

# FAST Globular Cluster Pulsar Survey



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# What are GCs



M3 – 4+2 psr



M4 – 1 psr



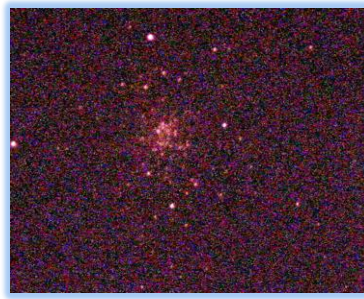
M5 – 5+2 psr



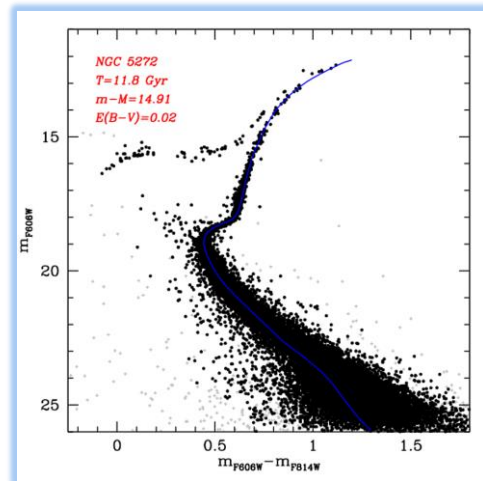
M13 – 6+1 psr



M80 – 0 psr



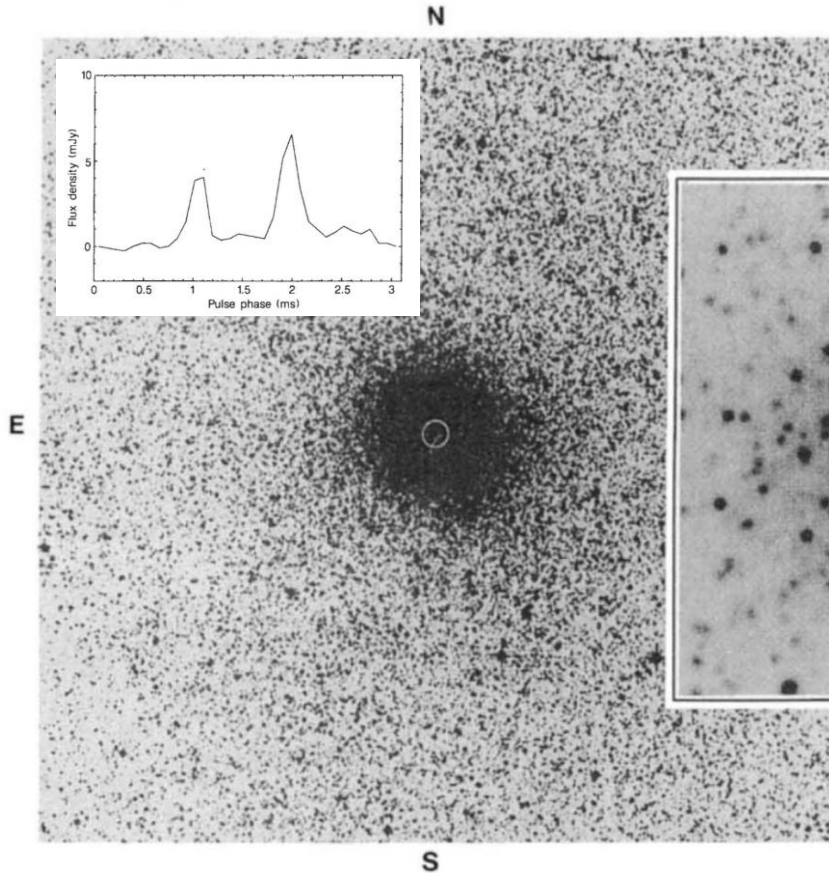
M107 – 0 psr



M3 11.8 Gyr

[https://people.smp.uq.edu.au/HolgerBaumgardt/globular/fits/phot/ngc5272\\_cmd.gif](https://people.smp.uq.edu.au/HolgerBaumgardt/globular/fits/phot/ngc5272_cmd.gif)

# The First GC Pulsar Discovery



M28A

3.054 ms, 120 (+/-1) pc cm<sup>-3</sup>

Isolated MSP

**Lyne et al. 1987, Nature**

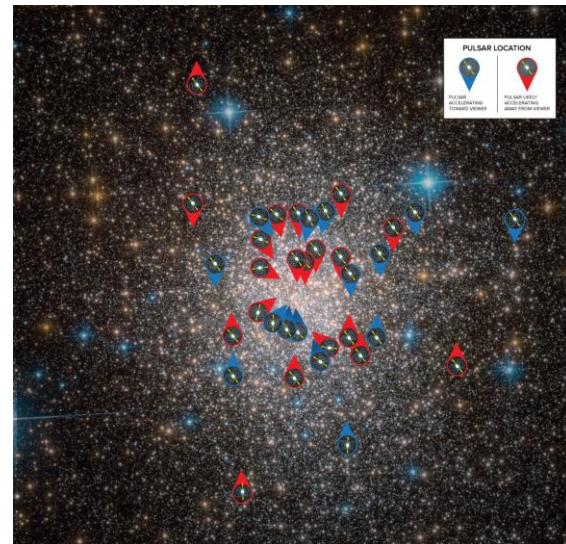
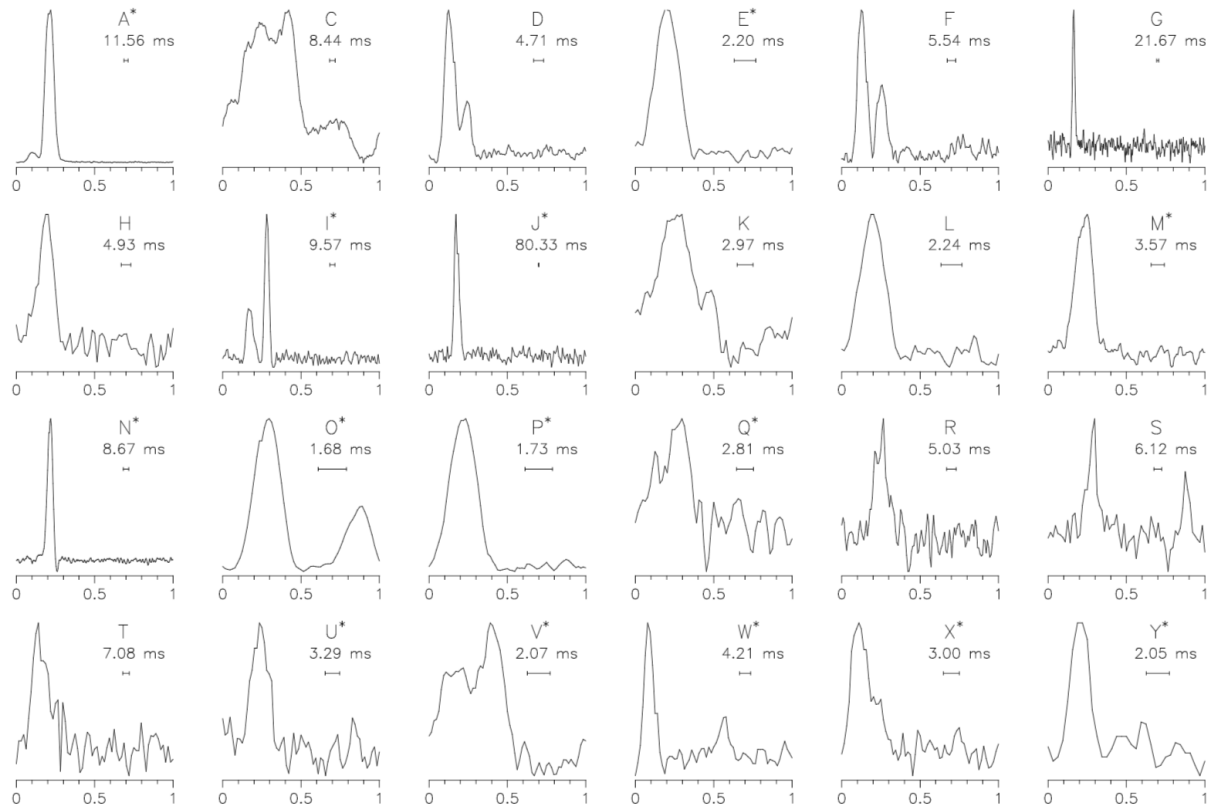
Now, there are 14 pulsars in M28  
ranging 119-123 pc cm<sup>-3</sup>, including:  
10 binaries

1 young pulsar

2 redbacks

5 black widows

# Terzan 5, the jackpot of GBT



Now, there are 39 pulsars in Terzan 5 (the GC with most pulsars). 20 binaries and 19 isolated.

# GCs in FAST Sky

45 GCs in FAST sky, 13 have 33 PSRs  
**21 GCs out of Arecibo sky, 2 have 5 PSRs**

Closest:

NGC6366, 3.5 kpc, no PSR

M71, 4.0 kpc, **1 PSR**

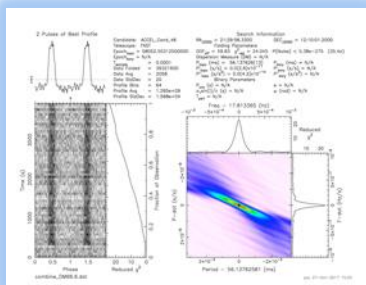
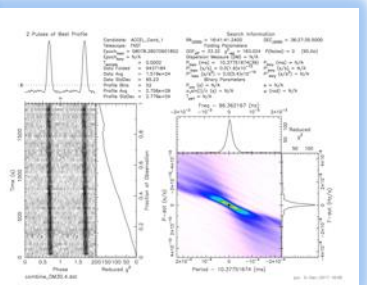
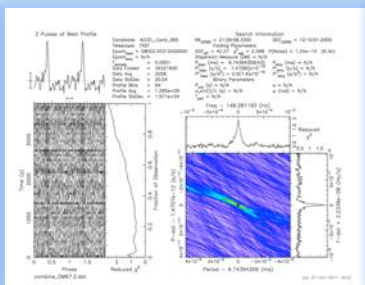
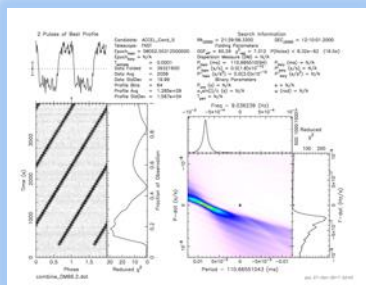
Farthest:

Palomar 4, 108.7 kpc, no PSR

M53, 17.9 kpc, **1 PSR**



Credit: FAST Office



# Pulsar M92A Eclipsing

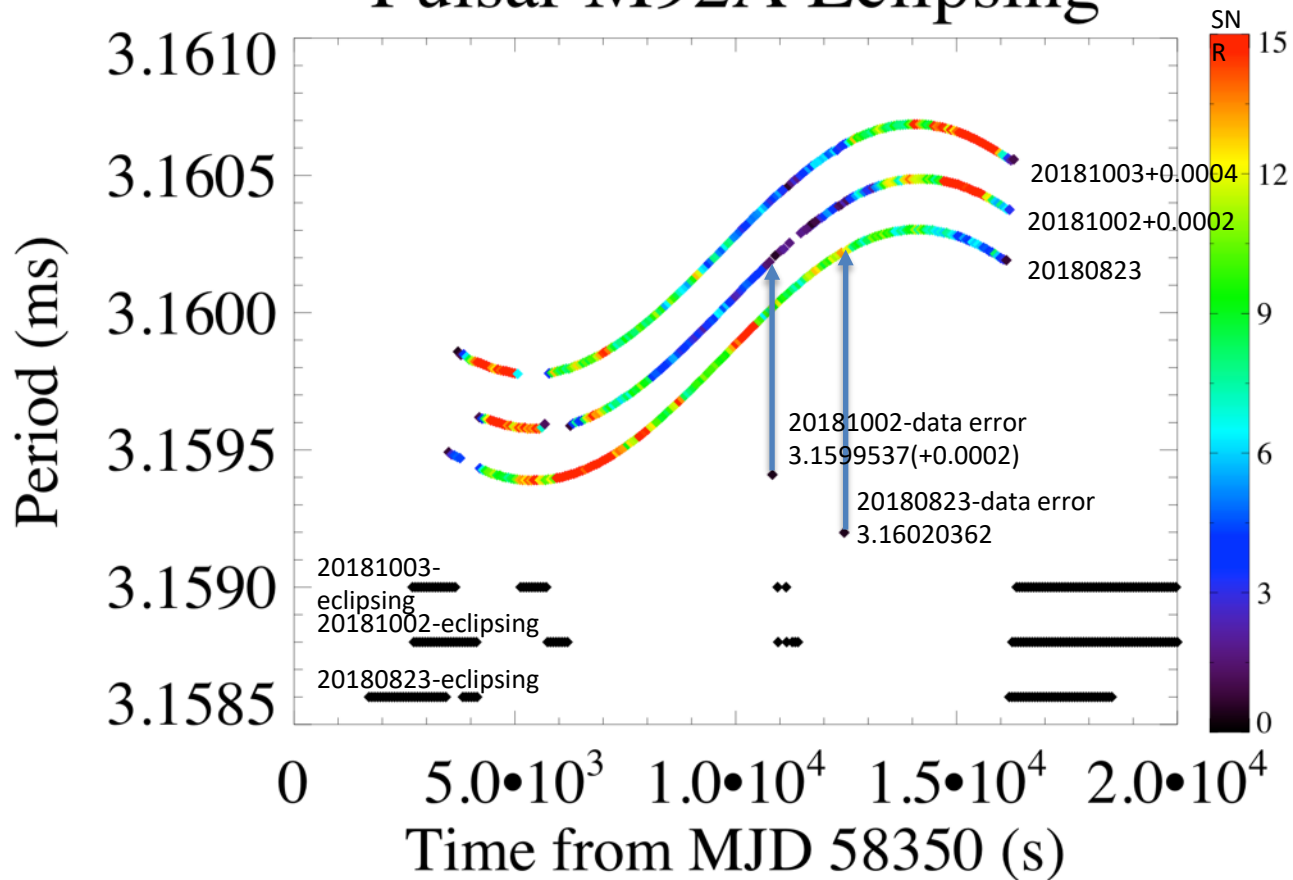
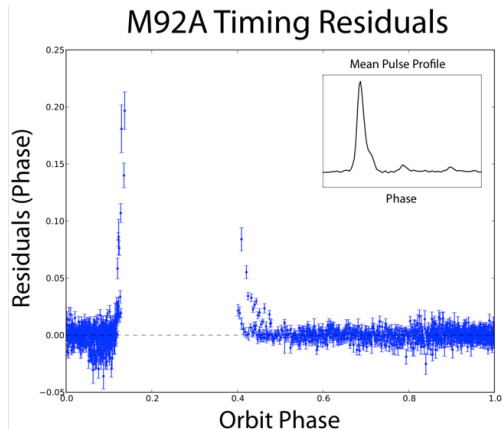
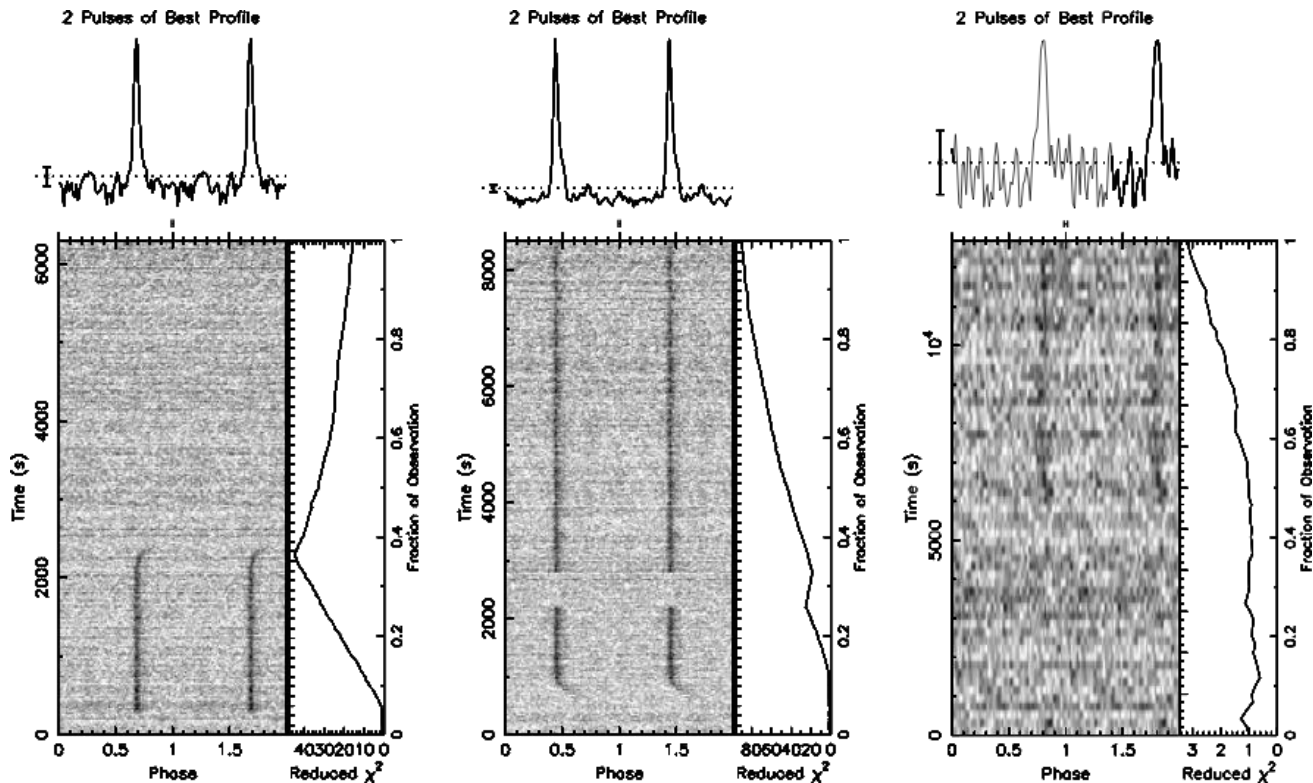


Table 1: Parameters for M92A

Fit and Data-set	
Pulsar Name	M92A, PSR J1717+4308
MJD Range	58351-58771
Data Span (days)	420
Number of TOAs	1197
Timing Residual ( $\mu$ s)	16.8
Measured Quantities	
RA (hh:mm:ss)	17:17:06.5099(6)
DEC (dd:mm:ss)	+43:08:00.492(2)
F0 (Hz)	316.4836871196(3)
F1 ( $10^{-15} \text{ s}^{-2}$ )	1.00(1)
Binary Model	BT
PB (days)	0.2008678691(4)
A1 (light second)	0.398708(1)
T0 (MJD)	58353.54908195(6)
ECC	0
OM	0

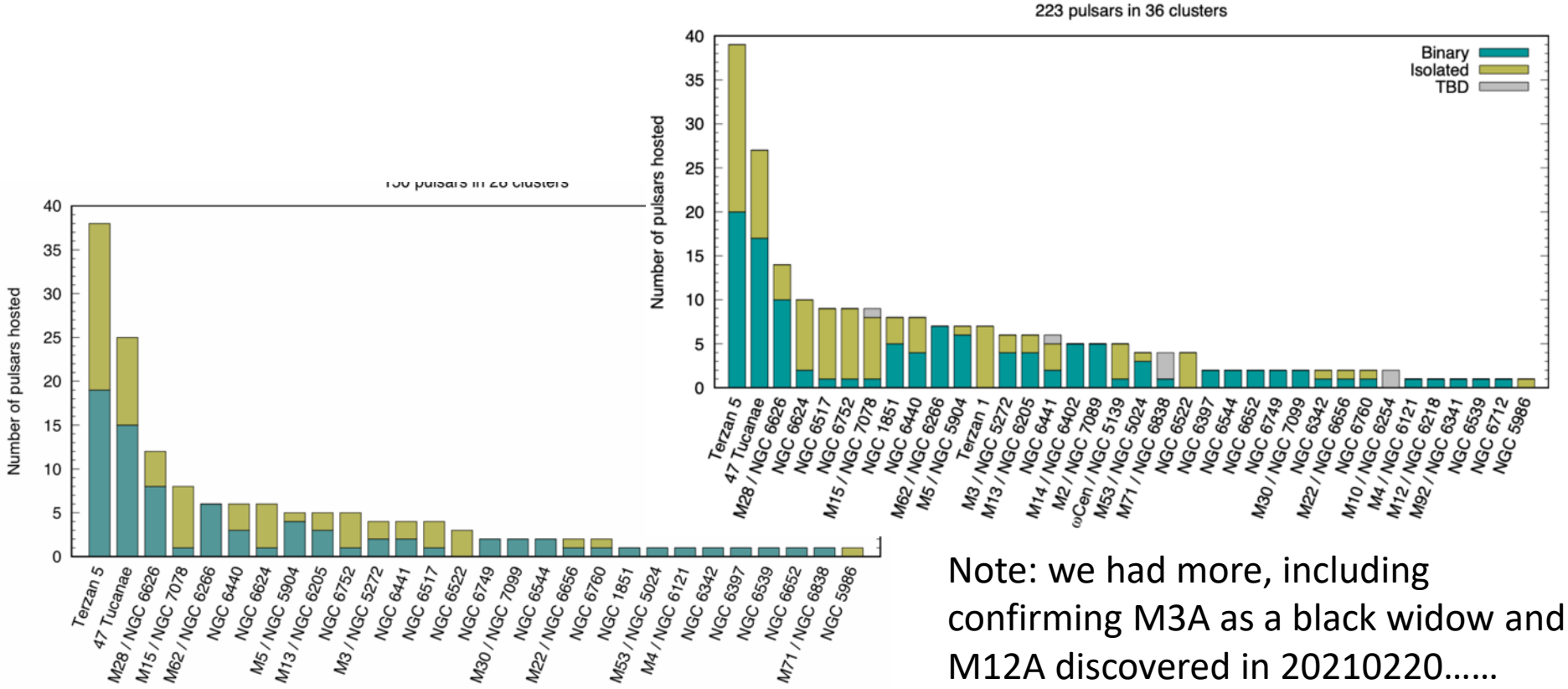


# Sensitivity: FAST (300 m) vs GBT (100 m)



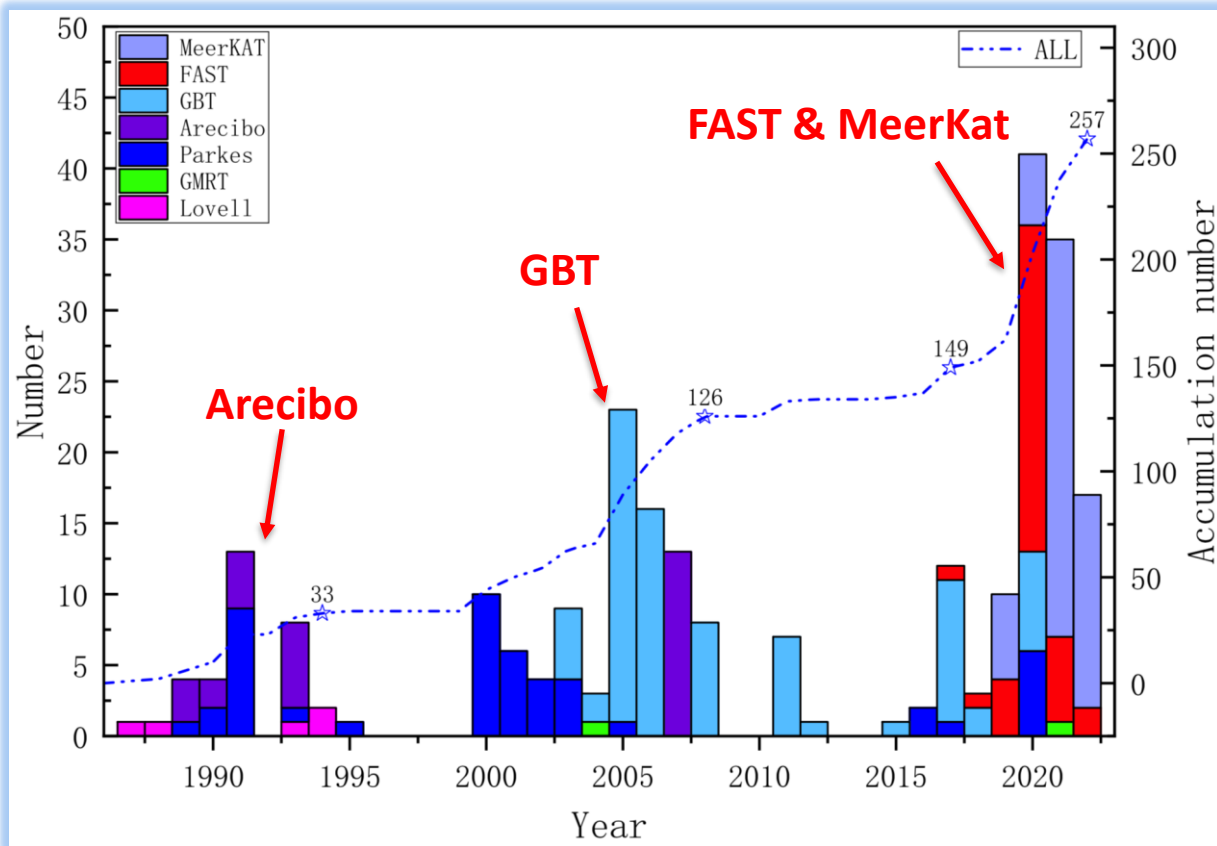
# Jackpot at FAST!

## 23 GC Pulsar Discovered in 2 Month





# GC Pulsar Discoveries



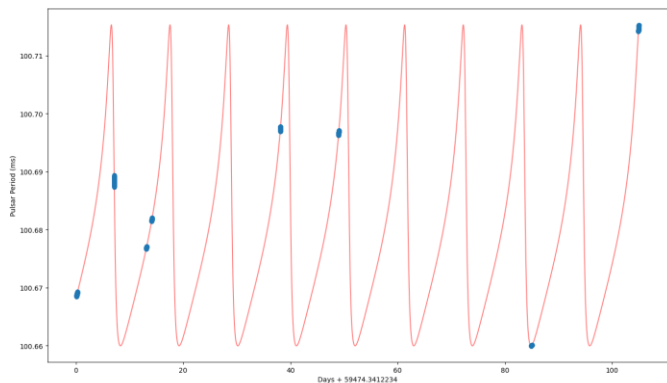
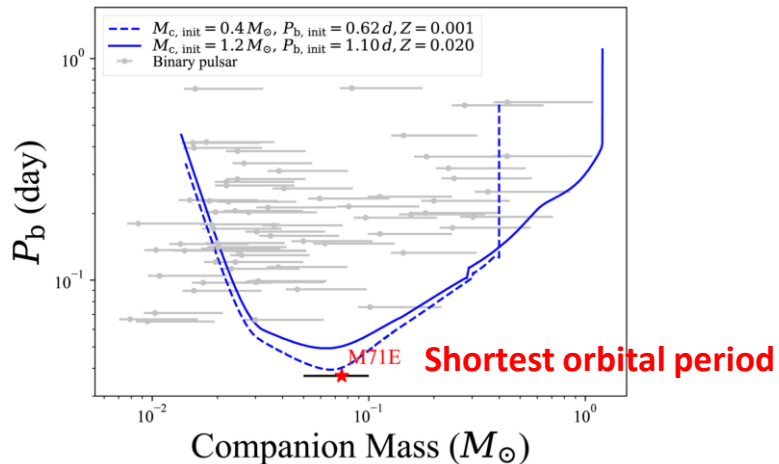
Parkes: 48 (47 Tuc: 25)  
 Arecibo: 28  
 GBT: 81 (Terzan 5: 38)  
 MeerKAT: 43  
 Others (GMRT + Lovell): 7

**FAST: 40+ pulsars**

Till 2022.7, 257 pulsars in 36 GCs

Yin et al. RAA accepted

# Studies from GC Pulsars



NOVA Research highlights from the journals of the American Astronomical Society

Pulsar Discovery from an Enormous Telescope

By Susanna Kohler on 17 April 2020

The 300-m FAST radio dish, built in a natural sinkhole in Guizhou, China, has discovered a new pulsar in the Globular Cluster M71.

HIGHLIGHTS

14 July 2021 **FEATURES**

**FAST Discovery of New Distant Pulsars**

The largest filled-aperture radio telescope in the world has discovered a new assortment of distant, pulsating neutron stars.

13 July 2021 **ASTROBITES**

**The Von Trapp Family Planets: A Sixth Planet Confirmed for...**

Astrobitis reports on the discovery of K2-138g, another sub-Neptune in K2's most harmonious system.

12 July 2021 **IMAGES**

**Featured Image: Do Planets Make Only Puffy Gaps?**

In the simulated cross-section of a protoplanetary disk shown here, dust swirls around as a consequence of the recent passage of an orbiting planet.

9 July 2021 **FEATURES**

**Science with a Single Merger Event**

Future gravitational-wave observatories could enable us to use a single binary neutron star merger to measure the universe's rate of expansion.

7 July 2021 **FEATURES**

**Connecting the Pieces of a Black Hole Temper Tantrum**

Recent observations shed light on a dramatic outburst from a black hole X-ray binary.

EurekaAlert!

NEWS RELEASE 24-APR-2020

**An eclipsing binary millisecond pulsar discovered by FAST**

CHINESE ACADEMY OF SCIENCES HEADQUARTERS

Using the data obtained by the Five-hundred-meter Aperture Spherical radio Telescope (FAST), a research team led by Prof. PAN Zhichen and Prof. LI Di from the National Astronomical Observatories of the Chinese Academy of Sciences (NAOCS) discovered an eclipsing binary millisecond pulsar in Globular Cluster (GC) Messier 92 (M92).

Named as PSR J1717+4307A or M92A, it is the first pulsar known in M92, with a spinning period of 3.16 ms and a dispersion measure (DM) of 35.45 pc cm<sup>-3</sup>. Follow-up observations showed that this binary system is in a circular orbit with an orbital period of 0.2 day and a radius of 120 thousand kilometers. The companion is a 0.18 solar mass star, evolving to be a sub-giant.

Due to the compactness of the orbit, materials from the companion are being swallowed by the pulsar. Such a binary system is nicknamed a "feedback spider." Like this type spider that the

JOURNAL: *Astronomical Journal Letters*

KEYWORDS: **PULSAR** **ASTROPHYSICS** **SPACELANDMARK NEWS SERVICE**

MULTIMEDIA

An image of GC M92 with the Pulsar M92A Embedded in the Dense Core (IMAGE)

# FAST Globular Cluster Pulsar Survey

Thank You!

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