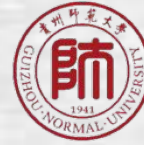




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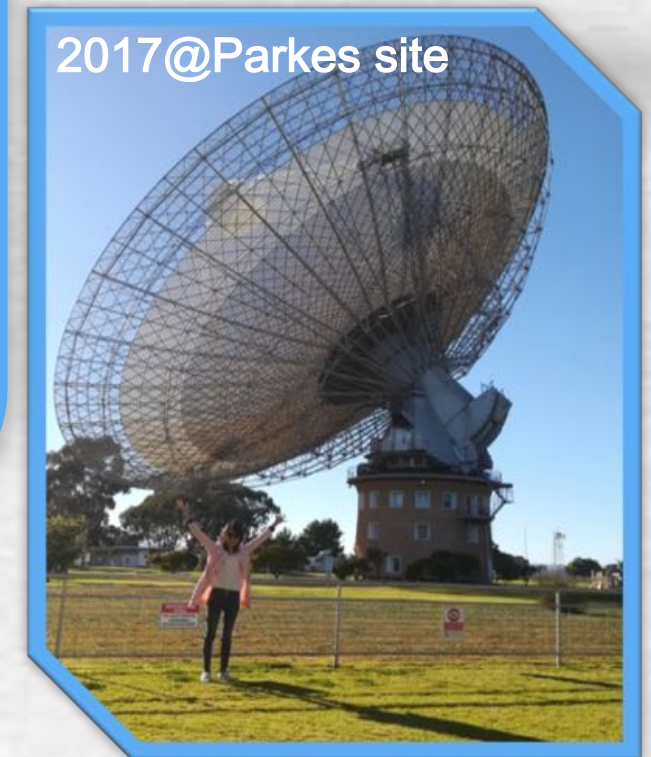
貴州師範大學
Guizhou Normal University

Pulsar Observation and Study with FAST and Parkes Radio Telescope

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2020.08.29 FPS9@Xiamen

Content

- FAST single pulse study for PSR J1926-0652
- Parkes globular cluster pulsar study with UWL receiver



An introduction

To date, more than **70** pulsar candidates have been identified using the UWB receiver, out of **51** have been confirmed by using **Parkes**, **Effelsberg**, **Arecibo**, **Fermi-LAT** or **FAST** self.

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FAST

Observations

2017.8: discovered at FAST using a single-pulse pipeline (Zhu et al. 2014)

2017.10: confirmed at Guizhou Normal University using Parkes telescope

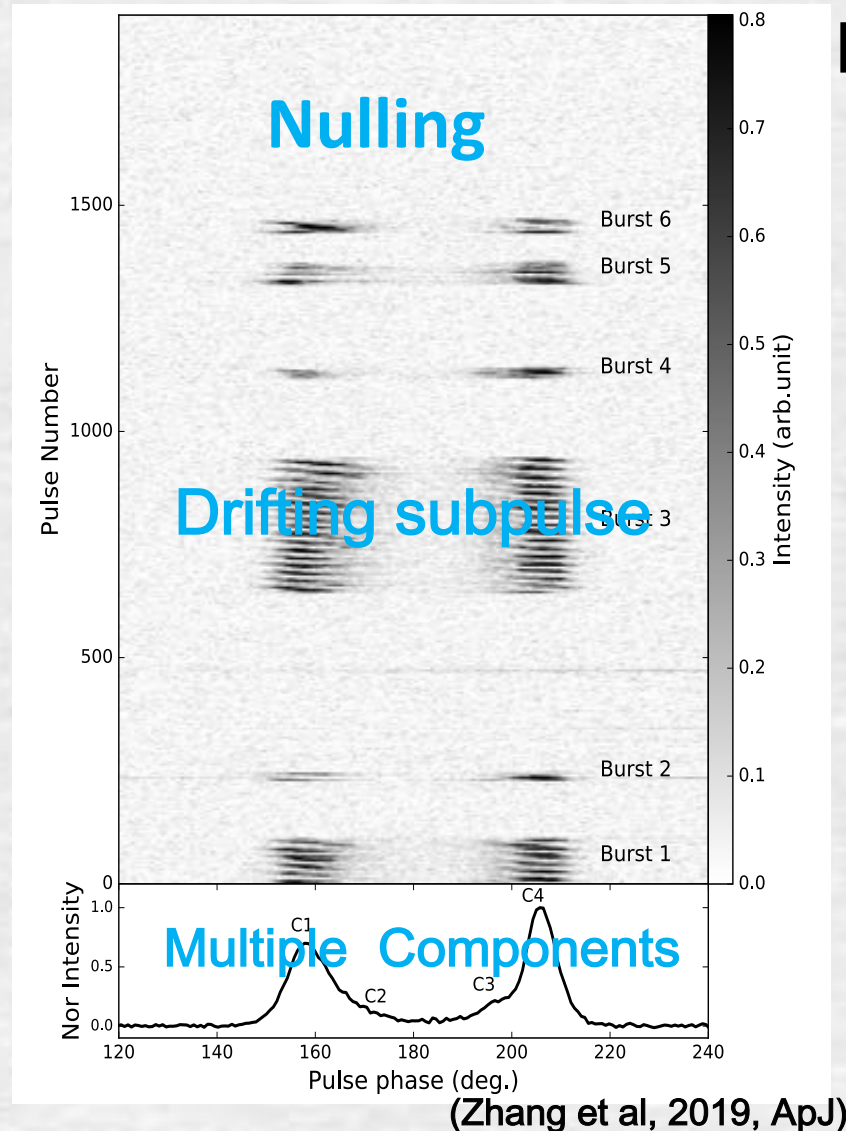
2017.10 - 2018.09: continued observations with both FAST and Parkes

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Emission properties overview

- FAST single pulse study for PSR J1926-0652
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Nulling Properties of the Pulsar

- FAST short-term single-pulse data sets (~ 50 minutes):
 - null fraction is $\sim 75\%$
 - short-term nulling lasting from 4 to 450 pulses.
- Parkes long-term monitoring observations (~ 1 yr):
 - the mean flux density at 20cm about 0.8 mJy
 - the average off-state duration of about 20 minutes

Conclusion: Nulling is the likely cause for its being missed by previous searches.

Complex subpulse drift behaviors

"Carousel model"

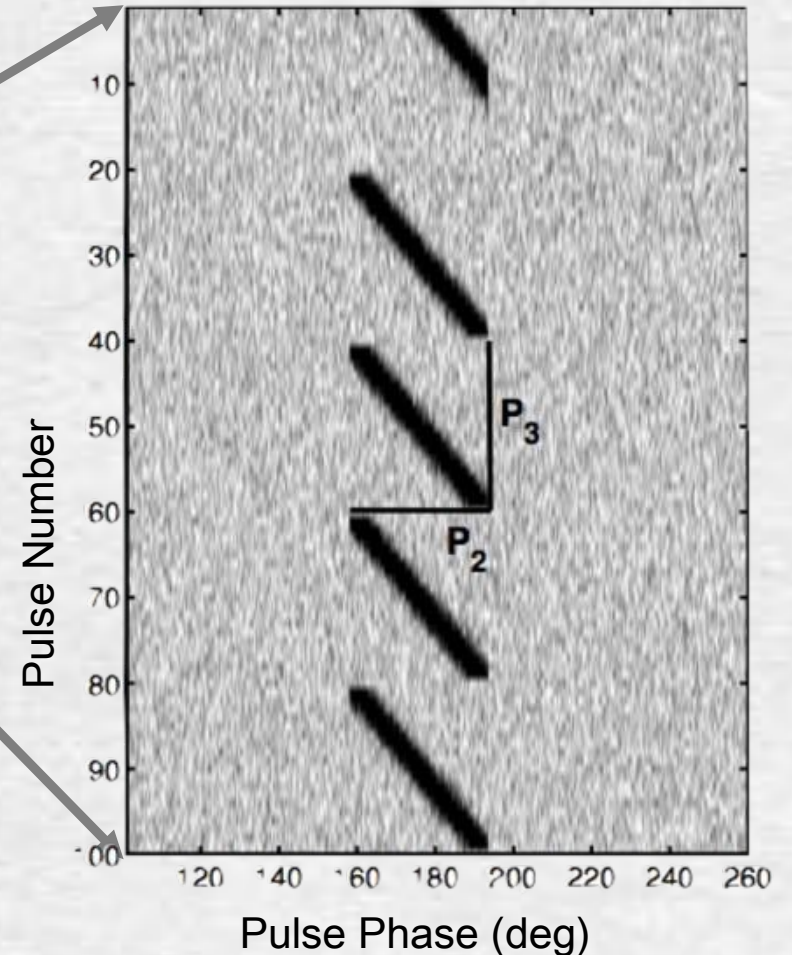
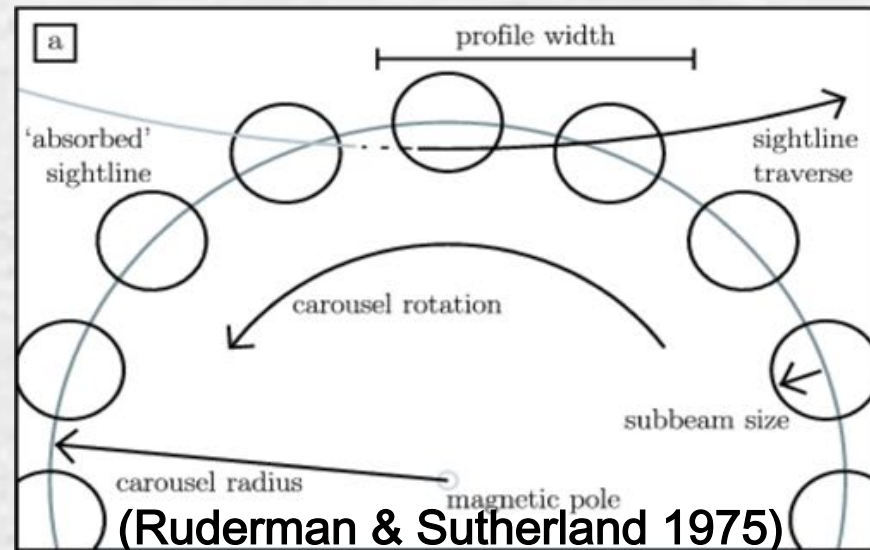
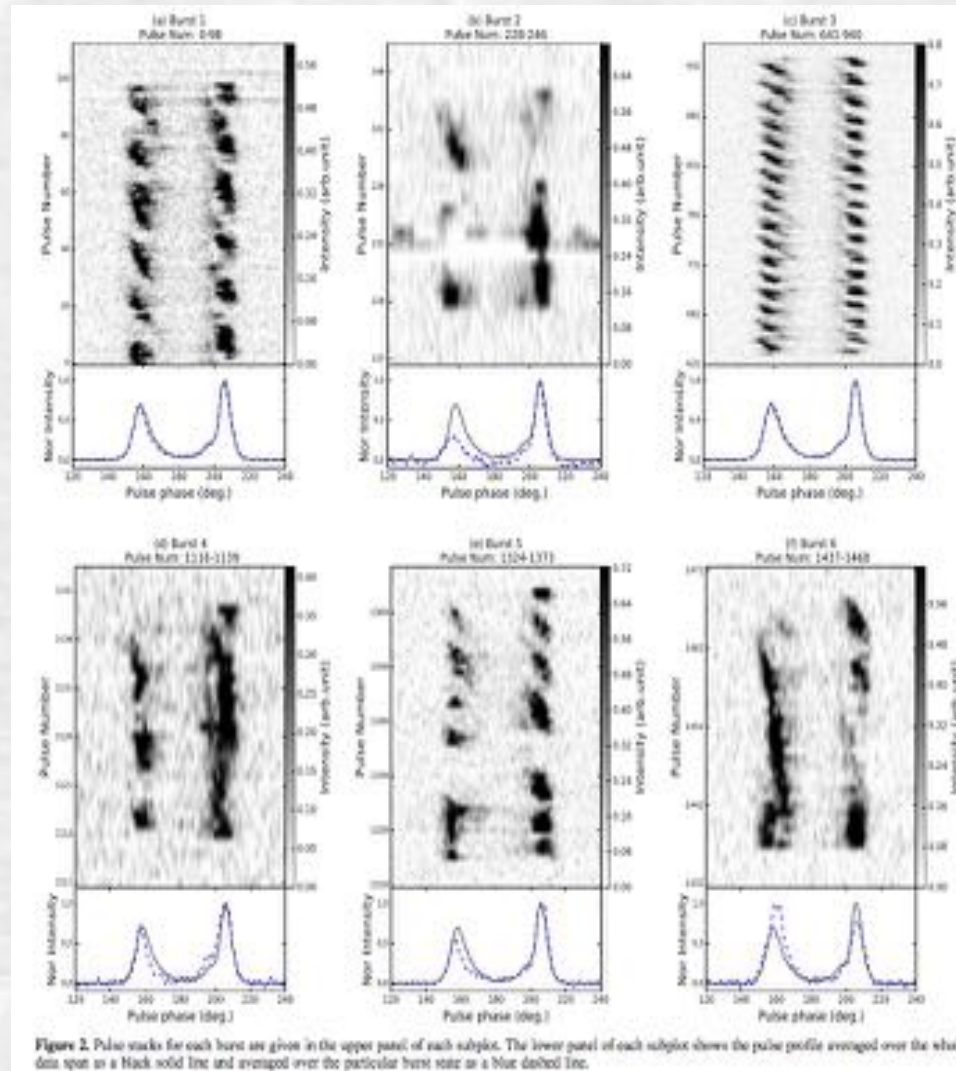


Figure: Schematic diagram for regular subpulse drifting with fake data (Wen et al. 2016).

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Complex subpulse drift behaviors

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These complexities pose challenges for the classic carousel-type models.

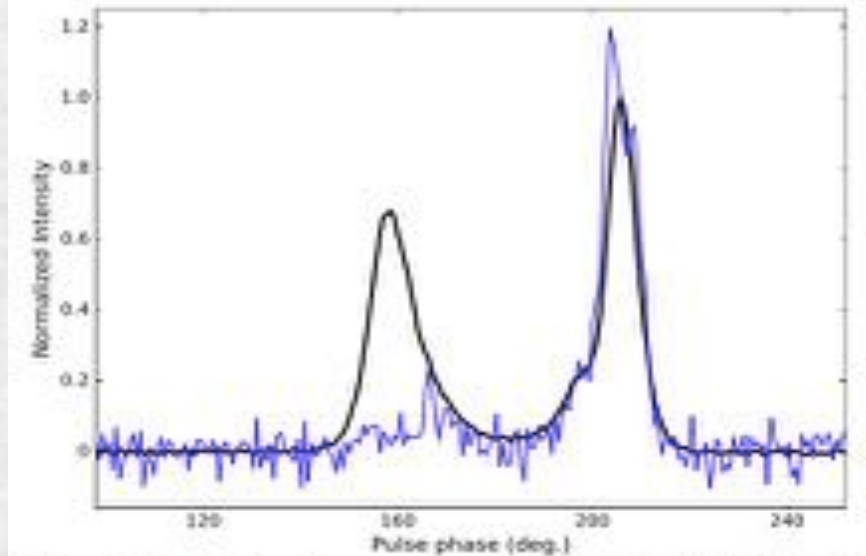


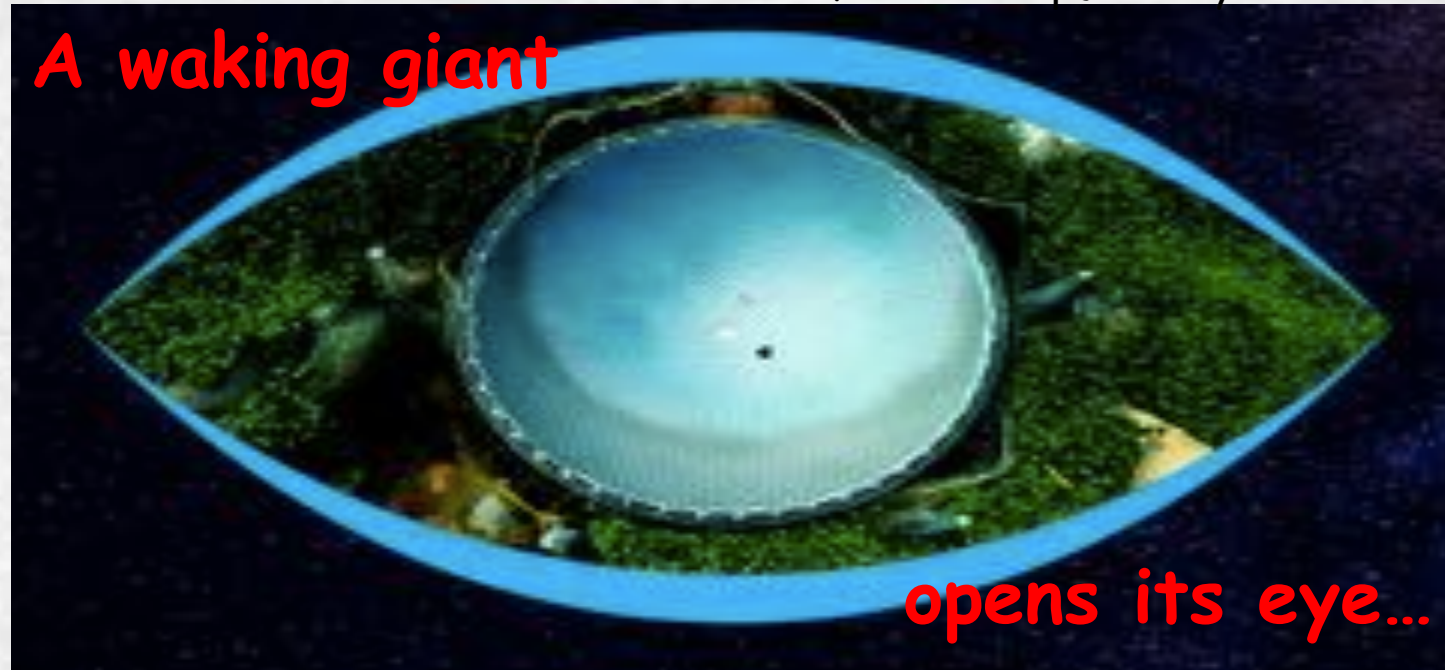
Figure 7. Mean pulse profile averaged over all bursts (thicker black line) and the average profile for the last detectable pulse of each burst (thinner blue line). The mean burst profile peak is normalized to 1.0. The profiles were averaged across the FAST observing band.

A summary

"FAST is a very sensitive telescope and it is likely to find a large number of pulsars along with also revealing a plethora of unexplored single pulse behavior previously unseen for many pulsars. PSR J1926-0652 is one such nice example. **The paper is written in a clear language and does attempt to cover various aspect of the observed single pulse emission properties...**"

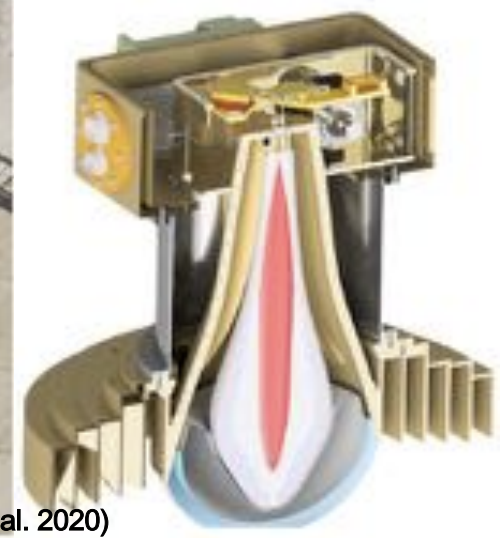
-- Comments from the ApJ Anonymous Reviewer

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An introduction

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P1006_2019APR (approved 106 hours for 11 GCs, PI) The first time wideband observations of pulsars in GCs

Strengths:

- Ultra-high time resolution (64us): It will be more sensitive for fast spin pulsars
- Coherently de-dispersed observation corrects for dispersion between channels
- The wide frequency range (704–4032 MHz), along with the well-calibrated system

Goals:

- Search for new pulsars in GCs: MSPs (e.g. fast spin pulsars, binary systems)
- Wide bandwidth study pulsars in GCs: emission properties (e.g. polarization, flux densities)

1

Wide Bandwidth Observations of PSRs C, D, and J in 47 Tuc

Overview Pulsars in 47 Tuc (Dec -72° , Distance ~ 4.5 kpc):

- To date, all of 25 known MSPs were discovered by Parkes.
- PSRs C, D and J are three brightest pulsars in the 47 Tuc.
- There are no previous wideband or well-calibrated polarization observations of pulsars in 47 Tuc.

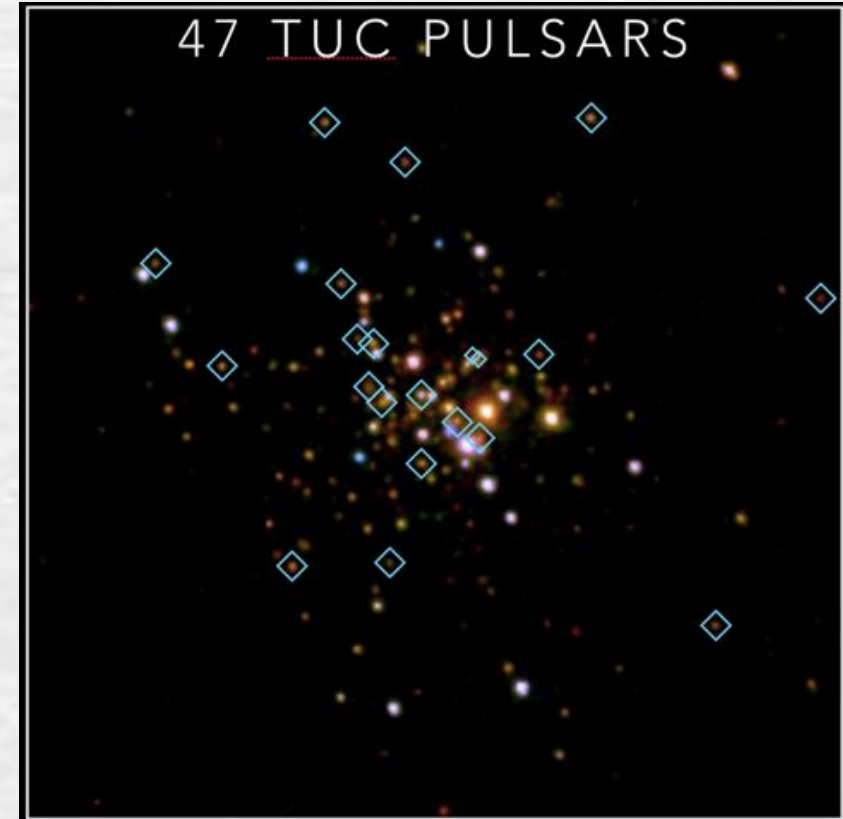


Figure: The pulsars in an X-ray map of 47 Tuc. (Credit: Craig O. Heinke)

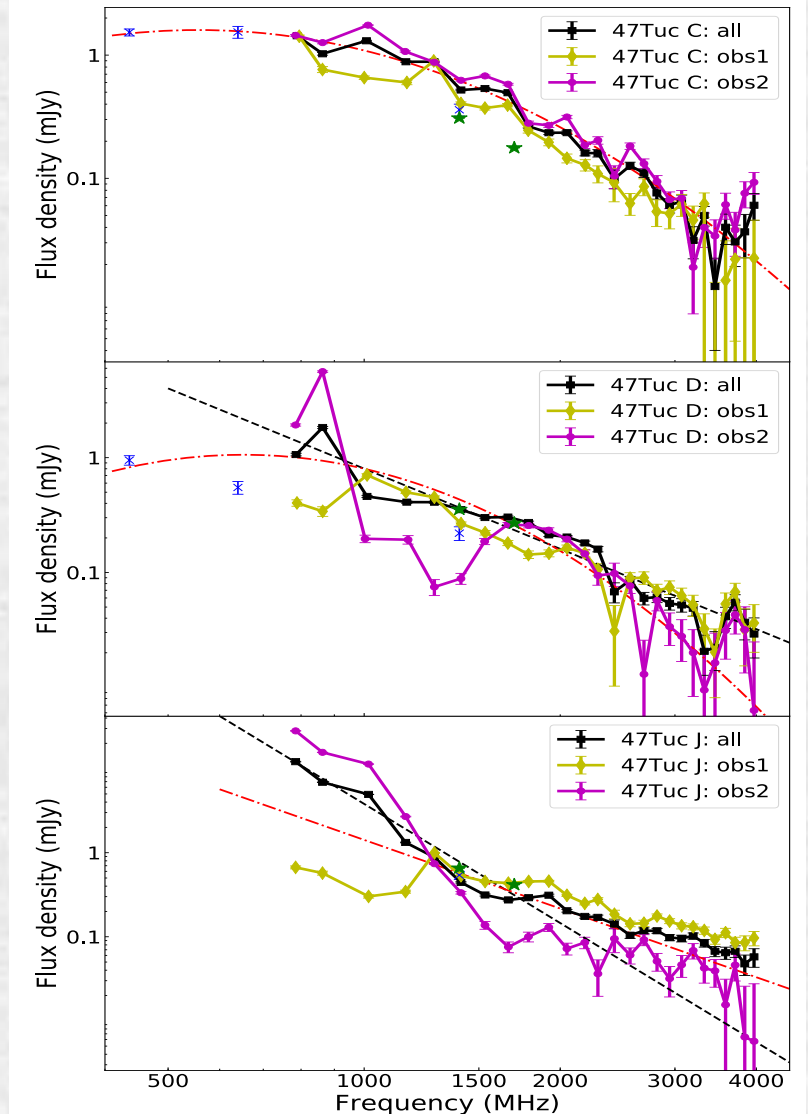
- FAST single pulse study for PSR J1926-0652
- **Parkes globular cluster pulsar study with UWL receiver**

1

Wide Bandwidth Observations of PSRs C, D, and J in 47 Tuc

Main Results in this work:

- FAST single pulse study for PSR J1926-0652
- Measured calibrated flux densities and spectral properties
- Updated dispersion measurements
- Presented polarization pulse profiles along with Faraday rotation measures
- 799–825 MHz and 970–1260 MHz are the optimal bands for independent pulsar searching with the UWL receiver at Parkes.



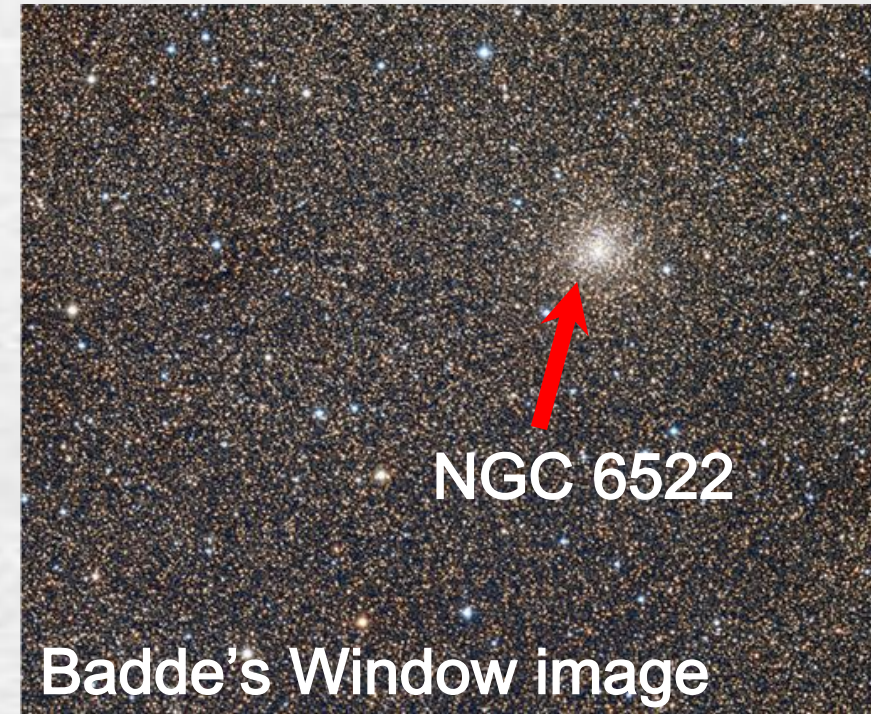
(Zhang et al, 2019, ApJL)

2

Wideband Monitoring Observations of PSR J1803-3002A in NGC 6522

Overview Pulsars in NGC 6522 (Dec -30° , Distance ~ 7.7 kpc):

- Three MSPs have been found in the cluster by previous pulsar surveys.
- PSR J1803–3002A is relatively strong and was discovered in the Parkes Globular Cluster survey at 20 cm. The other two pulsars were discovered using the GBT.
- To date, there have been no published long-term timing or polarization observations or flux density measurements for any of these three pulsars – they just have approximate positions, pulse periods and DMs from the search analyses.



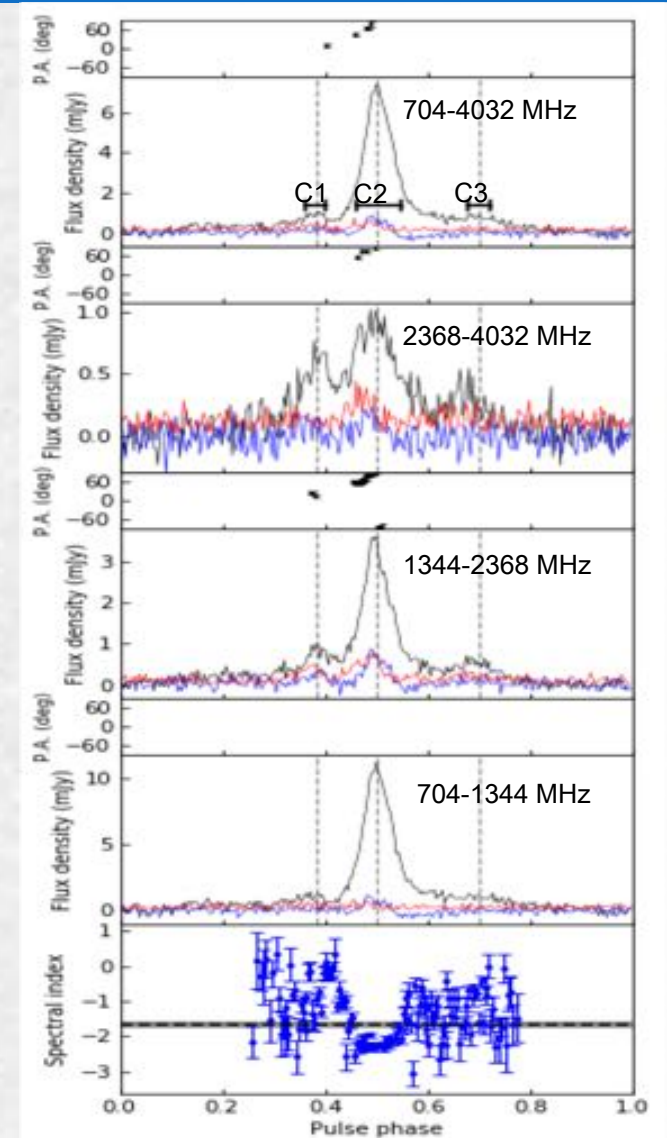
(credit: wikipedia)

- FAST single pulse study for PSR J1926-0652
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Main Results from in this work:

We present the timing solution and describe the emission properties of PSR J1803–3002A for the first time.

- It is a distant pulsar in the Galactic plane, but there is no evidence of pulse broadening due to interstellar scattering in our observations.
- No linear polarization was detectable in the lowest RF band (704–1344MHz) band.
- The over-all radio spectral index for pulsar, -1.66 ± 0.07 , is somewhat flatter than -2.0 , the mean spectral index for MSPs.



- FAST single pulse study for PSR J1926-0652
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3

Discovery of the “hidden” MSP in the NGC 6397?

Overview Pulsars in NGC 6397 (Dec -53° , Distance ~ 2.3 kpc)

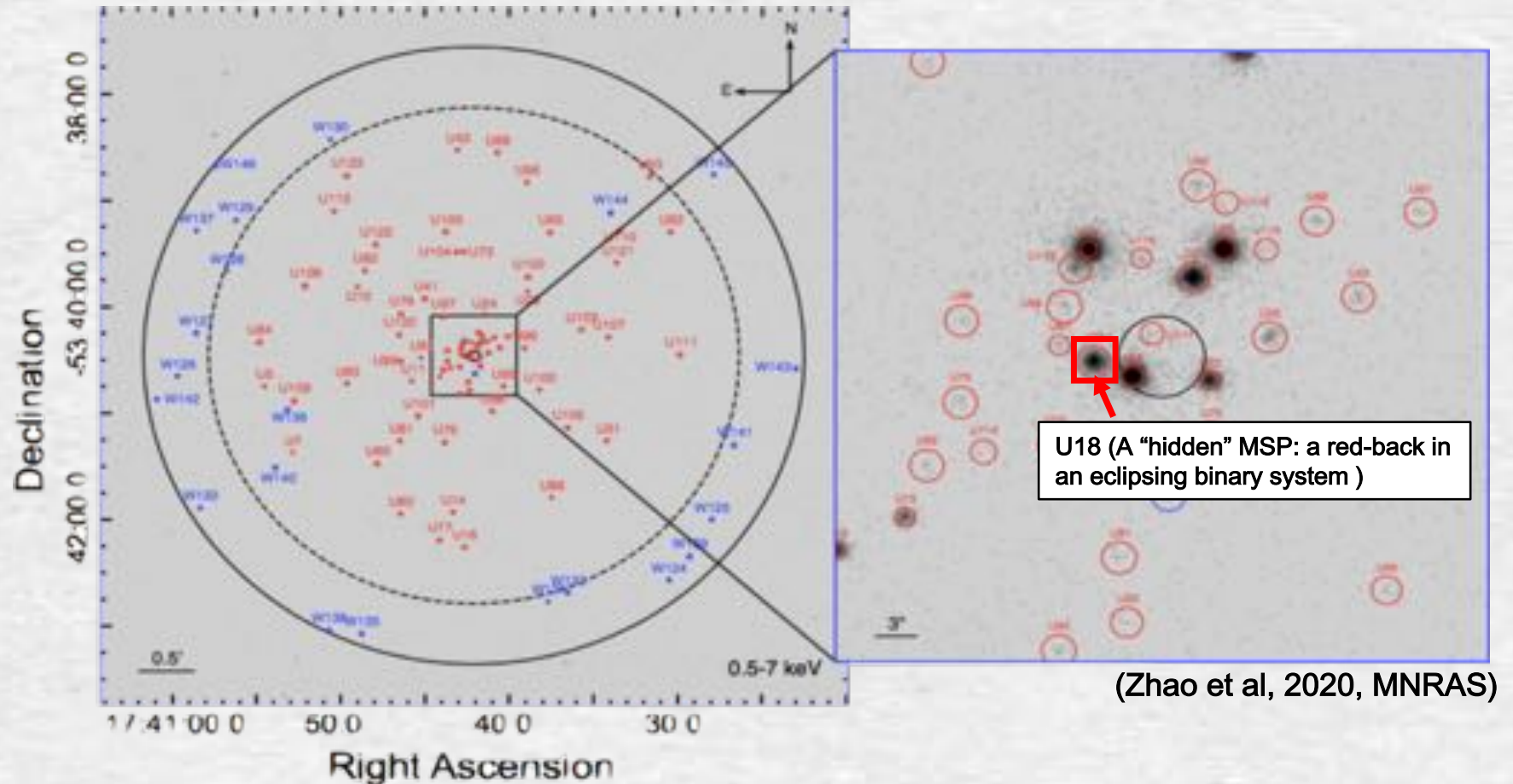


Figure. *Left:* 0.5-7 KeV X-ray image of $6'.6 \times 6'.6$ square region centered on the cluster. *Right:* A zoom-in $45'' \times 45''$ square region centered on the cluster. The solid black circle shows the $0.05'$ core radius.

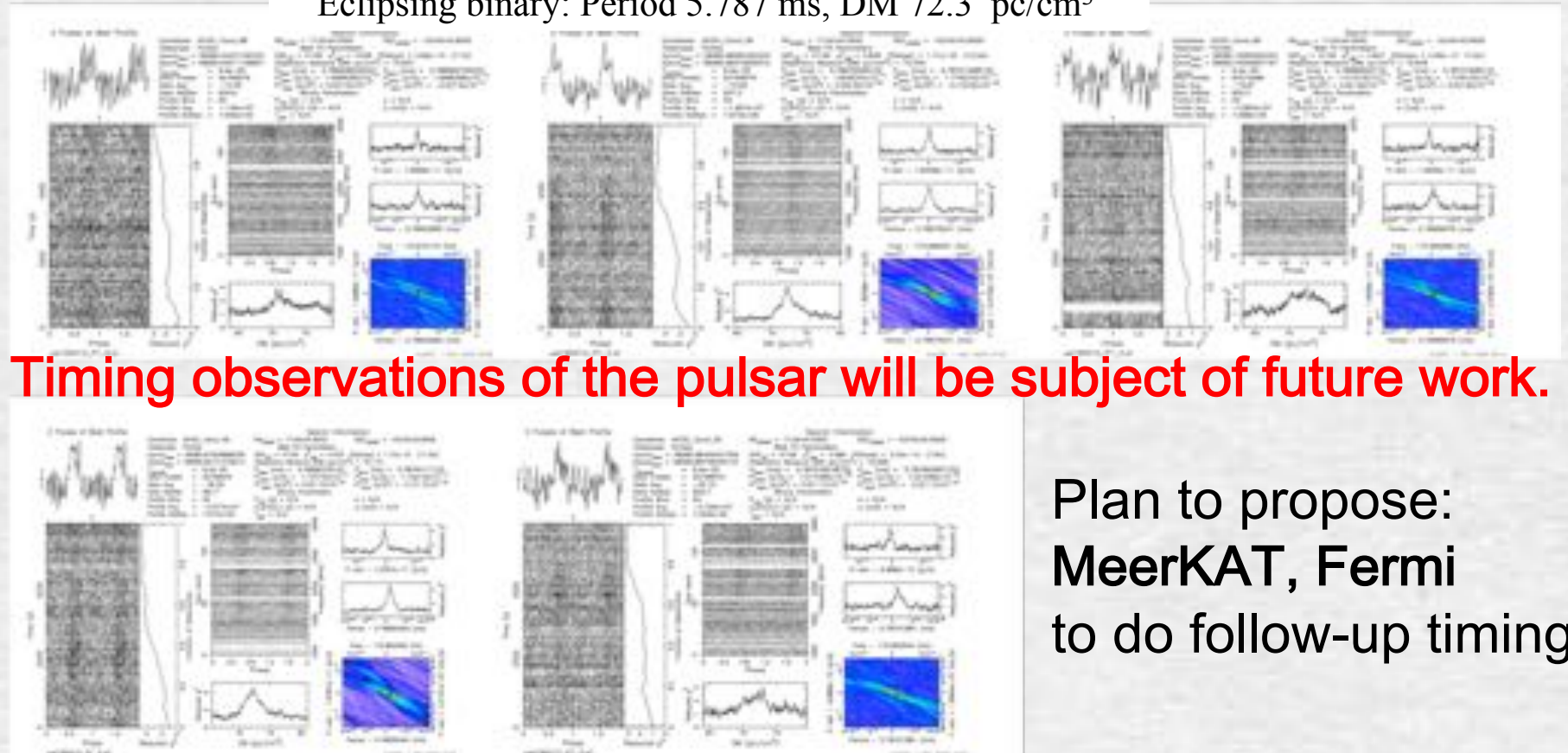
- FAST single pulse study for PSR J1926-0652
- Parkes globular cluster pulsar study with UWL receiver

3

Discovery of the “hidden” MSP in the NGC 6397?

The new MSP discovered with Parkes UWL receiver

Eclipsing binary: Period 5.787 ms, DM 72.3 pc/cm³



Timing observations of the pulsar will be subject of future work.

Plan to propose:
MeerKAT, Fermi
to do follow-up timing.

Figure. The discovery diagnostic plot of the new MSP in the NGC 6397 out of six 1.7 hour time blocks PRESTO accelsearch. (Zhang et al, 2020, in prepare)

- FAST single pulse study for PSR J1926-0652

- Parkes globular cluster pulsar study with UWL receiver

A summary

"This is a nice, straightforward paper that shows the power of the new ultra-wideband receiver at Parkes for pulsar observations. There have never been observations like this before, and it is great to see some early results come out on these globular cluster pulsars."

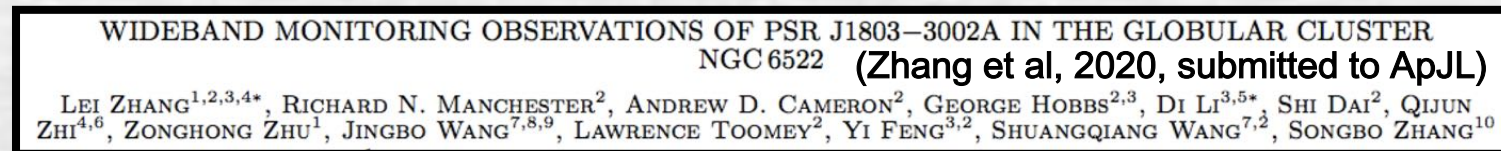
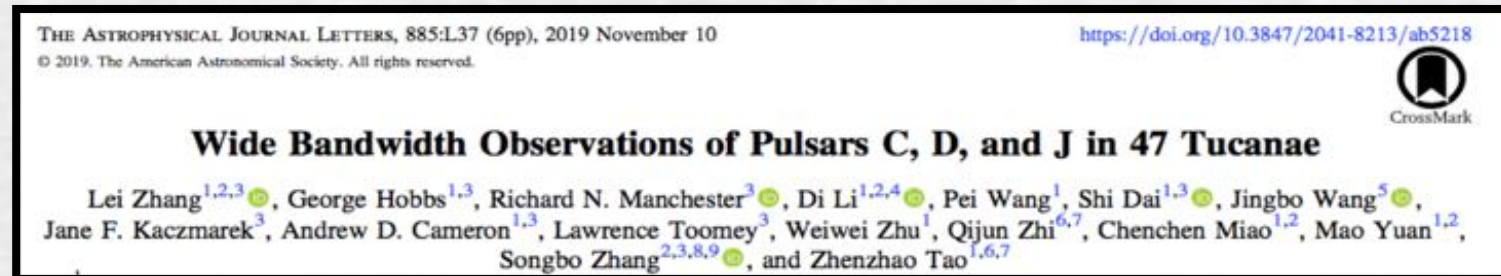
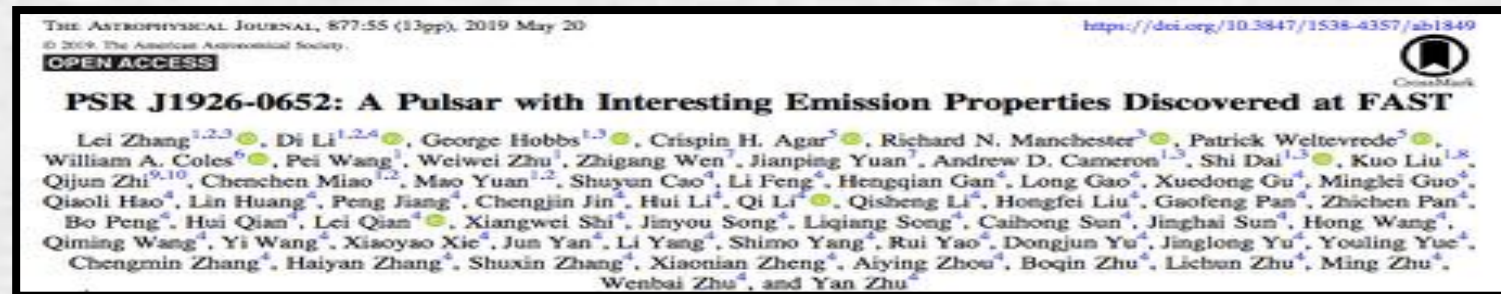
-- Comments for Zhang et al. (2019, ApJL) from Reviewer Scott Ransom



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Conclusion

A joint study with FAST and Parkes provide significant capability to study radio pulsars. Main results to today:



- An New Eclipsing Binary MSP in NGC6397
(Zhang et al, 2020, in prep.)

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Future work



THANK YOU

- FAST single pulse study for PSR J1926-0652
- Parkes globular cluster pulsar study with UWL receiver