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VHE gamma ray spectrum of 1ES 1218+304

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Abstract

The extragalactic source 1ES1218+304 with a redshift of z = 0.182 has been detected as a source of gamma rays above 90 GeV in January 2005. The differential spectrum obtained from the analysis of an 8.2h data set is given by $(1.5 \pm 0.9)\ 10^{-8}\ (E/TeV)^{-3.3\pm0.4}\ m^{-2}s^{-1}TeV^{-1}$. Significant spectral steepening is expected owing to pair production in interactions of the gamma rays with low-energy photons from the evolving metagalactic radiation field. Unfolding the effect of attenuation by using a semi-empirical model, we obtain an intrinsic spectrum characterized by a spectral index of 2.8 ± 0.4.

Introduction

The BL Lac object 1ES1218+304 (z=0.182) was observed by the MAGIC telescope in January 2005 as a part of a survey of the X-ray brightest, low-redshift northern HBLs in its Cycle-1 schedule. 1ES1218+304 has almost the same distance as the farthest blazar reported so far by HESS at a redshift of z=0.186. Studying the evolution of blazar properties with redshift (e.g., spectral energy distribution, effects of pair attenuation, luminosity function) constitutes a prime goal of this research.

Data analysis

The analysis of a total of 8.2h observation time has been performed as described in ref. [1]. The significance of the detection is 7.3 sigma. The spectrum shown in Fig.2 can be fitted by a power law with an index of 3.3±0.4. The differential flux corresponds to $1.5 \pm 0.9\ 10^{-8}\ E^{-3.3\pm0.4}\ m^{-2}s^{-1}TeV^{-1}$.

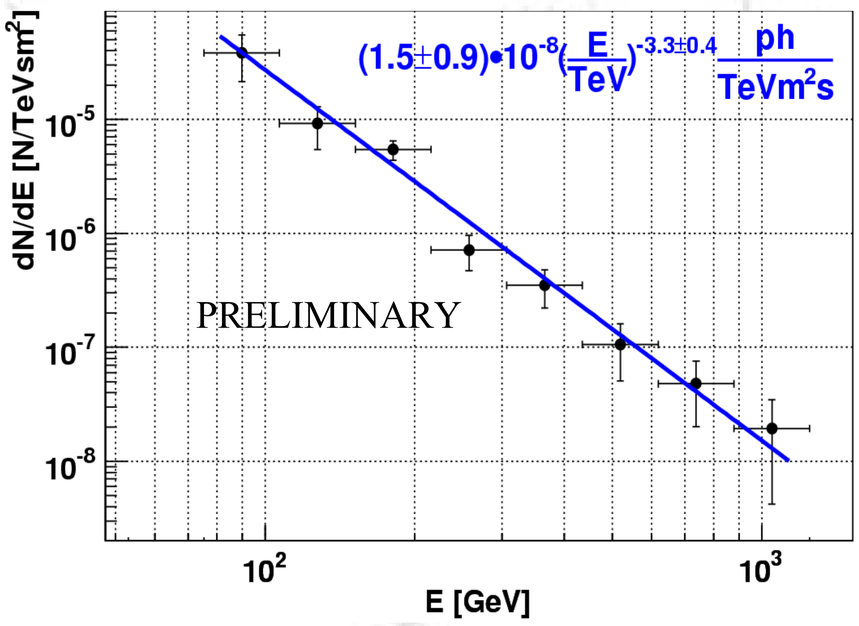

Fig.1: Differential energy spectrum of 1ES1218+304

Attenuation due to pair production in a background radiation field

To account for the attenuation of the observed gamma rays due to pair production in interactions with the evolving (with z) metagalactic radiation field (MRF) a semi-empirical approach has been employed [2]. The model of the MRF shown in Fig. 3 describes best results obtained in optical/UV and infrared galaxy surveys. Predictions of the MRF based on a particular scenario of galaxy formation through dark matter halos are very similar [3].

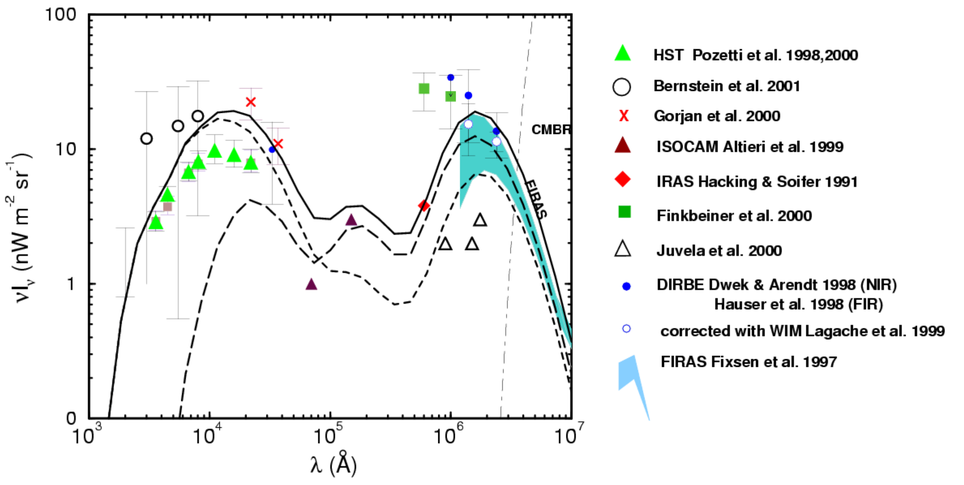

Fig.2: Present-day intensity of the MRF, commonly coined the extragalactic background light (EBL), from the semi-empirical model [2] (solid line).

Results

Using two extreme parametrizations of the semi-empirical MRF model (lower and upper limit) the observed spectrum has been unfolded yielding an intrinsic spectrum consistent with a spectral index of 2.8±0.4.

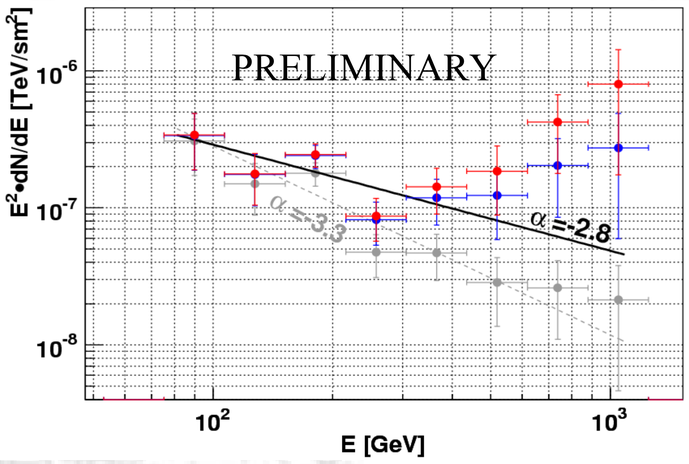

Fig.3: Intrinsic Spectrum of 1ES 1218+304 after unfolding with two extreme parametrizations of the MRF (blue and red dots for lower and upper limits in the model of ref. [2], respectively) fitted by a powerlaw (χ^2/ndf = 7.8/6).

Discussion

The intrinsic spectrum is consistent with a power law of index 2.8±0.4. The hard X-ray spectrum of 1ES1218+304 as observed with BeppoSAX in July 1999 shows power law slopes ranging from 2.4 to 2.5 [4]. Thus, the VHE emission seems to be consistent with an SSC origin. The marginal excess seen at TeV energies is probably related to unaccounted systematic errors, but could also indicate an over-estimation of the MRF or a different radiation mechanism responsible for the gamma rays. Extending the measurements to energies above TeVcould shed more light on this issue.

Acknowledgements

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