The Spectral Energy Distribution of Centaurus A (NGC 5128) 
– A Summary of all Observations Including all CGRO Results –

Helmut Steinle
Max-Planck-Institut für extraterrestrische Physik, Garching, Germany

Introduction
The elliptical galaxy NGC 5128 is the stellar body of the giant double radio source Centaurus A (Cen A). With a distance of only 3 – 4 Mpc (Hui et al. 1993), Cen A is the nearest active galaxy. It contains an active nucleus (AGN) and a jet with a large inclination (∼ 70°) to the line-of-sight which is detected in all wavelength bands where the spatial resolution is sufficient. Cen A belongs to the Fanaroff-Riley type I AGN and it even provides hints to the source of the cosmic diffuse background at gamma-ray energies. AGN and it even provides hints to the source of the cosmic diffuse background at gamma-ray energies.

Data
All available data have been combined into Fig. 2. About 40 % of the data (122 data points as of March 2000) are from the NASA Extragalactic Database (NED). The flux data is rather complete up to about 10^{18} Hz (5 keV (EINSTEIN data)), but lacks high energy data. Thus all available data from the Compton Gamma-Ray Observatory (CGRO) taken during its more than 9 years of operation and very-high-energy (VHE) observations summarized by Clay et al. (1994) have been added to the data set so that all about most 300 data points are now available.

Spatial Resolution of the Observations
Because Cen A is so close, the galaxy can be resolved into the nucleus and the outer regions, including the jet, with many of the instruments used. However, especially the instruments observing in the gamma-ray regime lack this resolution. Many authors, however, assume that the high energy emission observed can only originate in the nucleus and that emission from the jet is not visible if the object is viewed far from the jet axis (as is the case in Cen A with a viewing angle of ∼ 70°). Therefore, other than in cases where the spatial resolution of the observations was unknown, the CGRO data are included in the plots of the nuclear data, but they are marked with a different color.

Temporal Resolution of the Observations
Centaurus A is known to be a highly variable object in all wavelength bands and to show distinct emission states (Bond et al. 1996, Baity et al. 1981, Turner et al. 1999) when Cen A was observed in a low emission state. Bond et al. (1996, 1999) stated that the high energy emission observed can only originate in the nucleus and that emission from the jet is not visible if the object is viewed far from the jet axis (as is the case in Cen A with a viewing angle of ∼ 70°). Therefore, other than in cases where the spatial resolution of the observations was unknown, the CGRO data are included in the plots of the nuclear data, but they are marked with a different color.

Classifications of Data
To help to draw conclusions from this large collection of data (Fig. 2) in a reasonable manner, the data have been separated into the following groups as shown in Fig. 3:

According to spatial resolution:
- spatial resolution sufficient to observe the nucleus alone (Figs. 3 and 6)
- spatial resolution not sufficient to resolve Cen A (Figs. 1 and 4)
- spatial resolution unknown (no figure)

Simultaneous observations:
- simultaneous observations (including "long" observations of low sensitivity instruments as e.g. the gamma-ray instruments on board CGRO) (Figs. 4 and 6)
- observations without exact observation date or averages of many observations (no figure)

Results
The global structure of the spectral energy distribution of Cen A shows the typical two "humps" which are usually (for Blazars see e.g. Urry 1998) attributed to synchrotron emission and Compton-scattering for the low frequency (here: ∼ 10^{14} Hz) and high frequency peak (here: ∼ 10^{20} Hz) respectively. Possibly there are two more "humps" at very low and very high frequencies. However at low frequencies, this impression may be caused by the scatter of the data points. The simultaneous observations in 1995 (see Fig. 6) do not support the presence of a "hump" at lower frequencies. On the high frequency side of the SED, the two detections of Cen A at ∼ 10^{22} Hz have been questioned and await confirmation from instruments available soon with much more sensitivity. As one can see from the other figures below, despite the huge amount of data, only few data sets end up in the most interesting Figures 4 and 6. This shows dramatically the lack of coordinated simultaneous observations, an omission which hardly can be corrected, in the Compton Gamma-Ray Observatory, which covered a very important spectral region with so many instruments and which contributed many important measurements, was eliminated by NASA before further scheduled coordinated observations had taken place. No near-term future gamma-ray instrument will be able to close this gap in energy and in observational data.

References
NASA extragalactic database (NED)
"http://nedwww.ipac.caltech.edu"

For more information on Centaurus A see: http://www.mpe.mpg.de/Cen-A/