Observation of 3EG J1234-1318 with the CANGAROO-II Telescope

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Abstract

We observed 3EG J1234-1318 with the CANGAROO-II telescope in March, 2002. This source is one of the steady EGRET unidentified gamma-ray sources in high Galactic-latitude and the gamma-ray emission may be accounted for by dynamically merging clusters of galaxies. We here report preliminary analysis results. No significant gamma-ray excess signals are detected from this EGRET gamma-ray source position.

1. Introduction

The detection of synchrotron emission from clusters of galaxies at radio, EUV and hard X-ray energies (*e.g.*, see[1] for a recent review, [2], [3]) indicates the presence of non-thermal particles in these objects. A lot of numerical simulations for dynamics of merging clusters of galaxies have been carried out and the emission from non-thermal particles has been modeled.(*e.g.*, [4], [5], [6], [7], [8]). Gehrels et al. [11] are pointed out that some high Galactic-latitude EGRET unidentified sources are steady, unlikely AGNs. Totani and his colleagues ([9], [10]) searched for associations of positions between EGRET unidentified sources and some clusters of galaxies, and found that seven steady gamma-ray sources at high Galactic-latitude ($|b| > 45^\circ$) are statistically significantly correlated with close pairs of galaxy clusters. In their model, GeV gamma-ray emission mechanism may be explained by the inverse Compton scattering of the CMB photons by those electrons. They also pointed out that assuming the magnetic field strength, $B \sim 0.1\mu G$, and shock velocity for typical clusters, $V_{shoch} \sim 10^3 km\, s^{-1}$, the maximum gamma-ray energy is expected to exceed 1 TeV, the size of the emission region is expected to be $\lesssim 1^\circ$.

3EG J1234−1318, centered on $(\alpha, \delta) = (12^h34^m02^s.40, -13^\circ18'36'')$, is one of the seven steady EGRET unidentified sources at high Galactic latitude. Its spectral index is -2.09 ± 0.24 in the EGRET energy region. This source has a rich structure, revealed by the optical all sky catalog survey [10], and is considered to be merging site of clusters of galaxies. The location of the center of the clusters is 0.5° apart from the EGRET source position.

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Table 1. Shower and gamma-ray like event selection criteria.

Shower selection parameters	
ADC threshold	300 ADC counts($\sim 3.0 p.e.$)
Shower timing	$\lvert T_{ave}\rvert < 30 nsec.$
Signal adjacency	$\geq 5 signals$

Table 2. Image cut parameters for gamma-ray like event selection

Assuming a point gamma-ray source		
$sumADC < 6200$	$6200 < sumADC < 16900$	$16900 < sumADC$
$0.05 < Width < 0.10$	$0.05 < Width < 0.15$	$0.05 < Width < 0.15$
$0.05 < Length < 0.30$	$0.10 < Length < 0.25$	$0.10 < Width < 0.30$
$0.50 < Distance < 1.00$	$0.50 < Distance < 1.00$	$0.50 < Distance < 1.10$
Assuming a 1.0° diffuse gamma-ray source		
$sumADC < 6200$	$6200 < sumADC < 16900$	$16900 < sumADC$
$0.05 < Width < 0.10$	$0.05 < Width < 0.15$	$0.05 < Width < 0.15$
$0.05 < Length < 0.30$	$0.10 < Length < 0.25$	$0.10 < Width < 0.30$
$0.50 < Distance < 1.10$	$0.50 < Distance < 1.10$	$0.50 < Distance < 1.20$

2. Observation

We observed 3EG J1234−1318 with the CANGAROO-II telescope from March 7^{th} to 14^{th}, 2002. The total observation time is ∼23 hours and ∼24 hours for ON- and OFF-source data, respectively. For the ON-source data, the telescope pointing was offset 0.23° to the northwest of 3EG J1234−1318, which is the middle between the EGRET source and the center of the merging clusters indicated in [10]. We, therefore, can analyze for both the EGRET source position and the merging center of clusters even if they are irrelevant.

3. Analysis and Results

At first, we select shower events from the data using selection criteria listed in Table. 1. After removing not clear nights data, a stable shower rate of ∼2 Hz was obtained through our observation period. The effective observation time is ∼18 hours and ∼18 hours for ON- and OFF-source data, respectively.

We analyze the remaining shower data using the Hillas parameters and select gamma-ray like events. The criteria for the gamma-ray like events selections are summarized in Table. 2. To determine these cut criteria, we simulate shower event assuming two case, point and 1.0° extended gamma-ray source. After these reduction procedures, the detection efficiency of gamma-ray like events and the background rejection power are estimated to be 42.0% and 95.8% for the point source, and 37% and 93% for the extended source, respectively.

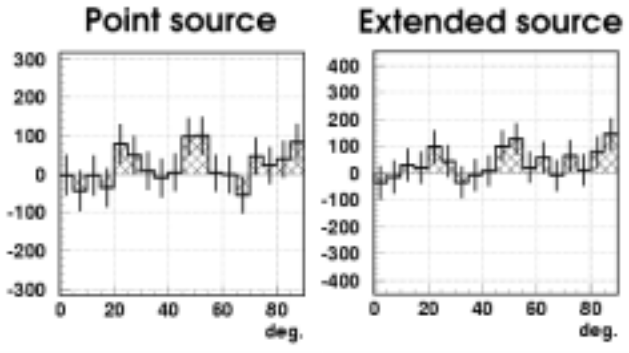

Fig. 1. Alpha distributions subtracted OFF-source data from ON-source data for the direction of the proposed merging clusters.

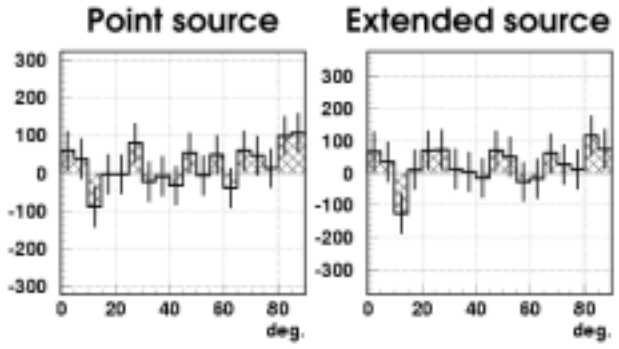

Fig. 2. Alpha distributions subtracted OFF-source data from ON-source data for the direction of EGRET source.

After all these image parameter cuts had been applied, alpha distributions are obtained. Fig. 1. and Fig. 2. show the preliminary results for the direction of the proposed merging clusters and for the direction of the EGRET source, respectively. In both figures, the left panel shows the result assuming point source and the right one for extended source, respectively. We find no significant excess of events from both directions. The 98% C.L. integral flux upper limits are obtained from the number of excess events at alpha less than 20° for point source and less than 30° for extended source. The results are shown in Fig. 3.

4. Discussion

Our results indicate that if we assume point source we can constrain the electron spectral index to be very soft and the assumption of merging clusters of galaxies model may be questionable. However, accepting the merging clusters

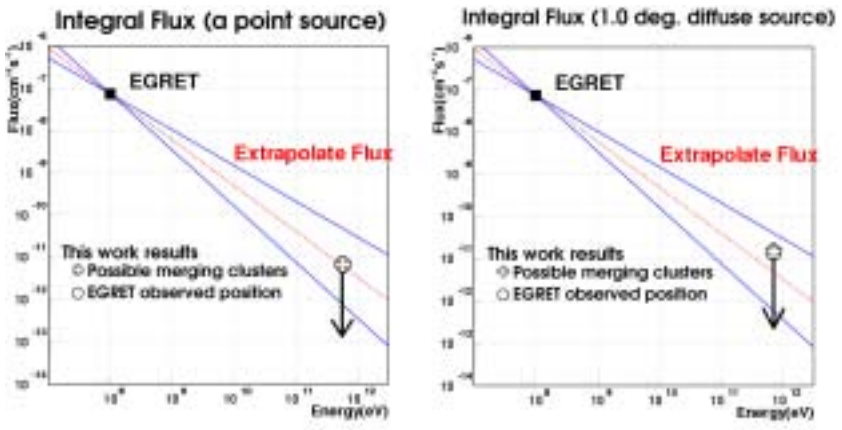

Fig. 3. Flux upper limit for the direction of the proposed merging clusters(the left figure) and EGRET source(the right figure). The dotted line spectrum is extrapolated from EGRET results. The inside region of thick lines shows the error of the spectrum.

model, our results with cut off below 680 GeV may limit the strength of the magnetic field. To criticize the merging cluster model, further quantitative studies are needed.

5. Reference

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