The variability of the quasar 3C 273: a radio to gamma-ray view

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on behalf of a larger collaboration
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Abstract: Fermi contribution to the study of the origin and variability properties of the inverse Compton peak in the quasar 3C 273

The multi-wavelength database

The quasar 3C 273 is one of the best observed AGN at all wavelengths. We continue the effort of collecting and making available to the community the 3C 273 data, updating the multi-wavelength database of Türler et al. (1999, http://isdc.unige.ch/3c273/) with the last 10 years of data (Fig. 1). For more detail, refer to Soldi et al. 2008, A&A 486, 41.

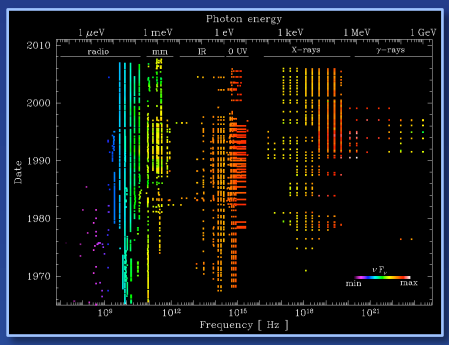

Fig. 1: Time coverage of all 3C 273 observations of the database as a function of the frequency, color-coded to represent the νFν intensity of the measured fluxes.

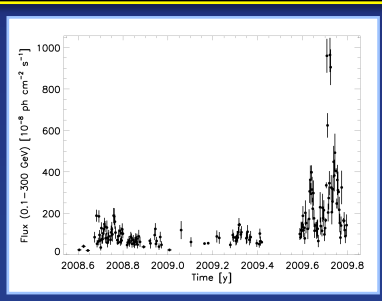

Fig. 3: Fermi/LAT light curve of 3C 273 in the 0.1-300 GeV band.

The gamma-ray emission

3C 273 has undergone several episodes of very intense gamma-ray activity since the launch of Fermi (Fig. 3). The average gamma-ray flux above 100 MeV seems to be significantly larger than the historical measurements of CGRO/EGRET (Fig. 4). The amplitude of the variations (with a fractional variability amplitude of 92% over the Fermi observing time) is the highest across the whole electromagnetic spectrum and it is in particular larger than what measured by EGRET (Fig 2a). This suggests that the decreasing amplitude of variations observed above 100 MeV with EGRET was likely due to its limited sensitivity.

The variability study

The amplitude and the time scales of the variations of 3C 273 depend strongly on the frequency and show trends that are characteristic of the underlying emission processes (Fig. 2a). The dominant hard X-ray emission is most probably not due to electrons accelerated by the shock waves in the jet as their variability does not correlate with the flaring millimeter emission (Fig. 2b). Instead, the hard X-rays seems to be associated to long-timescale variations in the optical. This optical component is consistent with being optically thin synchrotron radiation from the base of the jet and the hard X-rays would be produced through inverse Compton processes (SSC and/or EC) by the same electron population. Is the gamma-ray emission originating in the same region and through the same process as the hard X-ray one? (See also AGILE data, Pacciani et al. 2009.)

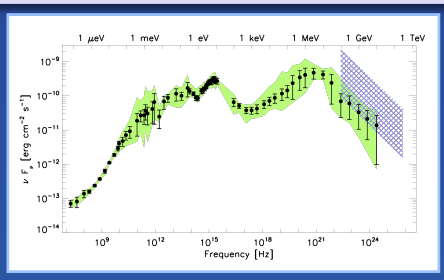

Fig. 4: Average spectral energy distribution of 3C 273 over up to 40 years. The error bars represent the standard deviation from the mean values and the green area indicates the observed range of variations. Above 30 MeV, the circles correspond to the average EGRET data, whereas the blue cross hatched area indicates the flux level of 3C 273 during Fermi observations.

The inverse Compton peak

Gamma-ray observations of 3C 273 are essential to constrain the whole shape of the inverse Compton peak and to better understand the connection between the jet emission in different energy domains. The most recent radio to gamma-ray campaigns carried out on this object, together with the numerous ones performed in the past, provide a large set of data to model the SED during several epochs and with different integration times (the average SED in Fig. 4).

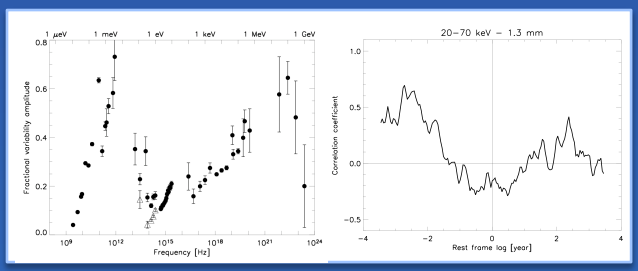

Fig. 2a (left): Spectrum of the fractional variability amplitude. Open triangles have been obtained after removal of synchrotron flares in the infrared band. Only EGRET data are included here to compute the variability amplitude in the gamma-ray domain.
Fig 2b (right): Correlation between the hard X-rays (20-70 keV) and the 1.3 mm light curve. No correlation is observed at short time lags.

If you have any data on 3C 273 which are not yet included in our database and you want to help us providing the community with a 3C 273 multi-wavelength data set, as complete and up-to-date as possible, and easy to access and use, please contact us!
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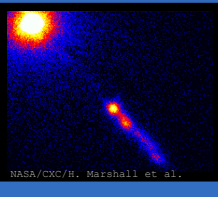

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