Temporal and Spectral Evolution of the X–ray Emission of the TeV Blazar Mkn 421

G. Fossati (UCSD/CASS), A. Celotti, M. Chiaberge (SISSA, Trieste, Italy)

Mkn 421 was observed repeatedly with *Beppo*SAX in 1997–1998. We present the results of a thorough systematic timing and spectral analysis of all the data available to us, focusing in particular on the flare of April 1998, which was simultaneously observed also at TeV energies.
The detailed study of the flare in different energy bands reveals a few very important new results: i) a hard lag of the order of 2–3 ks –a behavior opposite to what is normally found in High energy peak BL Lacs X–ray spectra; ii) the flare is symmetric in the softest X–ray band, while it becomes increasingly asymmetric at higher energies, with the decay being progressively slower than the rise; iii) the decay of this flare can be intrinsically achromatic if one allows for a stationary underlying emission.
Moreover, extracting X–ray spectra on few ks intervals, we can follow in detail the spectral evolution during the flare, tracking for the first time the shift of the peak of the synchrotron component, moving to higher energy during the rising phase of the flare, and then receding. The spectral analysis nicely confirms the delay in the flare at the higher energies, with the spectrum changing its shape above a few keV definitely after the peak of the outburst occurred.
The large amount of X-ray spectral and timing information challenges the current and simplest models for the synchrotron emission and most importantly for the particle acceleration. A theoretical picture accounting for all these spectral and timing observational constraints is discussed. It requires the electrons to be injected at low energies and then progressively accelerated during the development of the flare. The achromatic decay is then interpreted as an effect of the source crossing time dominating over the shorter particle cooling timescales.