Recent Cluster Pulsar Results from Caltech

Search Effort

Goal:
- Find new pulsars in rich galactic bulge globular clusters using 100 m Green Bank Telescope.
- Installed and integrated Berkeley-Caltech Pulsar Machine (96 channel digital filterbank) at GBT for search backend.
- Observed seven clusters at 1.4 GHz for about 6 hours each: NGC 6642, NGC 6266 (M62), NGC 6624, NGC 6544, NGC 6522, NGC 6440, NGC 6293.

With: Adam Chandler, Don Backer (Berkeley), Stuart Anderson, Shri Kulkarni
Dynamic Power Spectrum Technique

- Divide observation into several sub-integrations and compute power spectrum for each.
- Find bins with locally significant excess power.
- Search adjacent power spectra for excess power in bins within some pre-determined acceleration range.
- Allows candidates to be identified even when excess power in a given bin is not globally significant.
- Sensitive and efficient for orbital periods comparable to the observation length.

Dynamic Power Spectrum Examples

[Graphs and images related to power spectrum examples]
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Three New Pulsars in M62

M62 D, E

Image courtesy of NRAO/AUI and the Second Digital Sky Survey, copyright (c) AAO and AURA
<table>
<thead>
<tr>
<th>Name</th>
<th>$P_b$ (ms)</th>
<th>$a \sin i$ (ls)</th>
<th>$M_C$ (M$_\odot$)</th>
<th>$M_{\text{min}}$ (M$_\odot$)</th>
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<tbody>
<tr>
<td>J1701-3006A</td>
<td>5.241</td>
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New Millisecond Pulsar in NGC 6544

NGC 6544B, $P = 4.186$ ms

NGC 6544 Pulsars

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<tr>
<th>Name</th>
<th>$P_b$</th>
<th>$\alpha \sin i$</th>
<th>DM</th>
<th>(days)</th>
<th>(ls)</th>
<th>$\omega$</th>
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<td>134</td>
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<td>A' D'Amico et al. 2001</td>
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New Slow Pulsar in NGC 6624

NGC 6624C, $P = 405.9$ ms

NGC 6624 Pulsars

<table>
<thead>
<tr>
<th>Name</th>
<th>Period (ms)</th>
<th>DM (pc cm$^{-3}$)</th>
<th>$P_b$ (days)</th>
<th>$a \sin i$ (ls)</th>
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</thead>
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<tr>
<td>B1820-30B</td>
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<td>B1820-30C</td>
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<td>87</td>
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</table>

A, B: Biggs et al. 1994

Also contains LMXB 4U 1820-30.
NGC 6624 A, B, C Pulse Profiles

Slow Pulsars in Globular Clusters?

There are only 4 known cluster pulsars with $P > 200$ ms, and two of them are in NGC 6624! (See Lyne et al. 1996 and references therein for discussion of origin.)

- Could be from AIC or old pulsars with newly captured companions, but where did the companions go?
- More likely scenario is collision between old neutron star and non-degenerate star.
- Brief common envelope phase, then companion is disrupted.
- Accretion disk results, pulsar is mildly recycled.
In the near future...

- Complete timing analysis of new M62 pulsars (positions, cluster dynamics, etc).
- Completion of search analysis for remaining clusters.
- Hopefully more new pulsar discoveries!

References