

OBSERVATIONS OF POTENTIAL ULTRA HIGH ENERGY γ -RAY SOURCES ABOVE 10^{15} eV

A. Lambert, J. Lloyd-Evans[†], J.C. Perrett, A.A. Watson and A.A. West
Department of Physics, University of Leeds, LEEDS 2, UK.

[†] Now at NASA/Goddard Space Flight Centre, USA.

The Haverah Park 50 m water-Cerenkov array (Lloyd-Evans et al 1983) has been used to examine a number of periodic sources for ultra high energy γ -ray emission above 10^{15} eV. The data, recorded between 1 Jan 1979 and 31 Dec 1984, feature a modest angular resolution of $\sim 3^\circ$ with milli-second arrival time resolution post 1982. The sources investigated include the Crab pulsar, Her X-1, 4U0115+63 and Geminga. All objects have been detected by workers in the TeV region, with varying degrees of confidence (e.g. Dowthwaite et al 1984 (a and b), Chadwick et al 1985, Zyskin and Mukanov 1984, respectively).

We have previously examined the Crab direction for a time-averaged signal, setting upper limits to the γ -ray flux (Lambert et al 1983) more than an order of magnitude lower than the persistent signal reported by the Lodz group (Dzikowski et al 1983).

It has been noted recently (Hillas and Wdowczyk, private communication) that the excess showers from the Crab observed at Lodz occur in a very narrow shower size interval $(1-1.58) \times 10^6$ particles. The latest analysis of the Haverah Park data makes use of recent simulations by Hillas (private communication) in relating the shower size parameter measured at Lodz to the water-Cerenkov density parameter measured at Haverah Park. During the 6 years operation of the 50 m array, with an efficiency $\sim 90\%$, we have observed 477 showers above 10^{15} eV in a $6^\circ \times 6^\circ$ (RA, δ) bin, centred on the Crab pulsar (whilst less than 40° from the zenith), constituting the 'on-source' count. The remaining RA portion of the declination strip yields an expected background count of 463.9 ± 2.8 , resulting in an insignificant on-source excess. The 95% upper limit to the flux enhancement from the Crab is $1.5 \times 10^{-13} \text{ cm}^{-2} \text{ s}^{-1}$ at energies, $E_\gamma > 10^{15}$ eV. This flux limit is of the same order as the flux measured by the Lodz group, at a factor ten higher in energy, i.e. $2 \times 10^{-13} \text{ cm}^{-2} \text{ s}^{-1}$ for $E_\gamma > 10^{16}$ eV (Dzikowski et al 1983). An analysis matching the Lodz shower size intervals and also an investigation at the pulsar frequency is in preparation.

The presentation at the conference will be used to discuss the results of a more complete analysis for the above sources (Lambert 1985, PhD Thesis in preparation).

Acknowledgements

We thank A M Hillas and J Wdowczyk for useful discussions and the Science and Engineering Research Council (UK) for continued support of work at Haverah Park.

References

- P.M. Chadwick et al 1985 submitted to Astronomy & Astrophysics.
J.C. Dowthwaite et al 1984(a) Ap J 286, L35.
J.C. Dowthwaite et al 1984(b) Nature 309, 691.
T. Dzikowski et al 1983 18th ICRC (Bangalore) 2, OG 4-22.
A. Lambert et al 1983 18th ICRC (Bangalore) 9, OG 4-28, 219.
J. Lloyd-Evans et al 1983 18th ICRC (Bangalore) 9, XG 4-24, 65.
Yu. L. Zyskin and D.B. Mukanov 1983 Soviet Astr. Lett. 9, 117.