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Introduction to Markarian 421 Special Session

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Markarian 421 (Mrk-421) was discovered by a PhD student in the process of validating his *Super-Cut* analysis scheme of the images from the Whipple telescope. He had chosen Mrk421 as his first trial by chance among other sets of data at his disposal.

Soon after, published by Nature (Punch 1992), this discovery was communicated by Trevor Weekes at the first workshop *Towards a Major Atmospheric Cherenkov Detector* in Palaiseau in 1992. After the Crab nebula had been detected by the Whipple group and confirmed by the Themistocle experiment shortly before the workshop, we had convened with his encouragement although he was reluctant about our choice of title, arguing that a new astronomy could not be founded on only one detected source. We, particle physicists, did not realize that the Crab - pulsar and nebula - was such an atypical object, the brightest in the sky at so many wave lengths. Happily enough, the advent of a second source, and an extragalactic one, was quite a happy omen for the workshop and, more importantly, for the field.

The second appearance of Mrk421 was no less traumatic. It occurred in the form of a very intense and fast flare which occurred while Eckart Lorentz and Tadashi Kifune and others were at Whipple. The data acquisition suddenly went wild, at a counting rate quite above that of the Crab and doubling its rate in a matter of a quarter of an hour. This is direct evidence of the compactness of the emitting region, probably at the basis of the jet (Gaidos 1996). This achievement is specific to the large collection area that ground based detectors permit. Space detectors, even the newcomers AGILE or GLAST will not be sensitive to time scales of less than an hour.

A third manifestation of the gentleness of Mrk421 to human observers (although not worshippers) is that it entered into an active flare prepared a hundred million years ago to be in time with the advent of the new Indian devices, in Mt-Abu and in Pachmari.

Mrk-421, as well as Mrk-501 seen by Whipple three years later (Quinn 1996), are among the highest energy *blazars* which we believe to be accreting super massive black holes of *active galactic nuclei (AGN)* having a relativistic jet (for a $\gamma_{Lorentz} \approx 10$) oriented towards us. The relativistic Doppler effect enhances the flux and the energy of the detected γ-rays while focussing the emission within a small angle ($\approx 1/\gamma_{Lorentz} \approx 0.1 radian \approx 5^o$). The photon energies are distributed over a broad double-peaked structure reasonably assumed to be (our personal bias) the synchrotron emission of an electron flow within a magnetised plasma followed by the effect of its inverse Compton collision, possibly upon their own synchrotron photons. The corresponding SED, the spectral energy distribution ($E^2[dN/dE] = EdN/dlogE$) is shown in Fig 1.

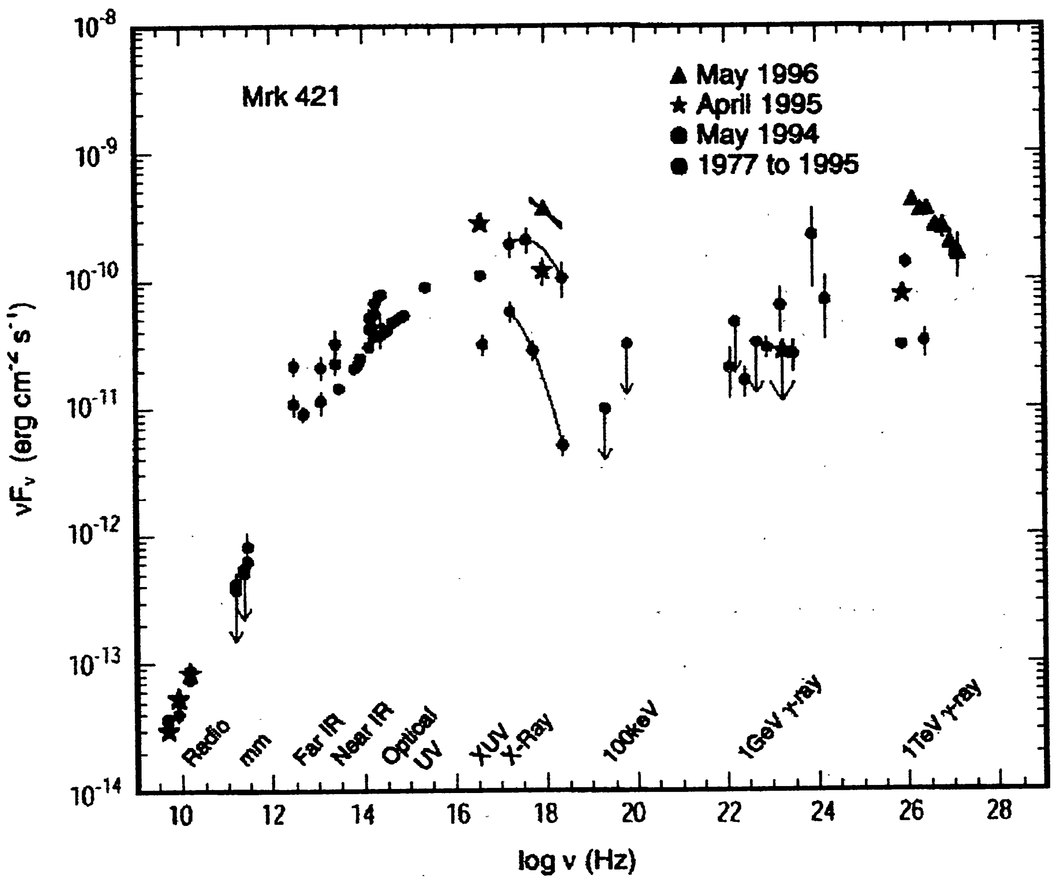

Figure 1. Spectral energy distribution of Mrk-421 (Compilation of data

Although most of the Mrk421 spectrum is at lower energy, its observation in the VHE domain is important :

- the maximum attainable energy is an important parameter for all jet models. In particular, the hardness of the spectrum, and its possible dependence upon the level of activity must be investigated. Fig.2 shows a compilation with a non conclusive indication of such a correlation;

- the absorption by the extragalactic diffuse infrared light must be investigated further (for the interest of both the blazar spectral shape and the infrared light intensity). Mrk501 is more adequate for this study since its emission probably extends to higher energies, but the cross study with Mrk421 is useful;

- γ-rays above the Cherenkov threshold open the way to fast variability studies.

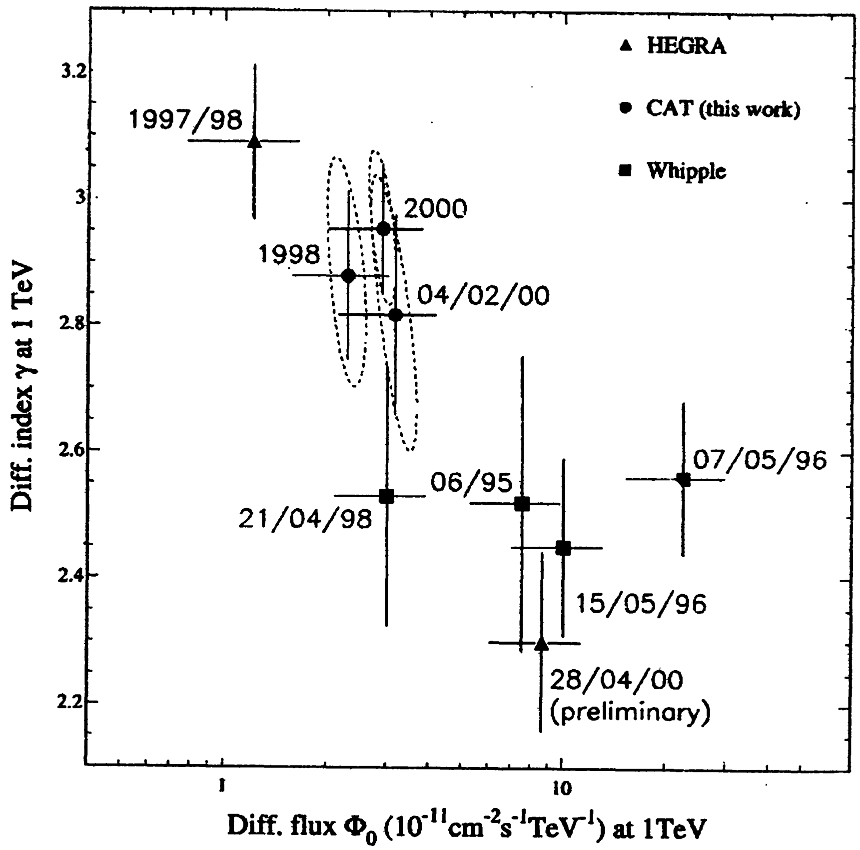

Figure 2. Unconclusive indication in favour of a correlation between the intensity and the power index of the flux distribution for Mrk-421.

References

Gaidos, J.A. et al., Nature **383** (1996) 319G
Punch M. et.al. Nature **358** (1992) 477
Quinn J. et al. ApJ **501** (1996) L83