

Blind Searches for γ -ray Pulsars in 2 years of *Fermi* LAT data



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Summary: We present the results of a targeted search for new γ -ray pulsars in the Fermi LAT First Source Catalog (1FGL), using two years of LAT data. Searching ~ 100 LAT sources, we discovered two new pulsars.

Introduction

The Large Area Telescope (LAT, [1]) has been scanning the sky in survey mode since August 2008. For pulsar science, the LAT represents a giant leap compared to the previous-generation EGRET experiment. Not only is the number of pulsars detected by the LAT over an order of magnitude larger, but the hugely improved sensitivity of the LAT means that we are now able to discover new pulsars in gamma rays, without the aid of radio (or X-ray) telescopes. This opens up the possibility of uncovering new populations of pulsars not detectable at other wavelengths. Radio-quiet pulsars were known to exist since the discovery of Geminga, but predictions for the so-called Geminga fraction varied widely, depending on the assumptions about the γ -ray emission models. Establishing this fraction therefore places constraints on γ -ray emission models. A large Geminga fraction favors outer-magnetosphere models in which the γ -ray beams are broader than in polar-cap-type models. For more details on LAT γ -ray pulsars, see David Smith's talk this Thursday.

Blind Searches of Fermi LAT data

Despite its sensitivity, the LAT detects a relatively small number of γ -ray photons (e.g. < 1 photon per 1000 rotations for Vela, the brightest γ -ray source). To lessen the impact of the long integrations required for blind searches of γ -ray pulsars, the "time-differencing" technique [2] was developed, in which FFTs are computed on the time differences (up to a maximum time window) of events, rather than the times themselves. 24 new pulsars have been discovered with this technique [3, 4]. For this search, we selected ~ 100 unassociated sources from the 1FGL catalog, based on their pulsar-like (spectral and variability) qualities and source significance in 1FGL ($> 8\sigma$). We used the improved positions of LAT sources from an internal 18-month catalog and searched for pulsations using ~ 2 years of data and a time-differencing window of ~ 6 days. Our searches resulted in the discovery of two new (radio-quiet) γ -ray pulsars: the middle-aged PSR J0734-1559 and the younger, more energetic PSR J1135-6055 powering PWN G293.8+0.6.

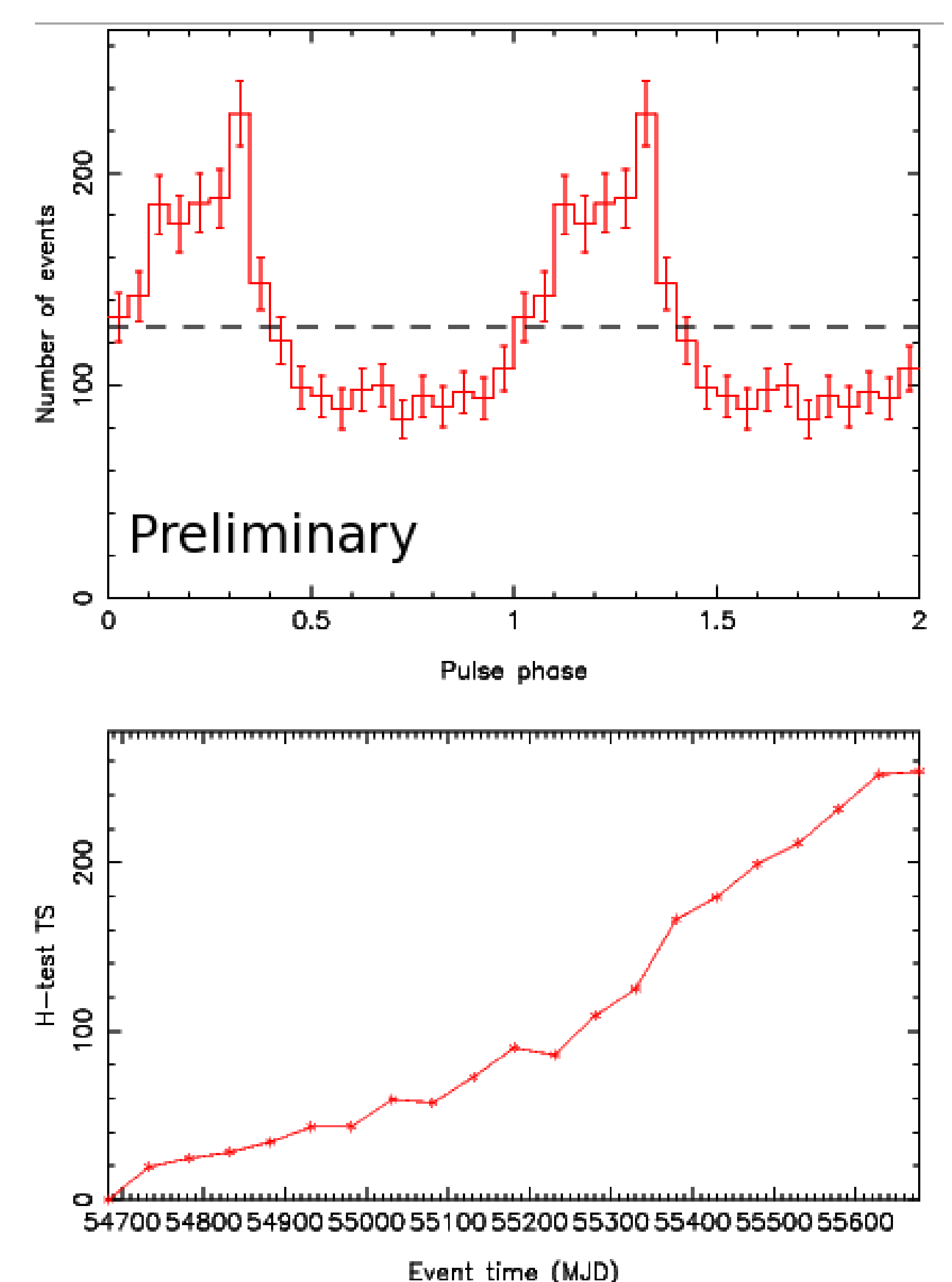
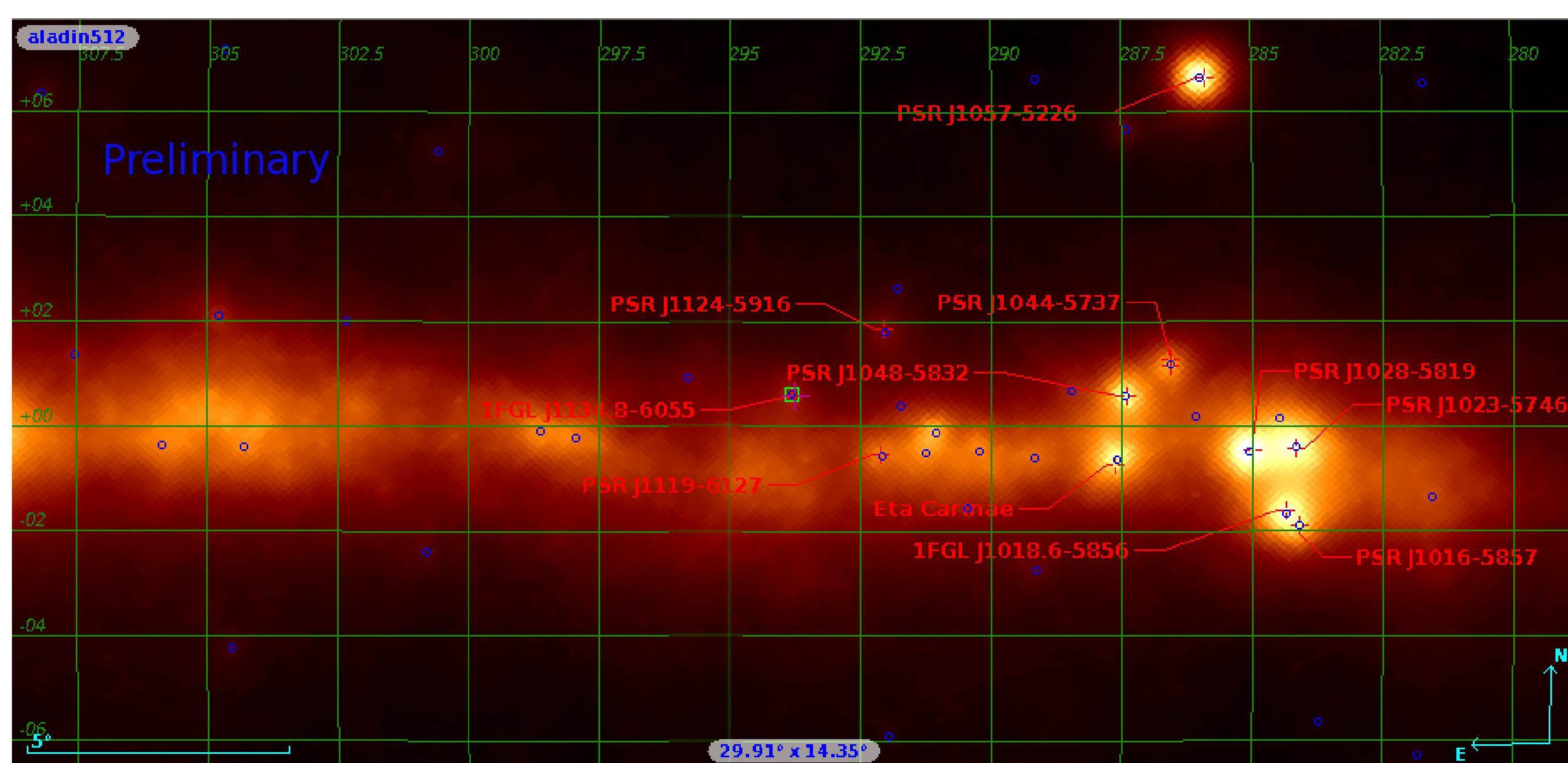


Figure 1: Preliminary pulse profile of the newly-discovered PSR J1135-6055.

PSR J1135-6055, in the Carina region of the Galactic plane



The image shows the region, in γ -rays around PSR J1135-6055. This previously-unassociated source (1FGL J1134.8-6055) is near the Carina region, surrounded by many γ -ray pulsars and other interesting sources, like Eta Carinae, and the newly-discovered binary 1FGL J1018.6-5856 (see talk by Robin Corbet).

PSR J0734-1559

- ▶ LAT source: 1FGL J0734.7-1557
- ▶ $F_0=6.4$ Hz, $F_1=-5.0 \times 10^{-13}$ Hz s⁻¹
- ▶ $\tau \sim 2 \times 10^5$ yr, $\dot{E} \sim 1 \times 10^{35}$ erg s⁻¹
- ▶ No radio pulsations (see talk by Paul Ray)

PSR J1135-6055

- ▶ LAT source: 1FGL J1134.8-6055
- ▶ $F_0=8.7$ Hz, $F_1=-6.0 \times 10^{-12}$ Hz s⁻¹
- ▶ $\tau \sim 2 \times 10^4$ yr, $\dot{E} \sim 2 \times 10^{36}$ erg s⁻¹
- ▶ Powering PWN G293.8+0.6 (see talk by Andrea De Luca)

Conclusions

Using the time-differencing technique [2], we ran blind searches for pulsars using 2 years of data at the positions of ~ 100 promising LAT unassociated sources from the 1FGL catalog [5]. We discovered two new γ -ray pulsars, PSR J0734-1559 and PSR J1135-6055, both of which show no evidence for radio pulsations, despite deep searches at the GBT and Parkes, respectively. PSR J0734-1559 is a middle-aged pulsar, slightly off the Galactic plane, while PSR J1135-6055 is a young, energetic pulsar located in the Carina region of the Galactic plane, and likely powering the PWN G293.8+0.6. The discovery of these latest two pulsars, in addition to the previously-reported 24 [3, 4], brings the total number of pulsars discovered in blind searches by the LAT to 26, of which 23 remain radio quiet.

References

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- [5] Abdo, A. A. et al., *Fermi Large Area Telescope First Source Catalog*, ApJS, 188, 405 (2010)