SEARCH FOR CELESTIAL GAMMA-RAY POINT SOURCES
WITH THE TIBET AIR SHOWER ARRAY

The Tibet ASΓ Collaboration
M.Amenomori1, Z.W.Bai10, Z.Cao9, L.K.Ding9, Z.Y.Feng10, K.Hibino4, N.Hotta2,
Q.Huang10, A.X.Huo9, H.G.Jia10, G.Z.Jiang10, S.Q.Jiao10, F.Kajino8, K.Kasahara8,
Labaciren12, D.M.Mei12, L.Meng9, Mimaciren12, K.Mizutani13, J.Mu11, H.Nanj1,
M.Nishizawa8, Nusang12, M.Ohishi8, I.Ohta2, J.R.Ren5, To.Saito4, M.Sakata8,
Z.Z.Shi9, M.Shibata7, T.Shirai8, X.X.Sun9, H.Sugimoto6, A.Tal11, K.Taira6, Y.H.Tan9,
N.Tateyama5, S.Torii5, H.Wang12, J.X.Wang10, C.Z.Wen10, Y.Yamamoto8, H.M.Yang12,
G.C.Yu10, P.Yuan9, T.Yuda4, J.G.Zeng10, C.H.Zhao12, C.S.Zhang9, H.M.Zhang9,
L.Zhang11, Zhasang12 and W.D.Zhou11

1Hirosaki Univ., Hirosaki, Japan 2Utsunomiya Univ., Utsunomiya, Japan
3Saitama Univ., Urawa, Japan 4ICRR Univ. of Tokyo, Tanashi, Japan
5Kanagawa Univ., Yokohama, Japan 6Yokohama Natl. Univ., Yokohama, Japan
7Shonan Inst. of Technology, Fujisawa, Japan 8Kanon Univ., Kobe, Japan
9IHEP, Academia Sinica, Beijing, China 10South West Jiaotong Univ., Chengdu, China
11Yunnan Univ., Kunming, China 12Tibet Univ., Lhasa, China

ABSTRACT

Searches for 10 TeV∼100 TeV gamma signals from Cyg X-3, Her X-1 and Crab nebula
were done using the data from October 1990 to April 1991. No DC excess was found
for these objects in this period. The flux upper limits for them are estimated to be 1.8
× 10⁻¹² cm⁻² s⁻¹, 1.5 × 10⁻¹² cm⁻² s⁻¹ and 2.0 × 10⁻¹² cm⁻² s⁻¹ with 95% confidence
level at 10 TeV, respectively. Also, no excess flux associated with a January radio flare of
Cyg X-3 of 1991 was observed.

1. Introduction

The Tibet ASΓ experiment1~3 has started from 1989 December at Yangbajing
(4300m a.s.l., 90.53°E and 30.11°N) in Tibet, China. Performance of our array is
described in another paper(OG 10.4.12) in this conference. Briefly the fast-timing
(FT) array consists of 45 scintillation counters (0.5m² unit) arranged in a grid pat-
tern of a spacing of 15m and they are surrounded by 20 density detectors (0.25m²
unit except for four 0.5 m² detectors). Since July of 1990 the data is successively
taken at a trigger rate of about 20 Hz under any 4-fold coincidence in 0.5 m² detectors.
Monte Carlo simulations enable us to estimate the mode energy for detectable
gamma-induced showers to be about 10 TeV. No detection bias is found for gamma
showers in the energy region over 40 TeV. The angular resolution for gamma-induced
showers is also estimated to be 0.8° for all selected showers whose core falls inside
the array. This angular resolution is also confirmed by detecting the moon shadow
OG 4.6-6
(see paper OG 10.4.12). At present the Tibet AS array is the only array which is able to detect gamma-induced showers with no detection bias in the energy region less than 100 TeV.

Data analysis was done for about $1.82 \times 10^8$ events obtained from October 16, 1990 to April 2, 1991, where the actual working time was $9.51 \times 10^6$ sec excluding 10% dead time. In this paper we present the results on search for gamma-ray signals from Cyg X-3, Her X-1 and Crab nebula or pulsar in the energy region above 10 TeV.

2. DC excesses

We have examined three candidates of Cyg X-3, Her X-1 and Crab nebula to search for DC excess of high energy gamma-rays. Events within a circle of $1^\circ$ radius are histogrammed as a function of right ascension at each declination of the candidates in Fig.1. Background is estimated from the adjacent five bins on both sides centered at the candidate on the same declination band. No DC excess is seen for each candidate. Therefore the upper limits of integral flux calculated in the method by Protheroe from these results are $1.8 \times 10^{-12}\text{cm}^{-2}\text{s}^{-1}$ for Cyg X-3, $1.5 \times 10^{-12}\text{cm}^{-2}\text{s}^{-1}$ for Her X-1 and $2.0 \times 10^{-12}\text{cm}^{-2}\text{s}^{-1}$ for Crab nebula at 10 TeV with 95% confidence level respectively. Although these values are obtained from only five months data, they are low enough to be compared with other long term data except for a few muon cut data as shown in Fig. 2.

![RA distributions for Cyg X-3, Her X-1 and Crab nebula.](image)

Fig. 1 RA distributions for Cyg X-3, Her X-1 and Crab nebula.
3. January radio flare from Cyg X-3

A radio flare from Cyg X-3 was detected on 21st January of 1991. Recently, the Soudan 2 collaboration reported a detection of short term excess of muons associated with this flare, and also AGASA observed a rapid (7 days) flux rising and a long term (~ 50 days) excess of giant air showers. The Tibet data, however, does
not show any significant excess not only on the daily flux but also on the cumulative flux of 50 days after flare, as shown in Fig. 3, for all showers detected (1° radius bins), and for showers with energies $\geq 30$ TeV and $\geq 100$ TeV (0.5° radius bins each) respectively. Here the shower energy is estimated as gamma-induced showers.

Fig. 3a RA distribution of flux from Cyg X-3 for 50 days after the flare.

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