Search for Gamma-ray Clusters of Galaxies with the CANGAROO-II telescope

T.Hattori*, K.Nishijima*, T.Totani for the CANGAROO collaboration**

*Department of Physics, Tokai Univ., Japan

**National Astronomical Observatory, Japan

Merging clusters of galaxies are a promising candidate for the origin of high galactic-latitude, steady unidentified EGRET gamma-ray sources. 3EG J1234-1318 is one such object, and it has also been suggested that it may be detectable at TeV gamma-ray energies. We observed this target for ~23hrs(on-source) and ~24hr(off-source) in Mar.7th-14th, 2002 with CANGAROO-II telescope. Here we present a preliminary result of our observation.

1.Introduction

Over half of all EGRET sources have not identified with known astronomical objects(Fig.1). Recently, Gehrel et al. choose seven steady sources, which don't have high variability such as AGNs, at high Galactic-latitude(|b|>45 deg.) from all EGRET un-IDs. Totani and his colleague pointed out that the steady EGRET un-IDs may be explained from dynamically merging clusters of galaxies and estimated the number which EGRET should detect(Fig.2). They found that seven such sources are statistically significantly correlated with close pairs of galaxy clusters. Following their model, if about 5% of shock energy is transferred to nonthermal electrons, GeV gamma-rays may be explained by the inverse Compton scattering of the cosmic microwave background photons by those electrons. They also pointed out the detectability of TeV gamma-rays. Assuming the magnetic field strength and shock velocity for typical clusters, maximum gamma-ray energy is calculated to exceed 1 TeV and expected size of emission region is <~1deg.

Fig.1

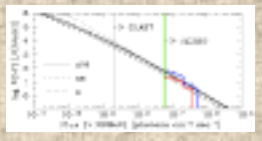


Fig.2

2. 3EG J1234-1318

3EG J1234-1318 is one of the seven steady EGRET un-IDs in high Galactic-lat., whose spectrum index is -2.09 ± 0.24 in EGRET energy region. This source has rich structure (fig.3). Estimated integral flux above 1TeV is 3.2×10^{-12} cm^{-2}s^{-1}. This flux is obtained from extrapolated EGRET spectrum. 3σ level gamma-ray flux is expected from ~39h observation with CANGAROO-II telescope.

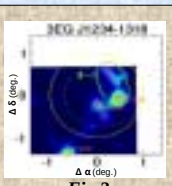


Fig.3

Object	Position(J2000) (RA ,DEC)
3EG J1234-1318	($12^h34'02''$, $-13°18'36''$)
Merging(3-1 in fig.2)	($12^h32'38''$, $-12°59'24''$)

3.Observation

3EG J1234-1318 was observed with CANGAROO-II telescope in Mar 4th - 14th, 2002. The total observation time is ~23 hours and ~24 hours for ON- and OFF-source run, respectively. Average and maximum elevation angle is 67.0 degree and 72.2 degree, respectively. In ON-source run, the telescope was pointed to the position of 0.23 degrees offset from the center of EGRET source position, so we can analyze for four clusters as gamma-ray sources(fig.4). Weather condition was good, so we can use ~75% of total observation time(Table.1).

Fig.4

Tracking position

(RA,DEC) = ($12^h33'19''$, $-13°09'00''$)

Table.1

	ON	OFF
All Obs. time	84389sec. (23.4h)	86395sec. (24.0h)
Effective time	65880sec. (18.3h)	66129sec. (18.3h)

4.Analysis

Data selection criteria is shown in Table.2, T_{ave} is average signal timing for event-by-event(Fig.5) and T5a is five signals adjacency. The data above 60 degrees of elevation is used. After this selection, shower rate is stable and is ~2Hz through the observation period.

Table.2

ADC	>300counts(~3.3p.e.)
TDC	$\|T_{ave}\|$<30nsec
Clustering	>T5a

We analyzed the data with Imaging method. Image parameters for simulated gamma-rays(red) and for OFF-source are shown in Fig.6.

Gamma-ray like events selection criteria are also shown in Table.3. After this selection, gamma-ray like events detectable efficiency and background rejection efficiency are 42.0% and 95.8%, respectively.

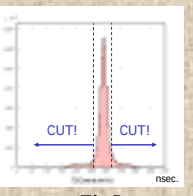


Fig.5

Table.3

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<Length<0.30
0.50<Distance<1.00	0.50<Distance<1.00	0.50<Distance<1.10

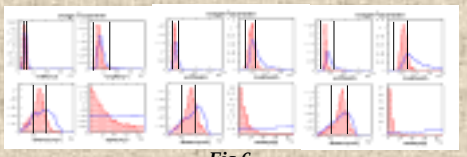


Fig.6

5.Preliminary Result - Alpha distributions -

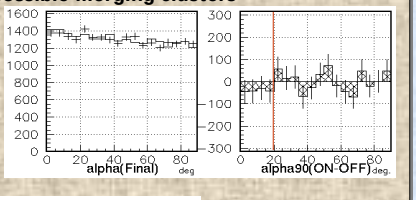
a)The position of possible merging clusters

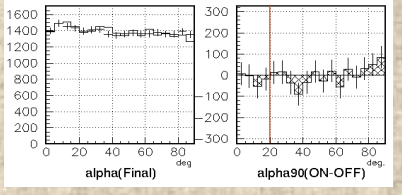
alpha<20 deg.

ON : 5382

OFF: 5434

-157±105





b)3EG J1234-1318

alpha<20 deg.

ON : 5775

OFF: 5742

-68±108

6.Summary

Our preliminary results show there are no significant excess signals from the direction of 3EG J1234-1318 or the direction of a possible merging clusters. In this presentation, we consider the gamma-ray source as a point source. However since extended source is theoretically predicted we should take this into account it in our analysis.