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Guizhou Normal University

FAST/Future Pulsar Symposium 15

The L-band Radio Emission Properties of PSR J0612+3721 with FAST Observations

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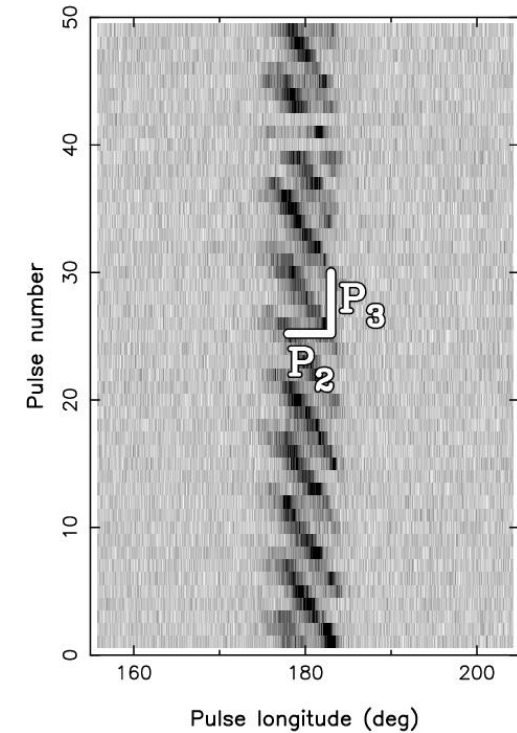
Guiyang, China, 2026, July 3



Background---Subpulse Drifting

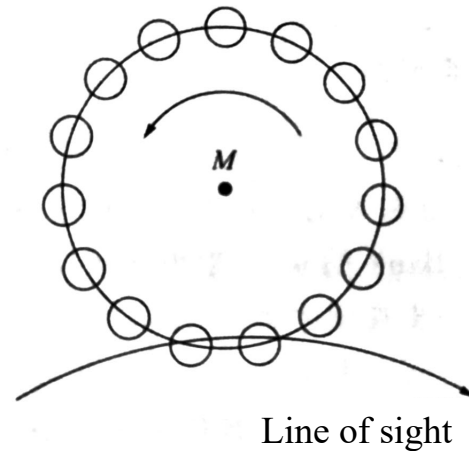


➤ Discovered by Drake & Craft (1968)

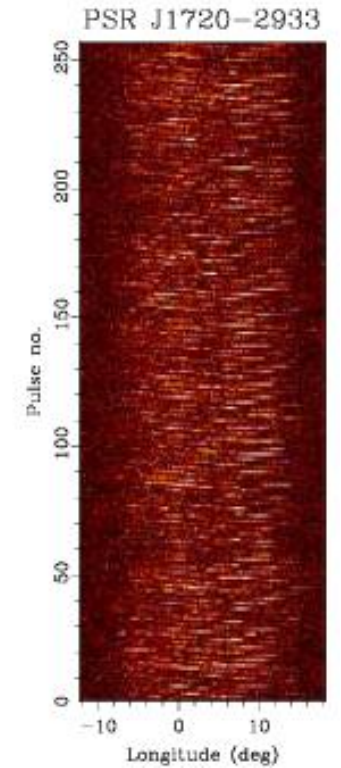
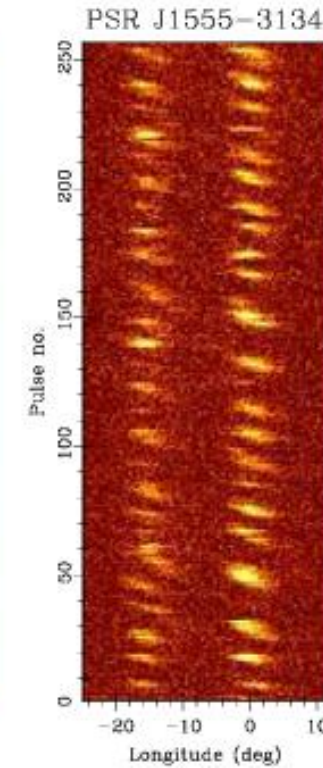
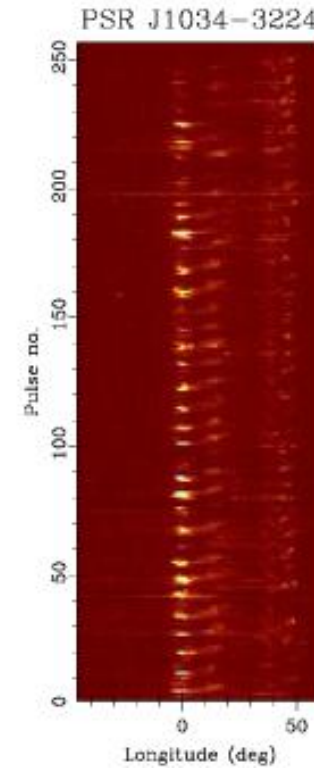
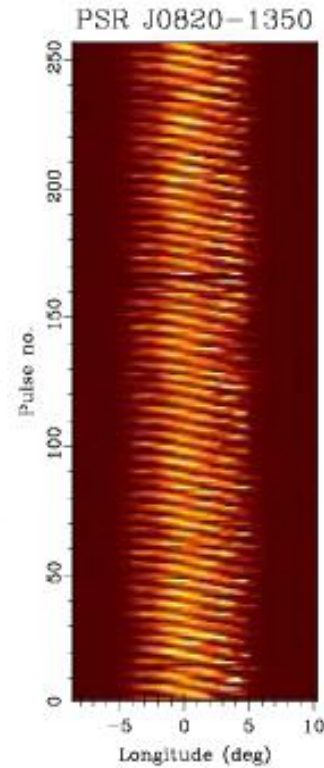


(P. Weltevrede et al., 2007)

“carrousel” model



(Ruderman & Sutherland.,1990)



(Basu et al., 2018)

- **inner acceleration gap** (R. Basu et al. 2019a)
- **inner annular gap** (G. J. Qiao et al., 2004)
- **quasi-central spark model** (J. A. Gil & M. Sendyk., 2000)
- **noncircular spark patterns** (G. Wright & P. Weltevrede., 2017)

More observations are meaningful for the constraint and further development of pulsar radiation models.



Pulsar name	PSR J0612+3721
Spin period P_1	0.29 s
Period derivative $\dot{P}$	$5.94 \times 10^{-17} \text{ s s}^{-1}$
Characteristic age τ_c	$7.94 \times 10^7 \text{ yr}$
Dispersion measure (DM)	$27.15 \text{ cm}^{-3} \text{ pc}$
Distance	0.534 kpc
Observe telescope	FAST
Observation band	L-band (1.0–1.5 GHz)
Observe time	2018.07.23
Total number of single pulses	6112

➤ For data processing:

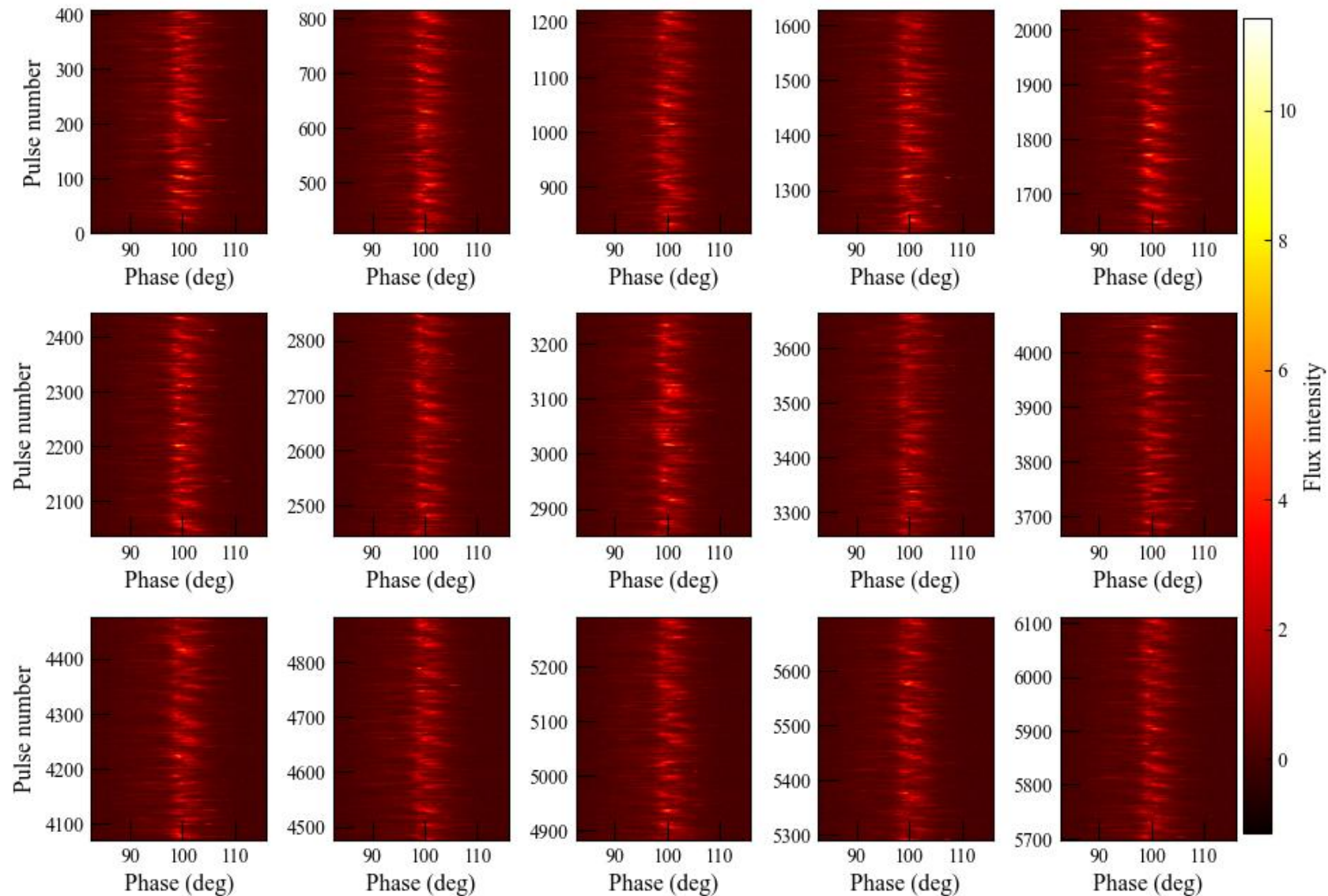
- **DSPSR** folding → **PSRCHIVE** RFI removal → single-pulse extraction
- Analysis with **PSRSALSA** + Python



The Single-pulse Stack



- Clear regular subpulse drifting can be observed

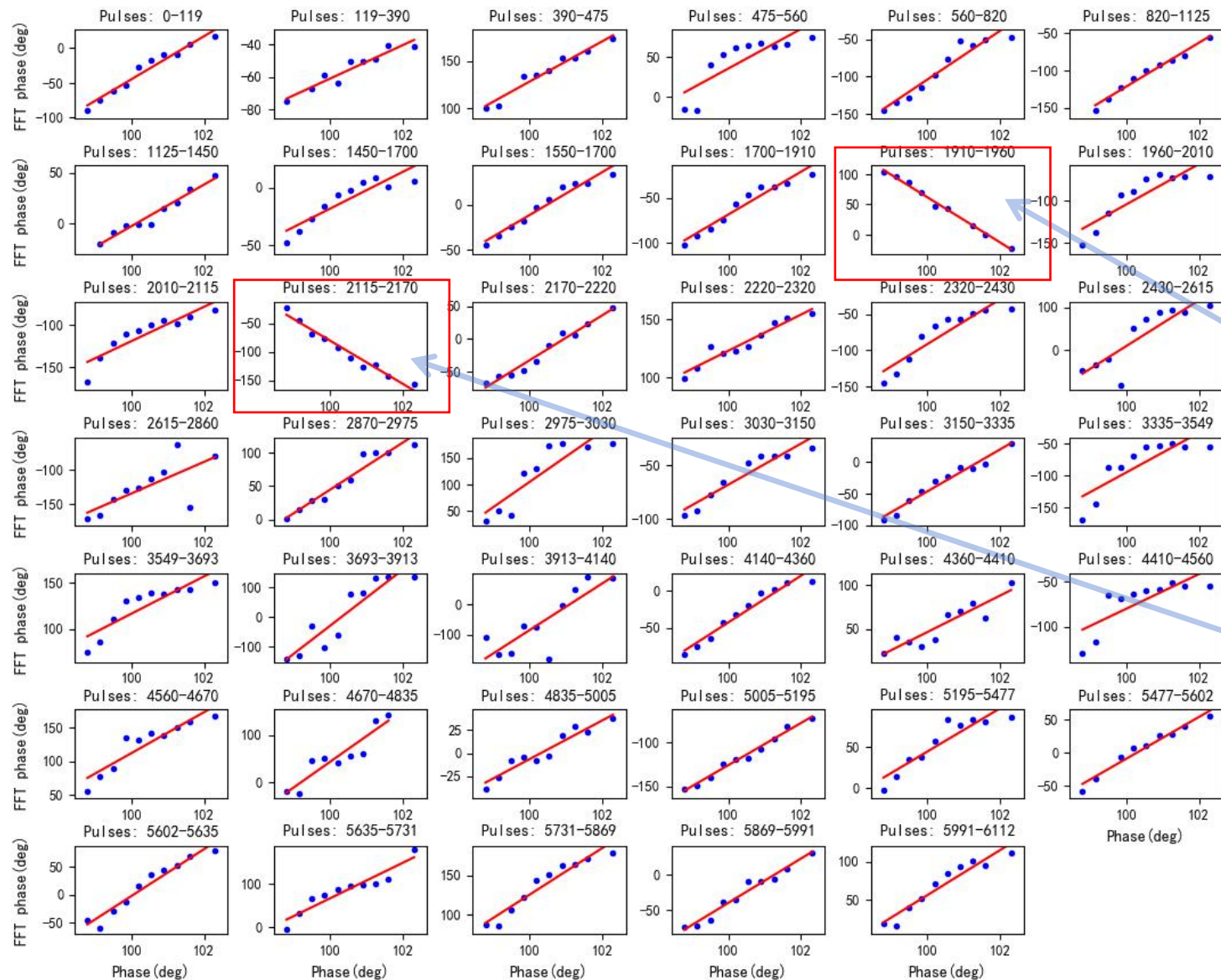




Phase Variation of Drifting

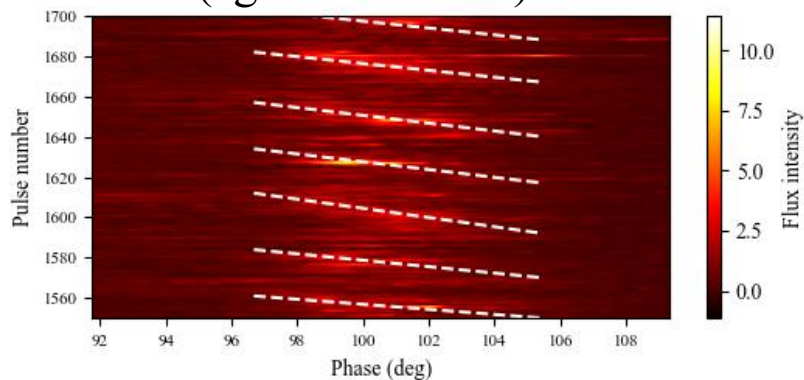


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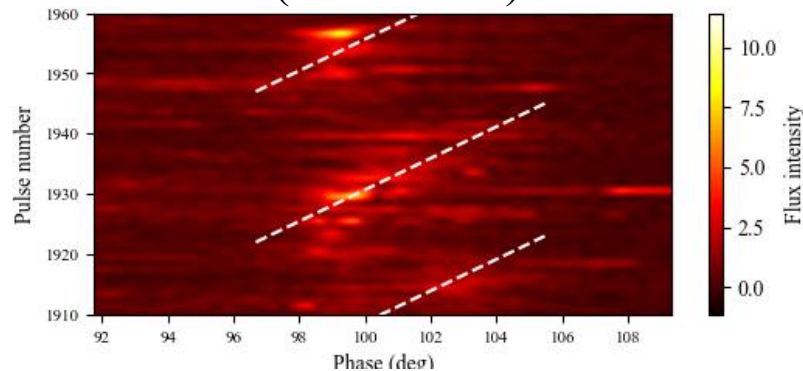


- Divided 6112 pulses into 41 segments, computed phase variation across pulse window
- Most segments show positive slope (negative drifting)
- Slope for negative drifting is stable, average ~ 9.47
- Exceptions (segments 1910-1960 and 2115-2170) show negative slope (positive drifting)

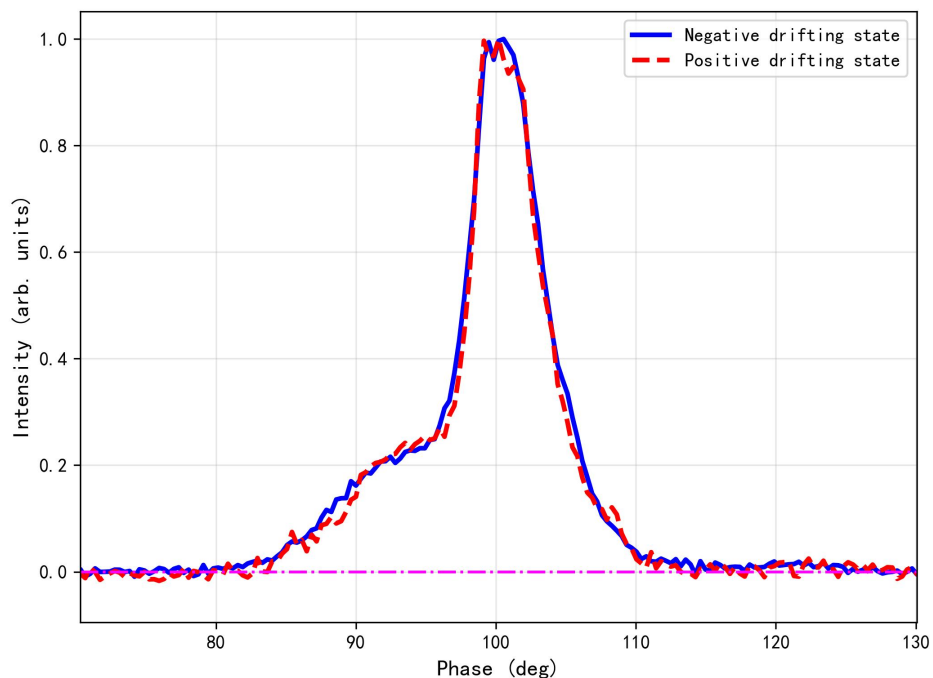
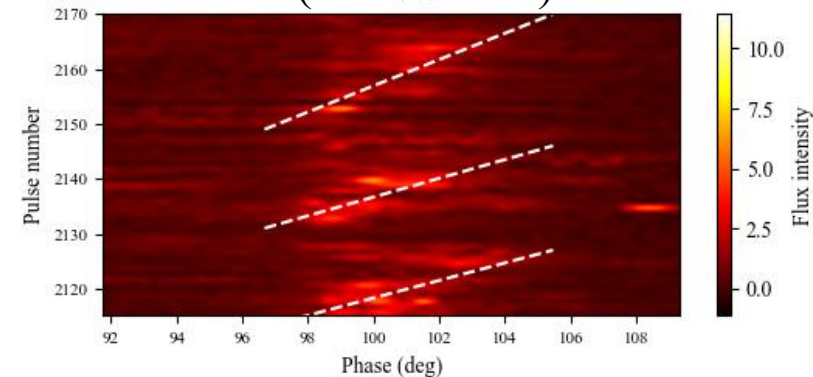
Normal(negative drifting)
(eg: 1550-1770)



Exception (positive drifting)
(1910-1960)



Exception(positive drifting)
(2115-2170)

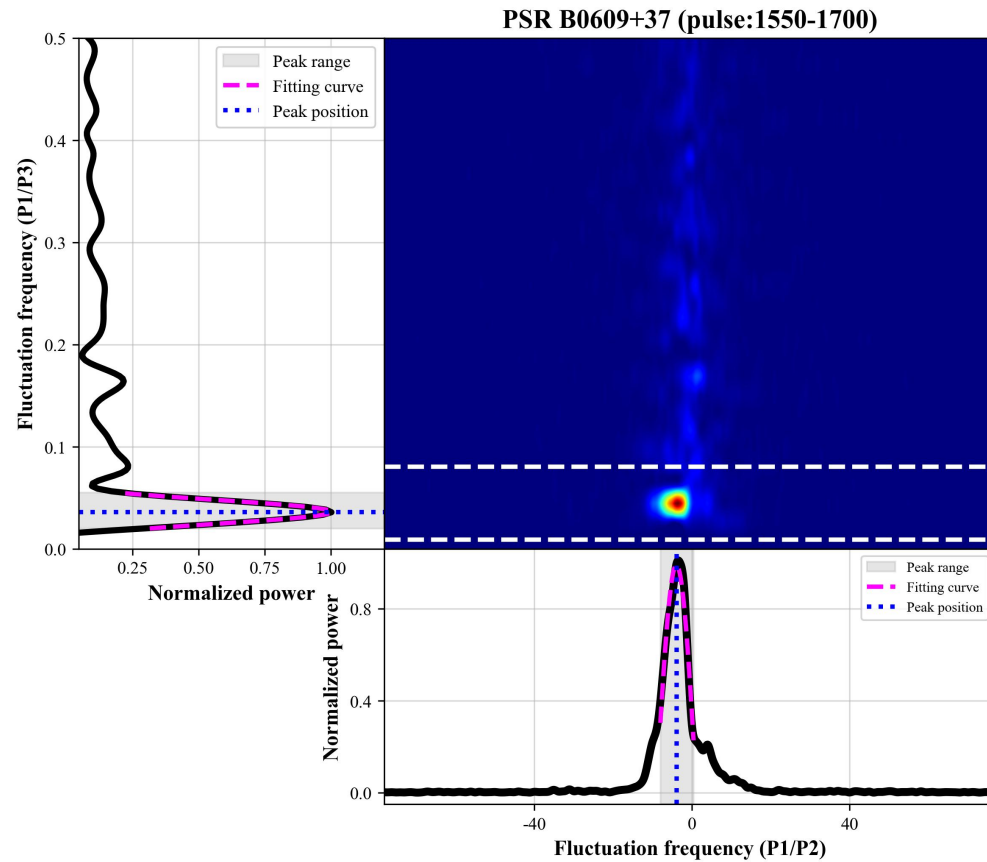


- **No morphological difference** – shapes are almost identical
- Implies that drift reversal does not change the underlying beam structure

Likely just a change in sightline cut through the carousel

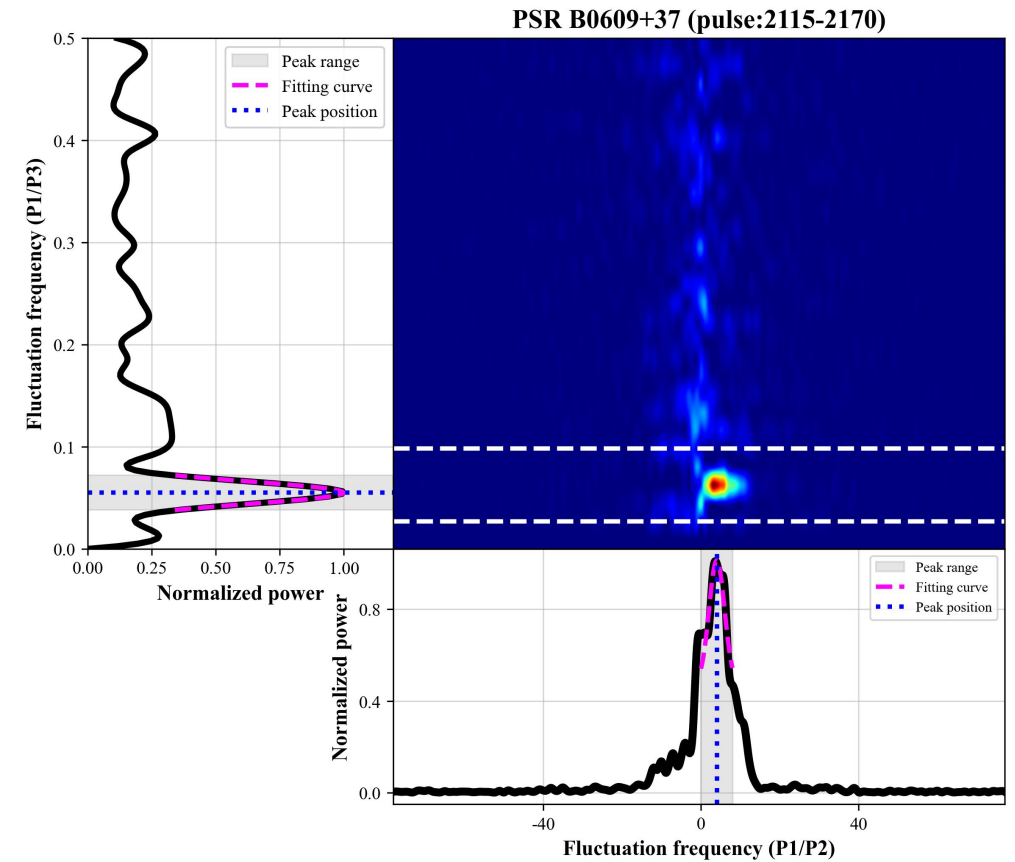


Drift Parameters P_2 and P_3 (2DFS)



➤ Negative drifting (Pulses 1550–1700):

- $P_2 = -0.25P_1$ (horizontal spacing)
- $P_3 = 27.58P_1$ (vertical spacing)

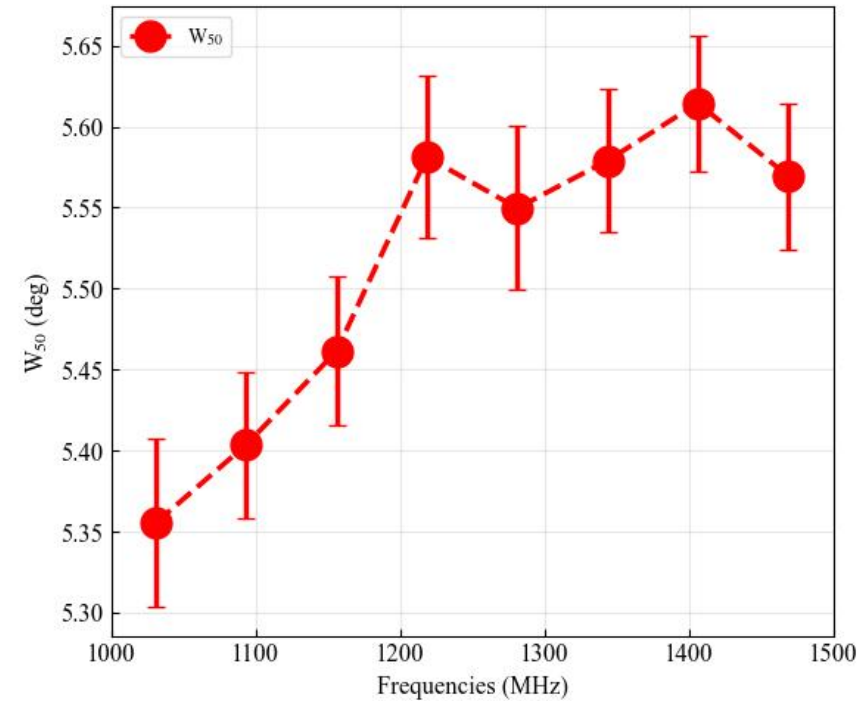
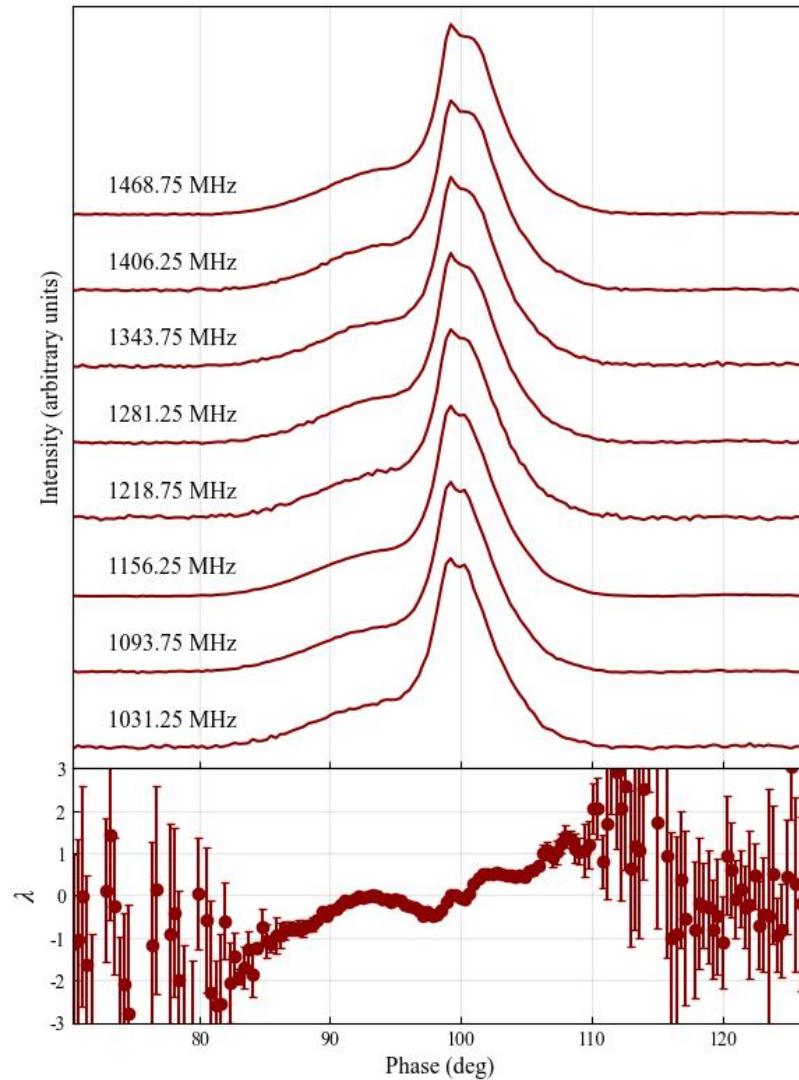


➤ Positive drifting (Pulses 2115–2170):

- $P_2 = +0.25P_1$
- $P_3 = 18.17P_1$



- investigated the frequency dependent behavior and phase-resolved spectra of these pulse profiles



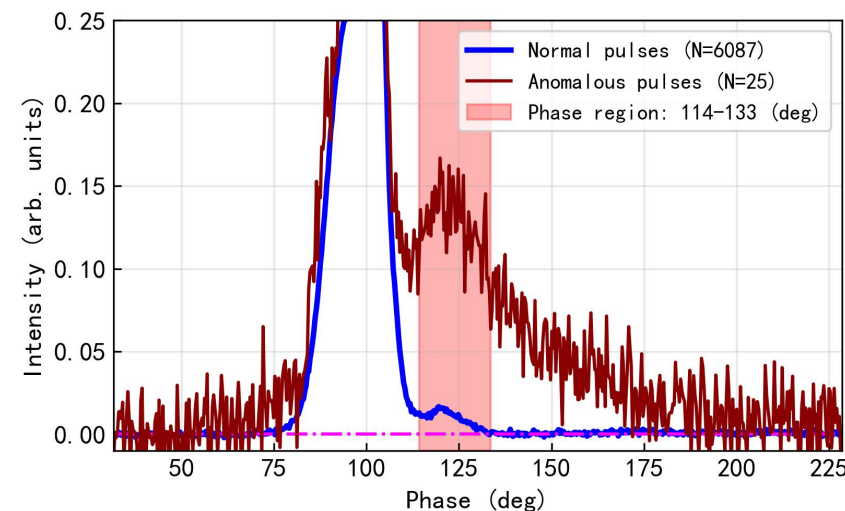
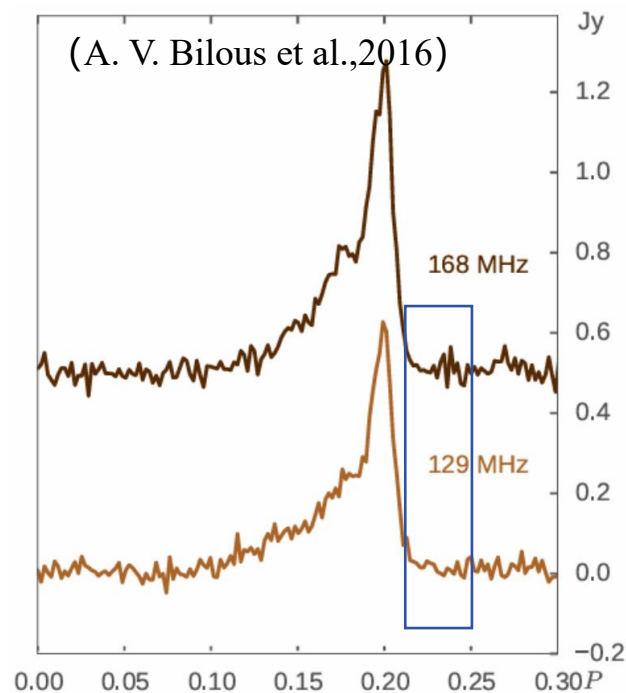
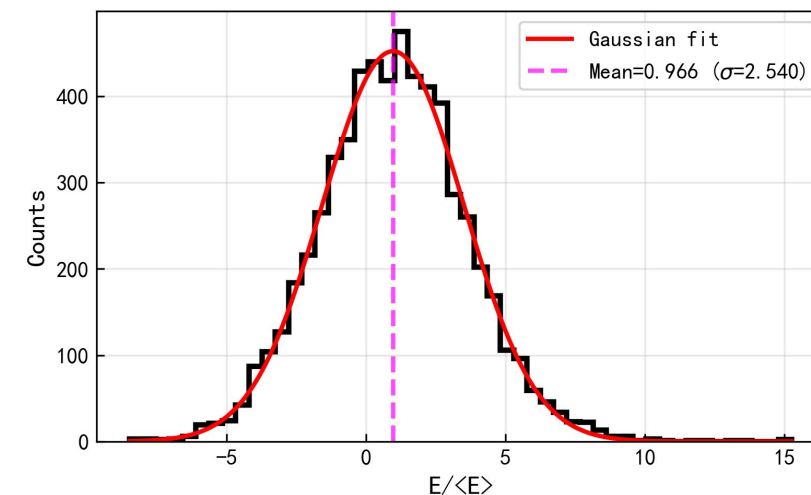
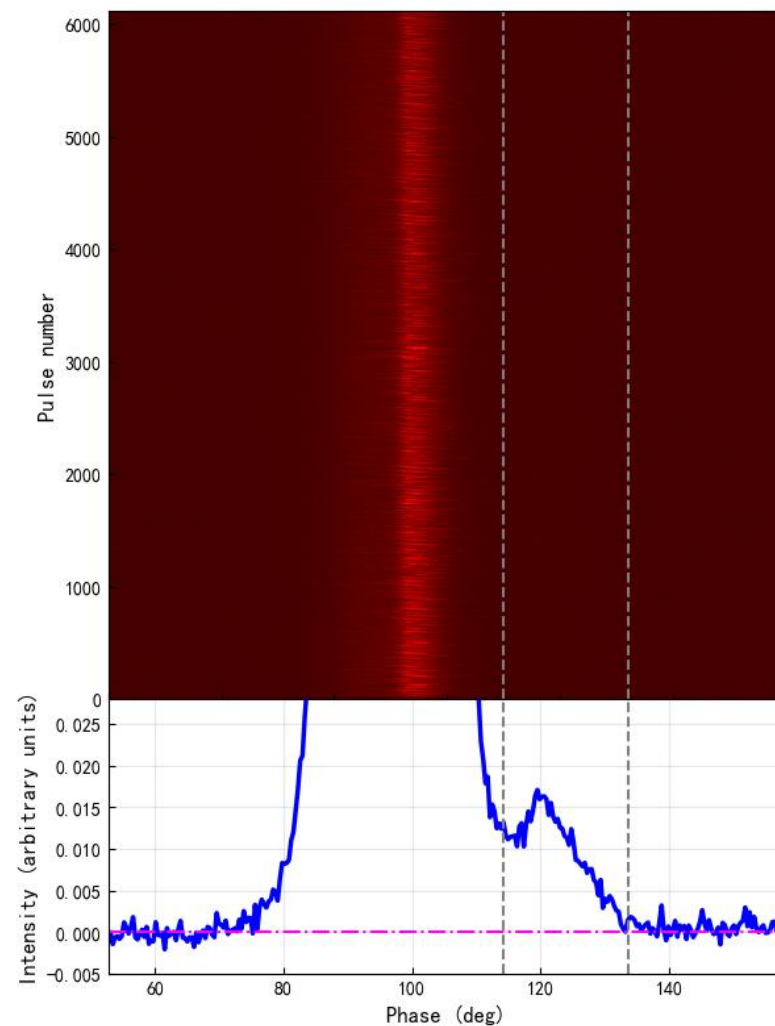
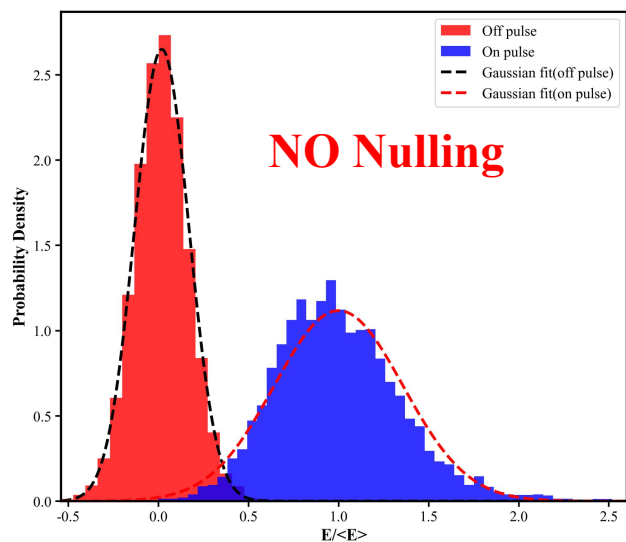
- **Opposite to most pulsars** (which are broader at low frequencies)



Discovery of a Weak Emission Component



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- Pulses with energy $> 3\sigma$ produce a broader average profile compared to normal pulses

Summary

This is the **first single-pulse study** of PSR J0612+3721 using FAST.

- ✓ The pulsar shows **stable negative drifting** with occasional reversals to positive.
- ✓ **No pulse nulling** is detected – the nulling fraction is consistent with zero.
- ✓ Drift parameters
 - Negative $P_2 = -0.25P_1$, $P_3 = 27.58P_1$
 - Positive $P_2 = +0.25P_1$, $P_3 = 18.17P_1$
- ✓ Profile width **increases with frequency**, contrary to most pulsars.
- ✓ Spectral index **hardens from leading to trailing edge**; the central component is frequency-independent.
- ✓ **A weak trailing component** exhibits intermittent bright bursts – a mode-switching phenomenon.

Thanks!