Abstract

RGB J0152+017 was discovered in TeV γ-rays by the HESS array of Cherenkov telescopes in October 2007. The discovery triggered a broad multi-wavelength observation campaign ranging from radio (Nancay telescope) and optical band (ATOM telescope) over X-rays (RXTE and Swift satellites) to the TeV observations with the HESS experiment. Simultaneous spectral and temporal variability measurements were obtained, which are used to study the acceleration mechanisms in the jet of the BL Lac object. The broadband spectral energy distribution (SED) is derived for the first time, and is well described by a synchrotron self-Compton emission model, with parameters commonly found in TeV blazars. RGB J0152+017 is found to be a high-frequency peaked BL Lac from the SED.

VHE observations and results

RGB J0152+017 was observed in October and November 2007 by the full array of four H.E.S.S. IACT telescopes. The total live-time used for analysis amounts to 14.7 h.

A signal of 173 γ-ray events is found from the direction of RGB J0152+017. The statistical significance of the detection is 6.6 σ. The observation was reported by Nedbal et al. (2007) and Aharonian et al. (2008).

Figure 2 shows the differential spectrum of RGB J0152+017. Between the energy threshold of 240 GeV and 3.8 TeV it is well described by a power law dn/dE = \Phi_0(E/TeV)^{−\Gamma} with a photon index \Gamma = 2.95 ± 0.36\text{me} ± 0.20\text{ext} and normalization at 1 TeV of \Phi_0 = (5.7 ± 1.1\text{ext}) × 10^{-12} cm^{-2} s^{-1} TeV^{-1}.

Search for variability

Figure 3 shows nightly evolution of flux above 300 GeV from RGB J0152+017. There is no significant variability observed. The lightcurve is well fit by a constant with \chi^2/DOF = 17/22. The overall integral flux above 300 GeV is I = (2.70 ± 0.51 ± 0.54\text{stat}) × 10^{-12} cm^{-2} s^{-1}.

Multiwavelength observations

Radio observations by Nancay telescope

RGB J0152+017 was observed by the Nancay Radio Telescope (Theureau et al. 2007) in 22 60-second runs on November 12 and 14. A flux density of 56 ± 6 mJy is determined at 2685 MHz for RGB J0152+017. No significant variability is found in the data.

Optical observations by ATOM

The target was observed by ATOM nightly between November 10 and 20. No significant variability is found on a nightly timescale. The host galaxy is subtracted using parameters from Nilsson et al. (2003). The core flux in the R-band (640 nm) is found to be 0.62 ± 0.08 mJy.

X-ray observations by Swift and RXTE

RGB J0152+017 was observed by the Swift/XRT (Burrows et al. 2005) for 5.44 ks on November 13-15 2007 as a target of opportunity (ToO). No significant variability is found. The spectrum can be described by a broken powerlaw (\Gamma_1 = 1.93 ± 0.20, \Gamma_2 = 2.82 ± 0.13, F_{\text{2-10 keV}} = 1.29 ± 0.12 keV) with a Galactic absorption of 2.72 ± 0.01 cm^{-2}. The unabsorbed flux is determined to be F_{\text{2-10 keV}} = 5.1 × 10^{-11} erg cm^{-2} s^{-1} and F_{\text{10-20 keV}} = 2.7 × 10^{-12} erg cm^{-2} s^{-1}.

Using RXTE/PCA (Jahoda et al. 1996), 3.2 ks exposure of simultaneous data on November 13-15 2007 were obtained. The resulting flux F_{\text{10-20 keV}} = 6.8 × 10^{-12} erg cm^{-2} s^{-1} is in disagreement with the one obtained by Swift, which is attributed to a contamination by a nearby galaxy cluster Abell 267.

Spectral energy distribution (SED)

Simultaneous observations in radio, optical, X-ray and TeV energy range allowed first determination of the SED of RGB J0152+017 (see Fig. 4).

The SED can be well described by a model containing:

- Non-thermal leptonic Synchrotron Self-Compton (SSC) model describing well the high energy X-ray and H.E.S.S. VHE data.
- Optical emission from the dominating host galaxy, modelled by the PEGASE code (Fioc & Rocca-Volmerange 1997).
- The radio data are well described by a separate synchrotron model for an extended jet (Katarzynski et al. 2001)

The model parameters of the emission region are: Doppler factor \delta = 25, radius of the emitting region R = 1.5 × 10^{19} cm and magnetic field B = 0.10 G.

Furthermore, the shape and flux of the synchrotron part of the spectrum lead us to identify the AGN as a high frequency BL Lac (HBL).

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References

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