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Unpulsed Optical Emission from the Crab Pulsar

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Abstract.

Using the high speed 2-d TRIFFID photometer, we have obtained phase resolved photometry of the Crab pulsar in UBV that allows us to flux the unpulsed light curve component. Following de-extinction, weighted least-square fitting indicates a power-law exponent of α = -0.62 $\pm$ 0.49. This is steeper than that reported for the peak components and its origin remains unclear with respect to contemporary magnetospheric theory.

1. Introduction

Optically to date phase-resolved observations of the Crab pulsar have been restricted to rudimentary 2-d or single pixel photometers, with variable temporal accuracy. Successes worthy of note include the detection of an unpulsed component by Peterson et al. (1978), and strong polarisation behaviour as a function of phase - most especially for this same unpulsed component (Smith et al. 1988). True characterisation of this interesting feature requires multi-band high speed 2-d photometry at μsec resolution, allowing for the acquisition of accurate phase-resolved photometry. We outline an analysis of such observations made of the Crab pulsar using the TRIFFID high speed photometer (Golden & Shearer, 1999).

2. Technical & Analytical Overview

The TRIFFID camera incorporating a MAMA detector was used to observe the Crab pulsar over 5 nights in January 1996 on the 6m telescope in the Russian Caucasus. Using the Jodrell Crab Ephemeris (Lyne & Pritchard, 1996), photons within specific phase regions were selected to produce a sequence of phase-resolved images over the pulsar's light curve. Figure 1 shows such a sequence, and confirms the reported constant emission. Via standard image reduction techniques, the relative fluxes per light curve component per colour band were determined, and normalized to archival integrated estimates (Percival et al. 1993). Flux components per colour band are plotted in Figure 1, and

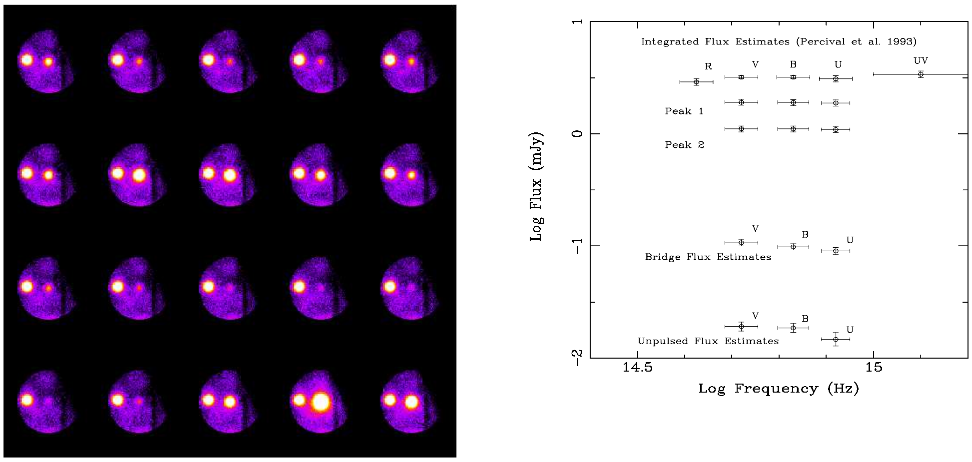

Figure 1. **Left:** Mosaic image of one full cycle of the Crab pulsar, via phase-resolved photometric analysis. The light curve moves from top left to bottom right. Note the 'on' emission throughout. **Right:** Integrated de-extincted flux estimates for the Crab from Percival et al. 1993 and the derived flux estimates for both the peaks, Bridge and unpulsed component of emission based on the TRIFFID datasets.

a weighted least squares fit to the unpulsed components indicate a power-law exponent of -0.6 $\pm$ 0.4, the reference integrated photometry contributing most of the associated error.

3. Discussion & Conclusions

We have resolved constant emission from the 'off' phase of the Crab light curve. Phenomenologically, the emission is nonthermal and *steeper* than that observed for the peaks, although similar to that of the bridge component. Whether it is directly related to the latter, or is a consequence of magnetospheric scattering is not clear. Further observations of this & the Vela pulsar may show evidence for a similar unpulsed component of emission, which as yet remains inexplicable in terms of contemporary high energy emission theory.

References

Golden, A. & Shearer, 1999, sub. ApJ.

Lyne A. & Pritchard R. S., 1996, Crab Timing Ephemeris, University of Manchester.

Percival, J.W., Biggs, J.D., Dolan, J.F., Robinson, E.L., Taylor, M.J., et al., 1993, ApJ, 407, 276.

Peterson, B.A., Murdin, P., et al., 1978, Nature, 276, 475.

Smith, F.G., Jones, D.H.P, Dick, J.S.B.,& Pike, C.D., 1988 MNRAS, 233, 305.