Aperture Spherical radio Telescope, FAST

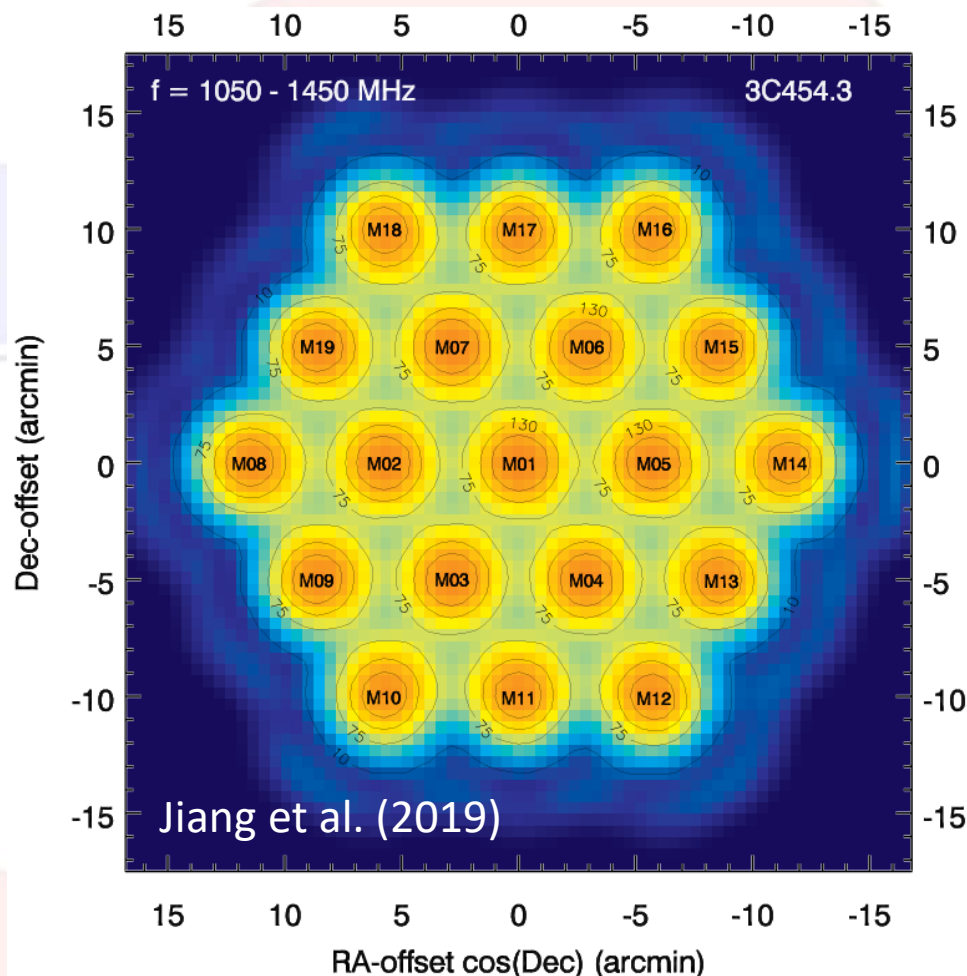


□ Five-hundred-meter Aperture Spherical radio Telescope, FAST

- ▣ 300m illumination aperture
- ▣ Aperture frequency band 70-3000MHz
- ▣ Maximum observable zenith angle $\theta_{zm}=40^\circ$, backward illumination for zenith angle $\theta_z > 26.4^\circ$ (asymmetric reflector)
- ▣ Resolution $\sim 2.9'$ @L Band
- ▣ Pointing accuracy $\sim 8''$ @L Band

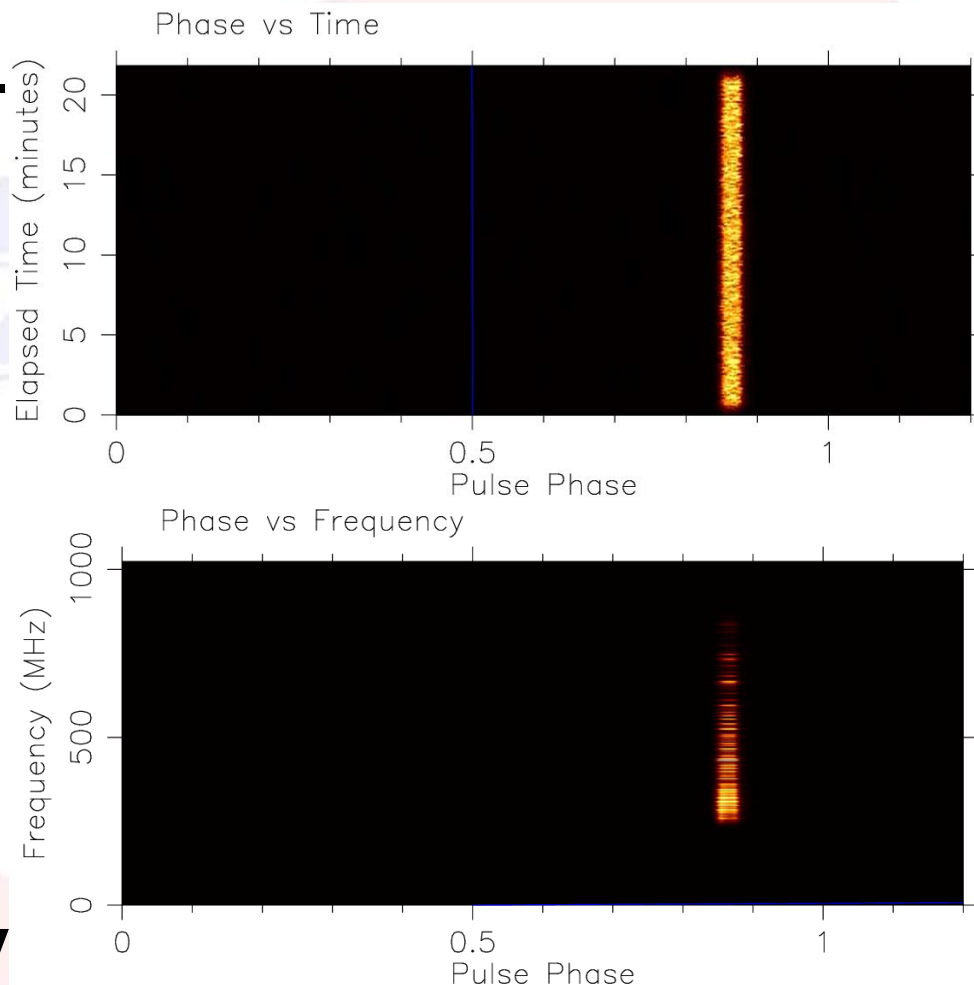
□ 19-beam receiver (the most commonly used)

- Frequency band
1.05-1.45GHz
- Aperture efficiency
 ~ 0.63 ($\theta_z < 26.4^\circ$)
- System
temperature $\sim 24\text{K}$
@1.4GHz
- Fluctuation of gain
 $\sim 1\%$ @3.5hr



FAST Pulsar data record

- Recording search-mode PSRFITS data
- Frequency resolution $>61\text{kHz}$
- Time resolution $>49.152\mu\text{s}$
($>98.304\mu\text{s}$ for $\sim 61\text{kHz}$ Frequency resolution)



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- FAST Observing Cycle: Aug. – Jul. (Next Year)
- Over the past five cycles (2020-2025 cycles), FAST has been supporting >5000h per year for Regular Science Programs (RSPs, ~50%) and Large Programs (LPs, ~50%).

□ FAST Large Programs

- The Commensal Radio Astronomy FAST Survey (CRAFTS)
- The Galactic Plane Pulsar Snapshot (GPPS) survey
- Pulsar timing: Chinese pulsar timing array
- HI Mapping and pulsars searching toward M31 region
- Fast radio burst searches and multi-wavelength observations
- Pulsar timing: Physics and evolution of pulsars



FAST Upcoming Observing Cycle

- Aug. 2025 – Jul. 2026
- Regular Science Proposals: each requests observing time **up to 50 hours**
- A new category of observing programs, **Medium-Sized Programs (MSPs)**
 - ▣ Up to 150 hours for the next 2-3 year
 - ▣ MSP candidates need to give a presentation to the FAST TAC.
 - ▣ Up to 3 MSPs are expected to be supported.
- **Deadline: Thursday (15th May 2025)**

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- Pulsar Search (Single Pulse Search, Long-period Transient, Extragalactic Pulsar, ...)
- Pulsar Timing (Parameter Measuring, GW Detection, Pulsar Time, ...)
- Pulsar Monitoring (Mean Profile, Single pulse, Polarization, Scintillation, ...)

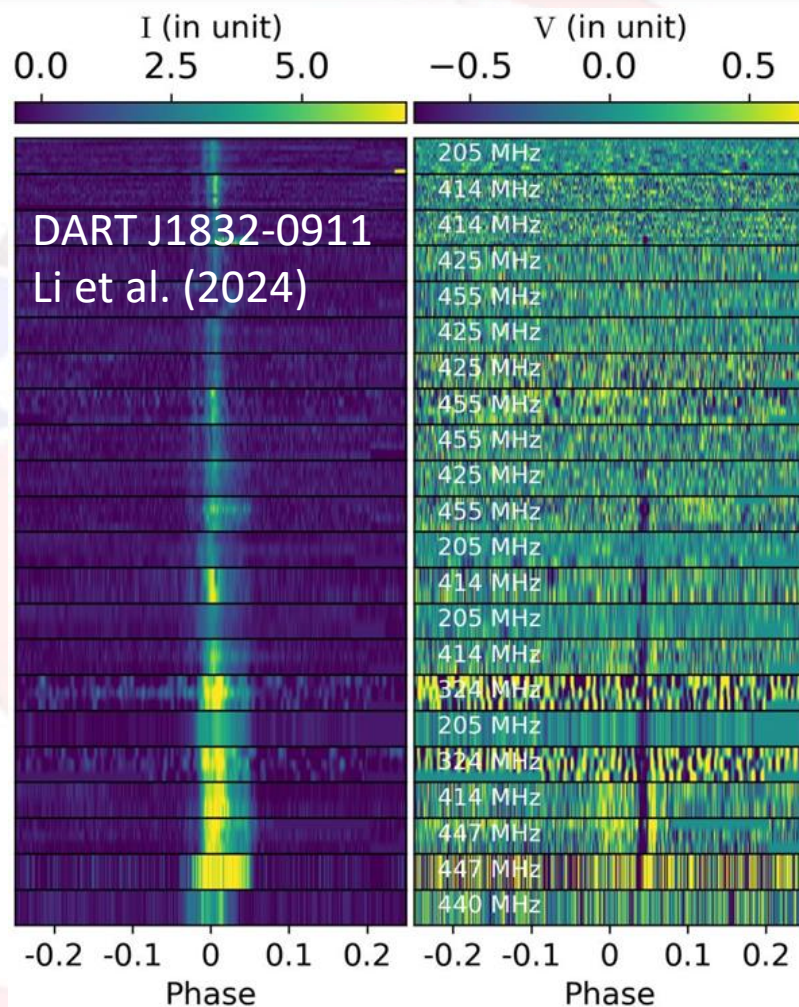
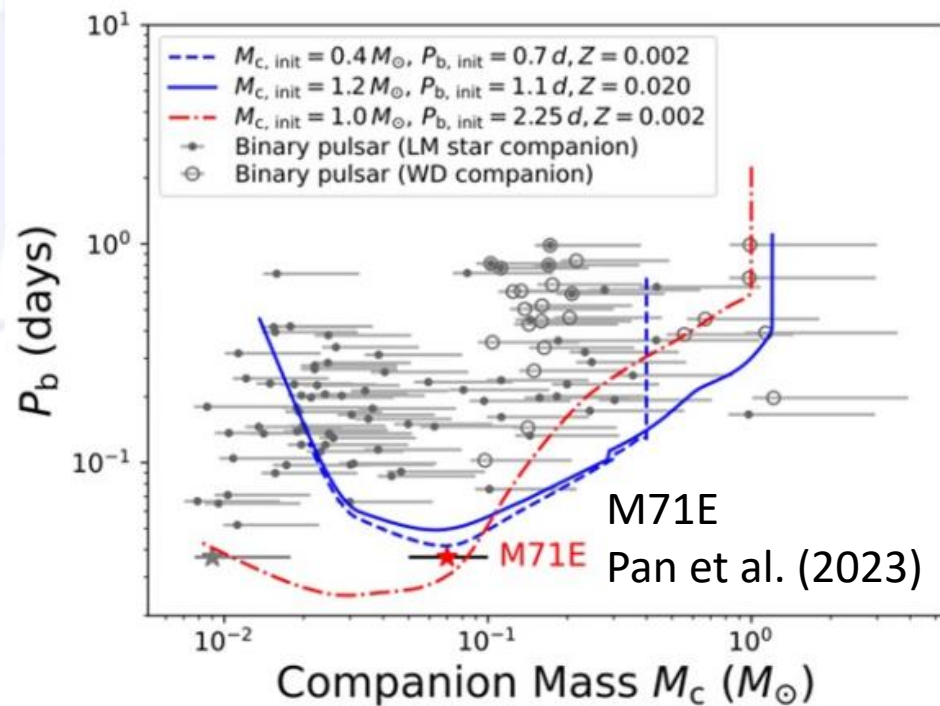
□ >1000 Pulsars have been discovered.

中国天眼FAST 发现脉冲星数量突破1000颗



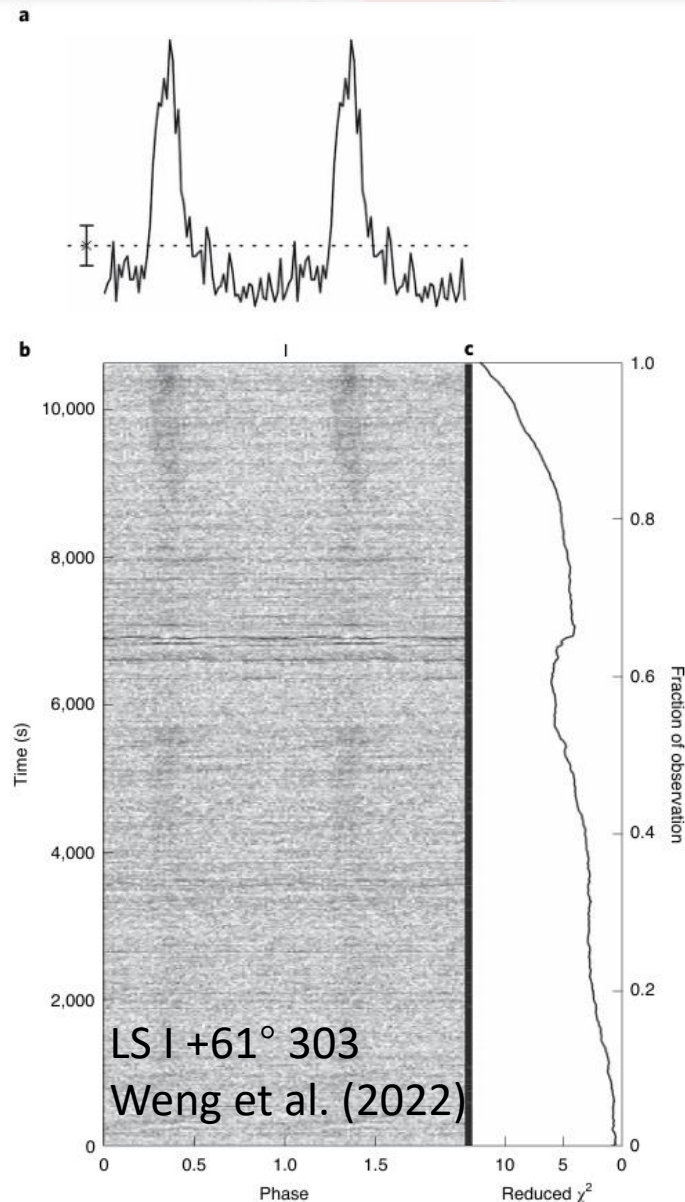
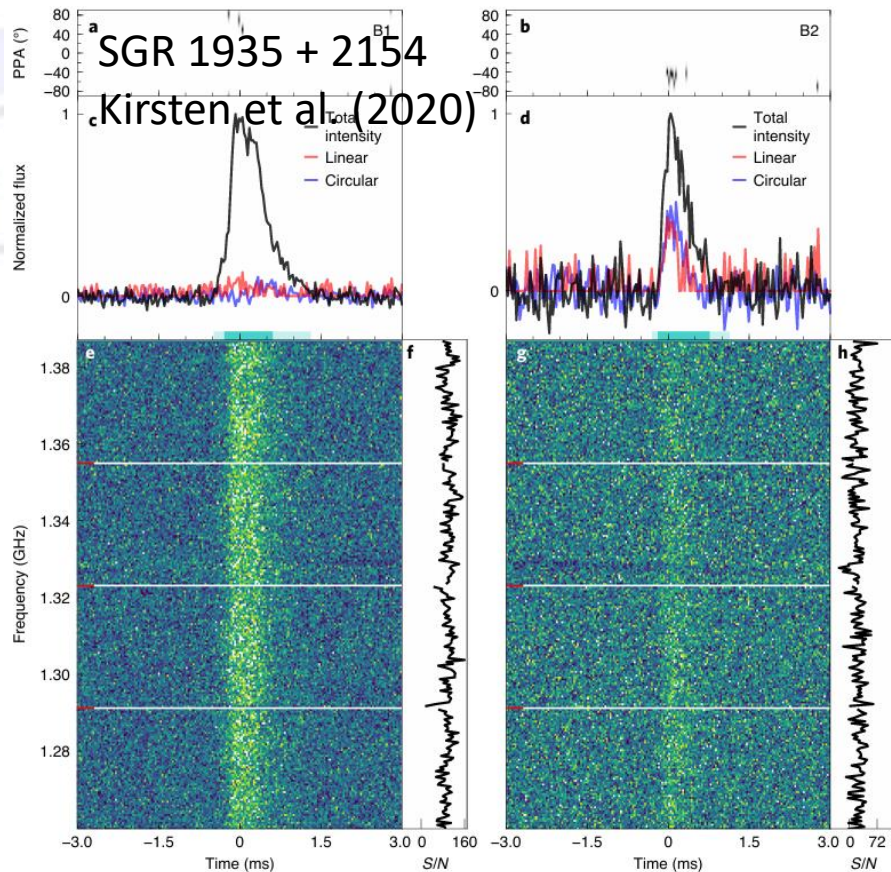
□ Peculiar pulsars

- ▣ Long period pulsar
- ▣ Compact binary



□ Peculiar pulsars

▣ Radio pulses from high energy source



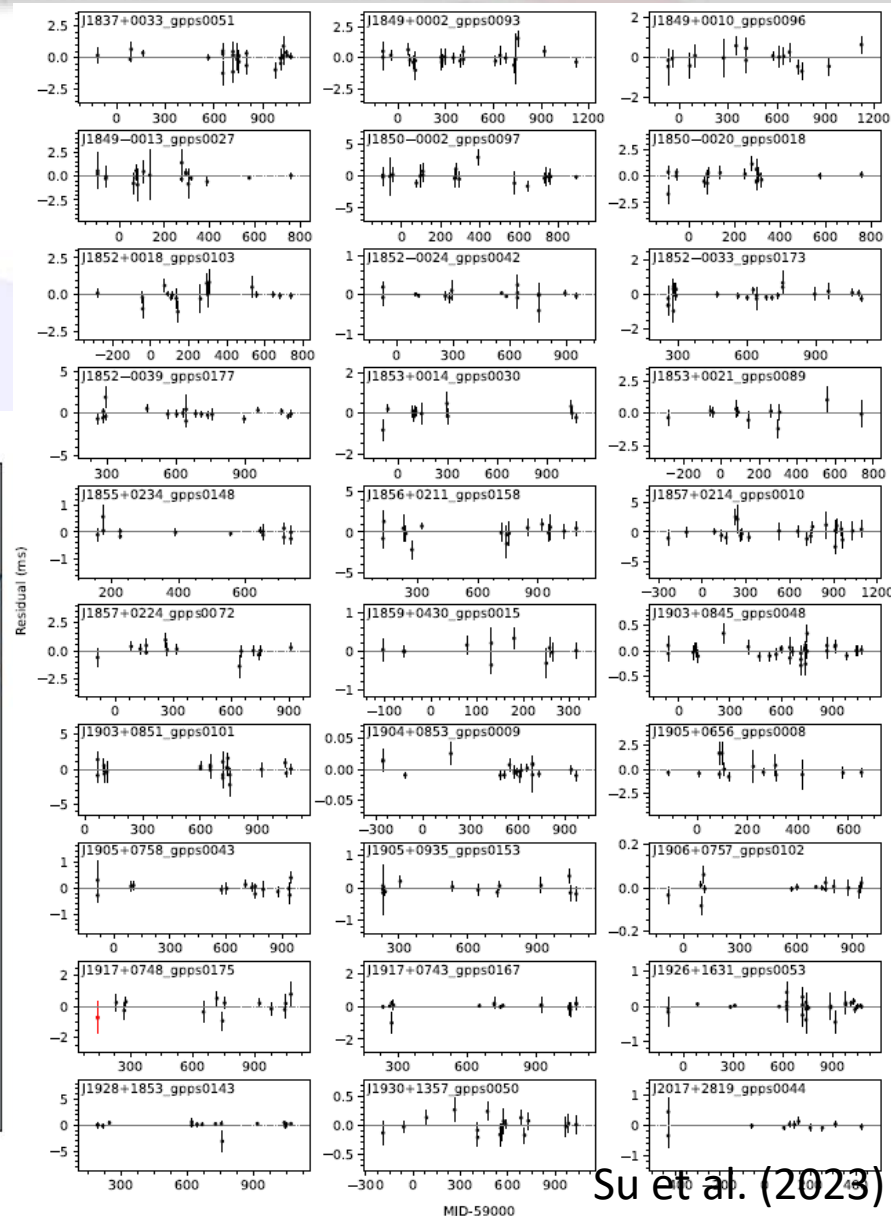
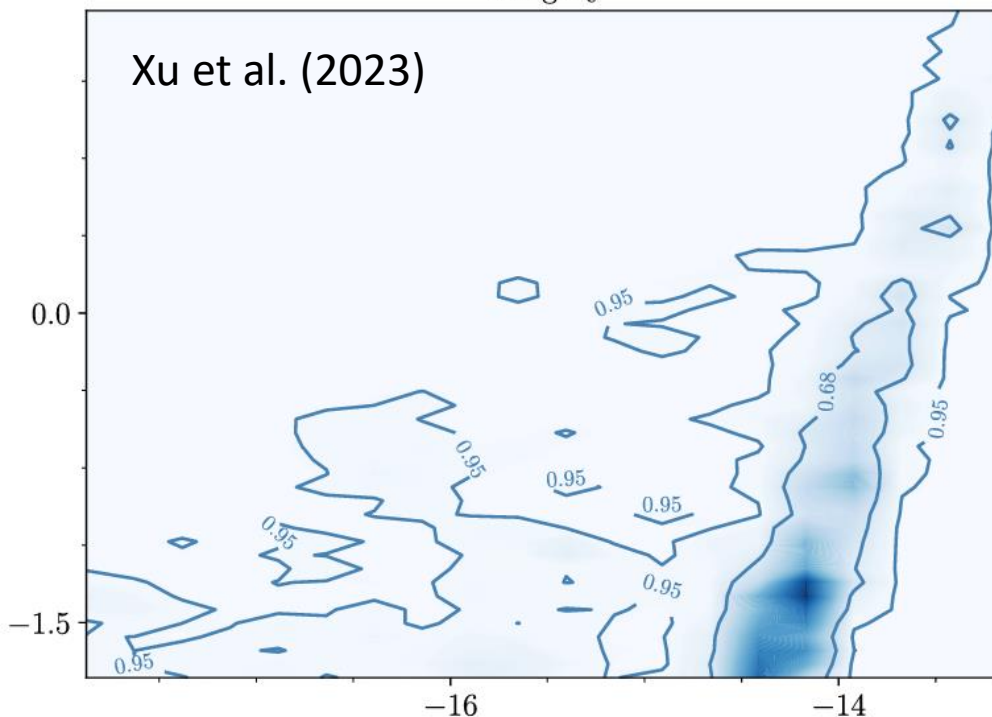
□ Pulsar Timing

▣ Parameter Measuring for new pulsars

▣ GW Detection (CPTA)

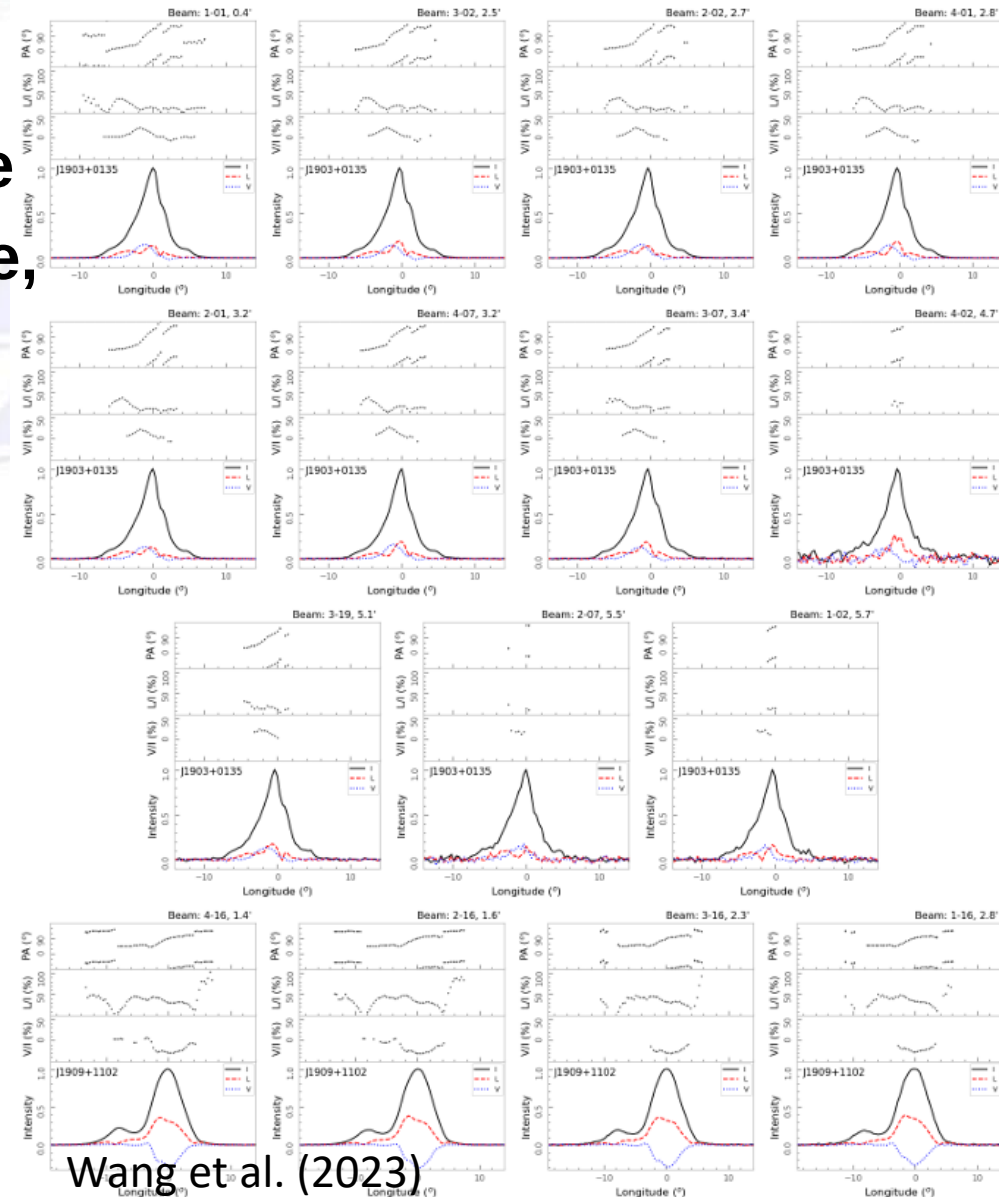
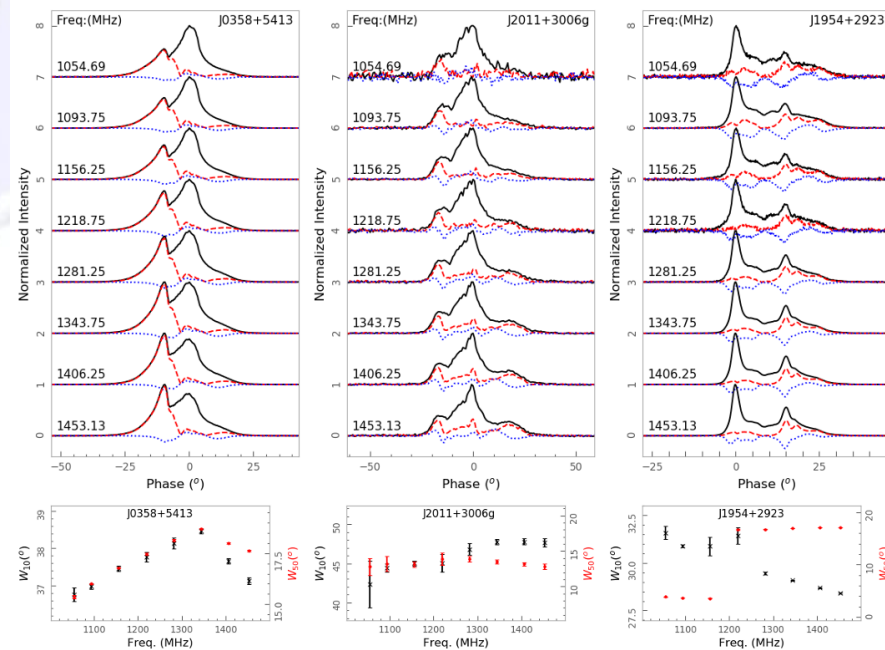
$\alpha\text{-log } A_c$

Xu et al. (2023)



□ Mean Pulse Profile

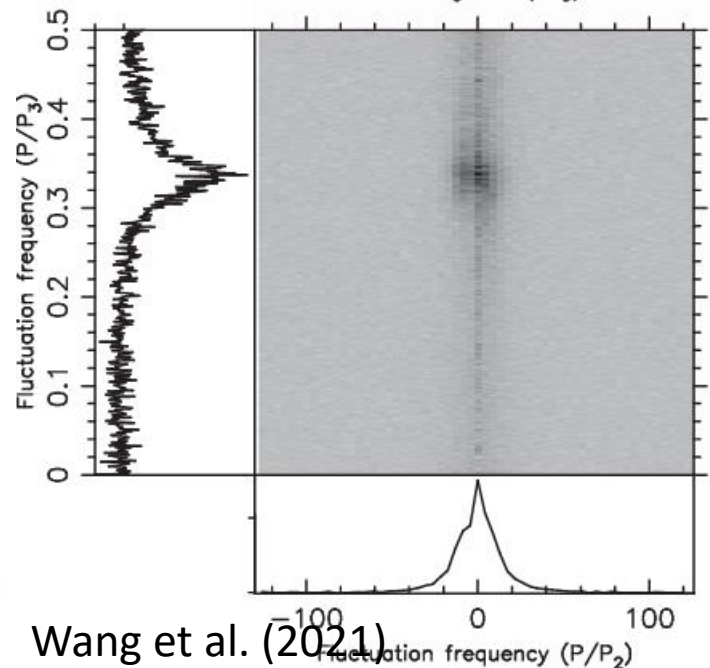
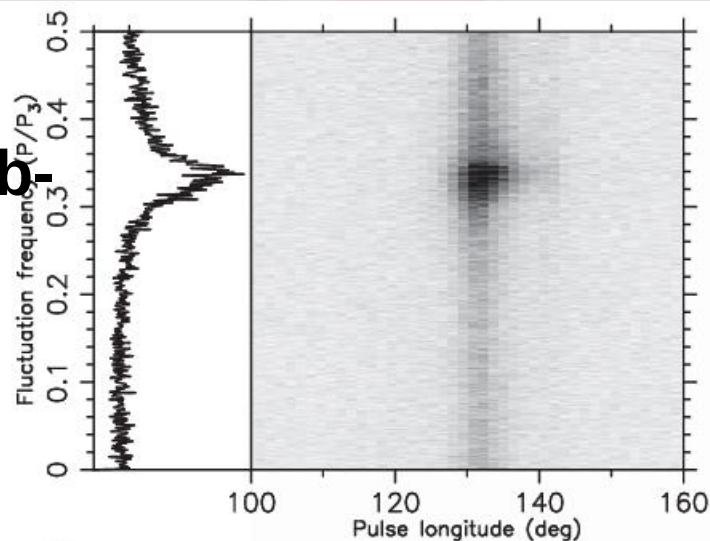
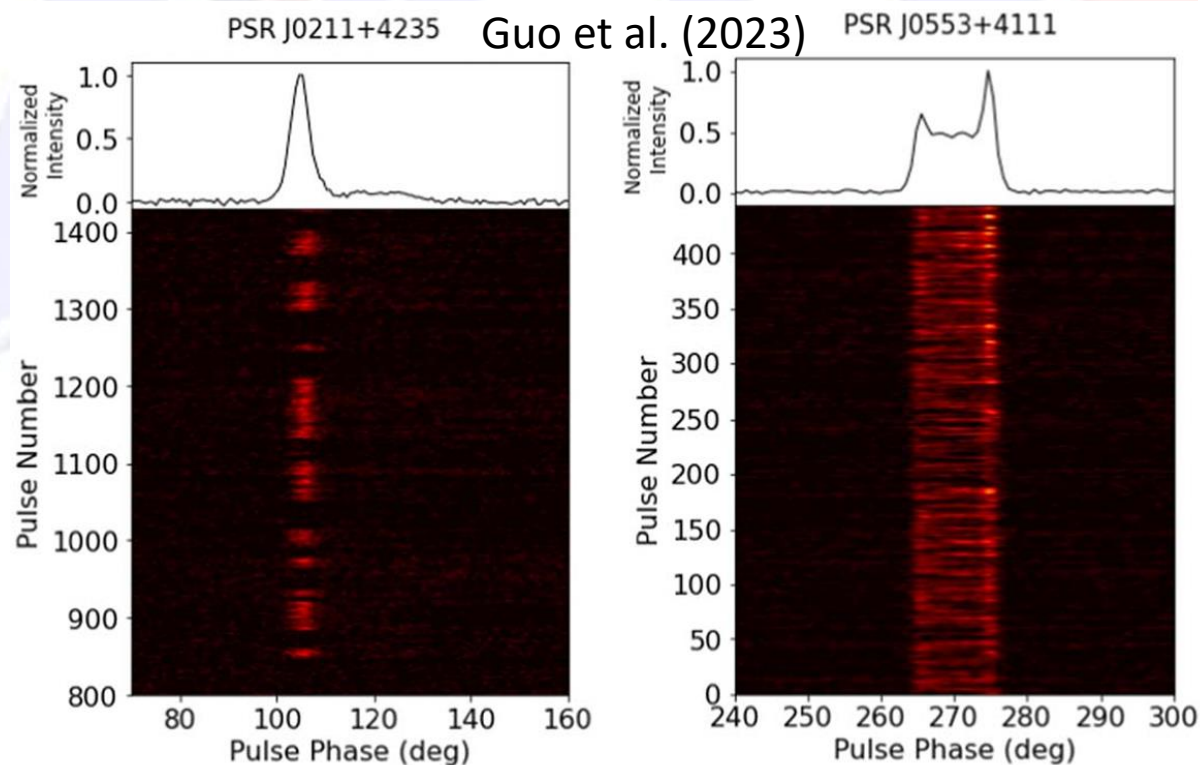
■ The mean pulse profile and polarization profile, and their evolution with frequency



Wang et al. (2023)

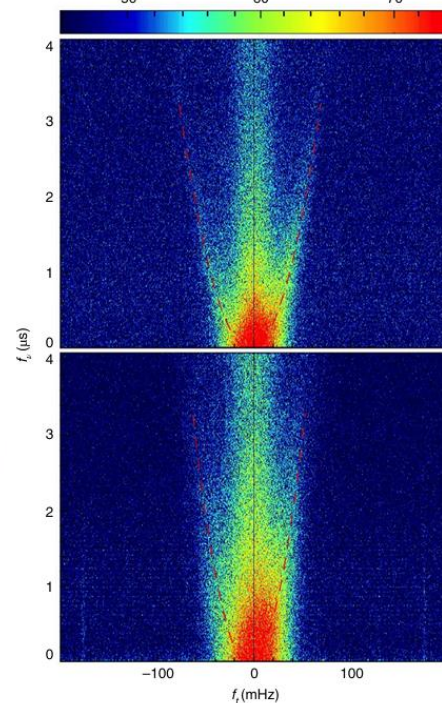
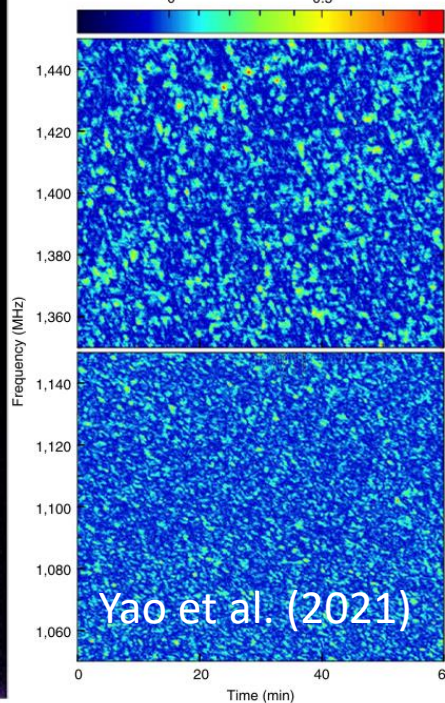
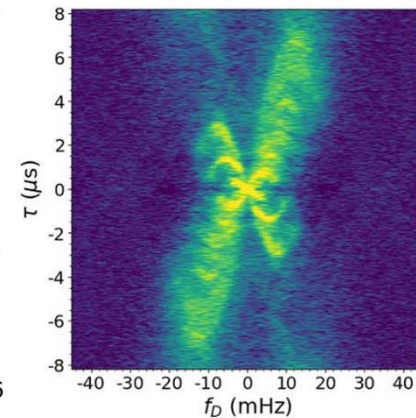
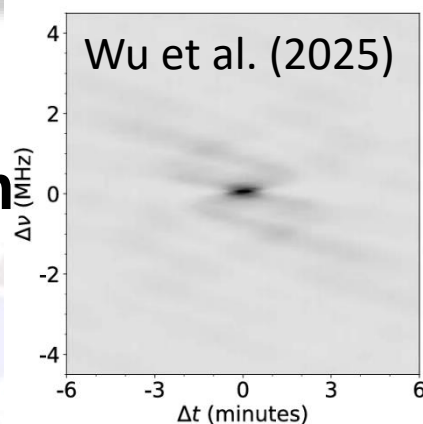
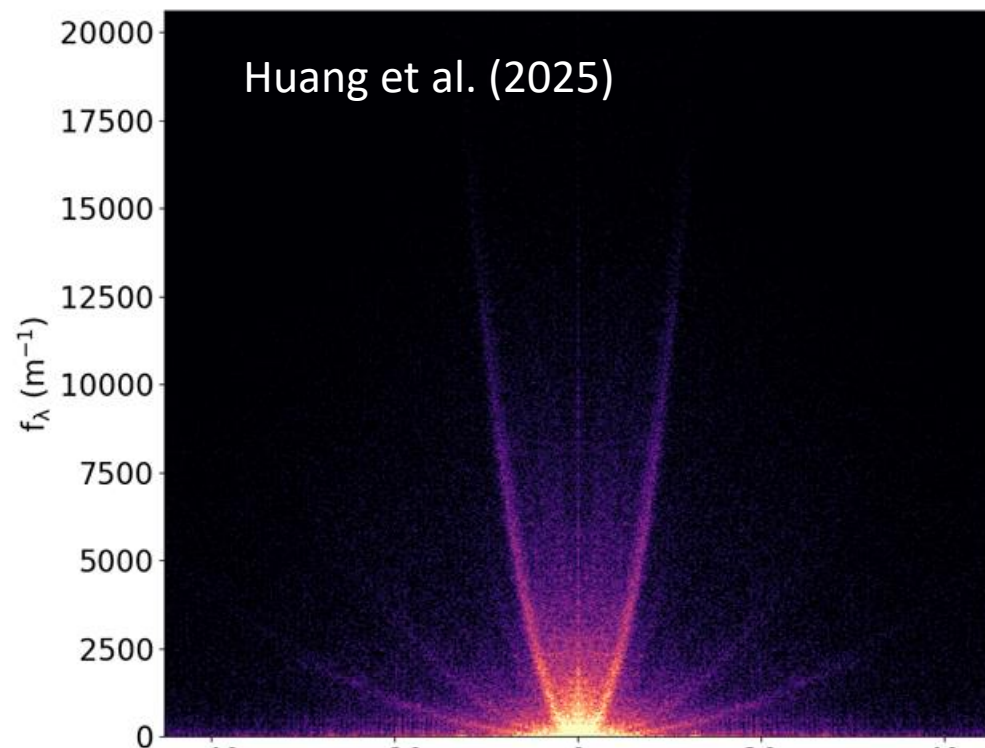
□ Single pulse

- ▣ Nulling, mode change, drifting sub-pulse, single pulse polarization, and the statistical property



□ Pulsar scintillation

- ▣ Study the interstellar medium
- ▣ Study the motion of pulsar



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□ Pulsar Search

- ▣ Single Pulse Search
- ▣ Long-period transient
- ▣ Extragalactic Pulsar
- ▣ Sub-millisecond Pulsar
- ▣ Pulsars with extreme physics

□ Pulsar Timing

- ▣ Parameter Measuring (massive pulsar?)
- ▣ GW detection (GW astronomy?)
- ▣ General relativity test
- ▣ Pulsar braking study
- ▣ Timing with single pulse properties
- ▣ Pulsar time

□ Pulsar Monitoring

- ▣ Profile Evolution
- ▣ Polarization
- ▣ Single pulse: Hidden Markov process, Fractional Brownian Motions
- ▣ Pulsar magnetic field configuration, radiation geometry, radiation mechanism



Thanks!



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