The Motivation for GLAST Periodicity Searches

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If the outer gap model for pulsar γ-ray emission pertains, it is expected that the γ-ray emission of pulsars is beamed into a much broader pattern than the radio emission. Romani and Yadigaroglu (1995, ApJ **438**, 314) calculate that a large number of γ-ray pulsars, in fact 2.5$\times$ the number of radio-selected γ-ray pulsars, will be detected *only* at high energies. This implies that $\sim$10 of the unidentified EGRET sources are Geminga type sources, i.e. gamma-ray pulsars without detectable radio emission.

Mattox et al. (1996 A&A S, **120**, C95) used a super-computer at Caltech to compute Gigapoint power spectra for unidentified EGRET sources in search of periodicity. Multiple frequency derivatives were searched by accelerating event times before computing the Fourier transform. Figure 1 demonstrates that such a search detects the pulsation of the radio-quiet pulsar Geminga with 10^{-12} significance directly from 6 days of EGRET data. No significanct periodicity was detected for the remaining unidentified EGRET sources. Because the EGRET data for these sources provide only marginal signal to noise to support a periodicity search, the periodicity upper limits are consistent with plausible harmonic content.

The GLAST mission will provide the exciting opportunity to detect $\sim$50 radio-quiet pulsars directly from the GLAST data using this technique (if the outer gap model pertains). These detections would be of great utility in understanding pulsar magnetospheres. They will also be useful for a better understanding of the total number of neutron stars and the occurrence rate of super novae.

The GLAST software requirements for periodicity searches are described on a subsequent viewgraph.

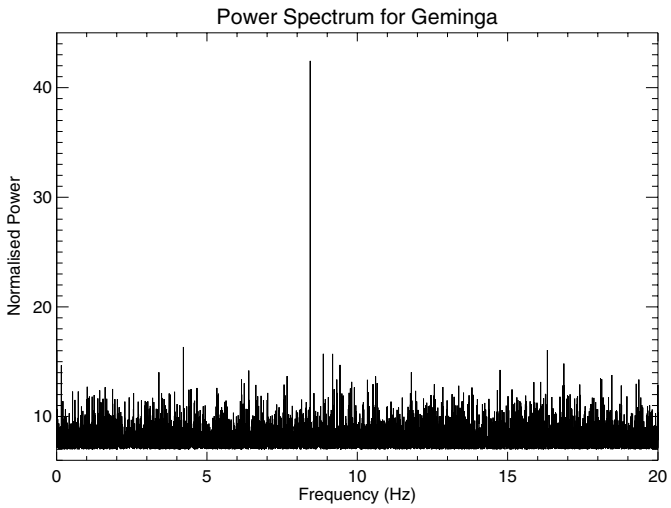

Fig. 1.— The power spectrum from an FFT of 2^{28} time bins for the first 6 days of the EGRET viewing period 1.0 observation of Geminga. The spectrum has been normalized by the average power, so that the power shown here multiplied by 2 is expected to be distributed as χ^2_2 in the absence of periodicity. The Geminga pulsar rotation frequency and its 2nd and 4th harmonics are readily apparent at 4.2, 8.4, and 16.9 Hz. The power of the 2nd harmonic dominates because of the shape of the light curve — two nearly equal peaks separated by $\sim$180°. This power spectrum is for unaccelerated event times — the frequency deriviative of Geminga is small.