

Millisecond Pulsars in 47 Tucanae

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Abstract. Recent observations of the globular cluster 47 Tuc, made with the Parkes telescope at a wavelength of 20 cm, have resulted in the discovery of nine new millisecond pulsars (MSPs), all in binary systems. The number of timing solutions available has risen from two to 14. These results will make possible a more detailed study of the cluster dynamics.

Table 1. The 20 pulsars known in 47 Tuc. The solutions are based on data taken between August 1997 and July 1999. R_c is the pulsar's projected distance to the cluster centre in units of r_c , the core radius (12.2''). Asterisks denote binary pulsars.

Pulsar	Period (ms)	P ($\times 10^{-20}$)	Dispersion measure ($\text{cm}^{-3} \text{pc}$)	R_c (r_c)
Previously known pulsars				
C	5.75678	-4.99(1)	24.60(1)	5.9
D	5.35757	-0.28(1)	24.72(2)	3.4
E	3.53633*	9.860(8)	24.24(2)	3.3
F	2.62358	6.459(6)	24.39(2)	0.8
G	4.04039	-4.21(3)	24.5(1)	1.4
H	3.21034*	-0.17(1)	24.4(1)	3.7
I	3.48499*	-4.58(3)	24.5(1)	1.4
J	2.10063*	-0.976(1)	24.59(2)	4.8
L	4.34618	-12.23(2)	24.4(1)	0.7
M	3.67664	-3.83(5)	24.4(2)	5.2
N	3.05395	-2.18(9)	24.57(3)	2.4
Newly discovered pulsars				
O	2.64334*	2.99(2)	24.4(1)	0.3
P	3.64302*	...	24.4(2)	...
Q	4.03318*	3.43(3)	24.3(1)	4.8
R	3.48046*	...	24.3(2)	...
S	2.830*	...	24.3(2)	...
T	7.589*	...	24.4(1)	...
U	4.34283*	9.47(4)	24.3(1)	4.6
V	4.81*	...	24.2(1)	...
W	2.35234*	...	24.4(2)	...

1. Pulsar searching

The cluster 47 Tucanae (47 Tuc) was long known to contain 11 MSPs, with four of them in binary systems (Robinson et al. 1995). In 20 cm observations made since 1997 at Parkes, we have detected all the previously known pulsars and discovered nine new MSPs, 47 Tuc O–W, all of which are in binary systems. Of

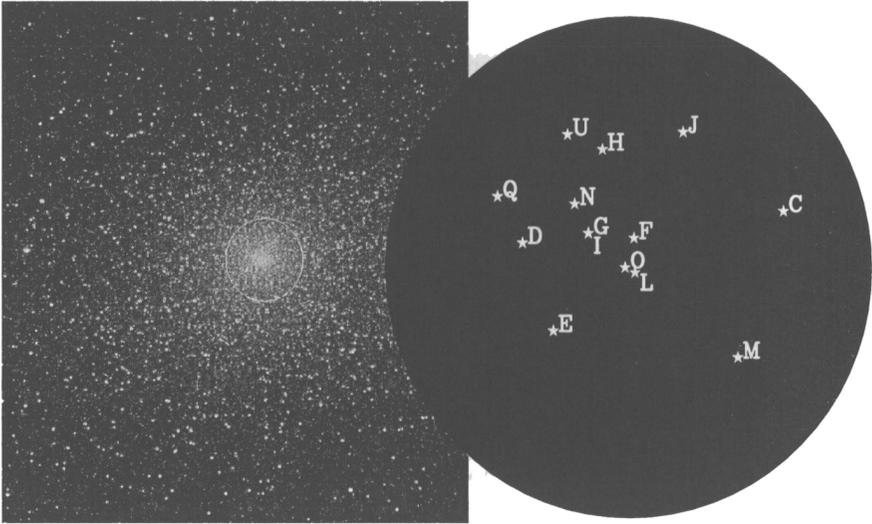


Figure 1. Positions of 14 pulsars near the core of 47 Tuc. The circle has a radius of 100 arcseconds.

these, 47 Tuc R has the shortest orbital period for any radio pulsar (96 minutes). For details on the search, orbital parameters, pulse profiles, and luminosities, see Camilo et al. (2000).

2. Pulsar timing

The frequent detections of 14 pulsars allowed the determination of 12 new coherent timing solutions, and the confirmation of the two previously known. All pulsars lie in a circle of 1.5 arcmin about the centre of the cluster (see Fig. 1). Nine pulsars out of 14 have negative period derivatives (see Table 1), indicating that they are accelerating towards the Earth in the cluster's gravitational potential, which can thus be probed in some detail. The number of pulsars with projected distance from the centre of the cluster smaller than R_{\perp} is proportional to R_{\perp} . This is typical of an isothermal distribution. According to Phinney (1992) this indicates neutron stars are the dominating mass species in the core of 47 Tuc.

References

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