Observation of Very High Energy Gamma Rays from SS433/W50 with CANGAROO-II Telescope


S.Hayashi

Seiichi Hayashi*, Fumiyoshi Kajino*, Tsuguya Naito+ for the CANGAROO collaboration
(* Konan University, + Yamanashi Gakuin University)

SS433 is the unique star located at the center of supernova remnant called W50, and is a close proximity binary star system which consists of a compact star and a normal star. Jets of material are directed outwards from the vicinity of the compact star symmetrically to the east and west. The radiation of non-thermal X-rays considered to have been formed by the jets is detected at both of X-ray lobes. Observation of the western X-ray lobe region was performed by the CANGAROO-II telescope in August and September, 2001. Here we present a preliminary result of our observation.

1. SS433/W50

W50
- Galactic SNR (2x1deg)
- Distance: 5 kpc
- Age: ~10000 year

SS433
- Center of W50
- RA: 19h12m20s
- Dec: +4°55'
- Magnitude: 14.2
- Binary system (13.1day)
- Parsec-scale jet (v = 0.26c)
  - Precession period: ~162day
  - Inclination of precessional axis: ~80deg
  - Precessional angle: ~20deg

Fig1. Image of SS433 jets

2. X-ray Lobes

The X-ray lobes of SS433/W50 were discovered by Einstein observatory (Watson et al. 1983), and confirmed by ROSAT and ASCA (Safi-Harb and Ogelman 1997).

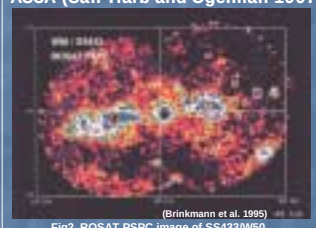

Fig2. ROSAT PSPC image of SS433/W50

The X-ray spectrum of each lobe has no apparent emission lines, and is well described by power-law models. They are considered to have been formed by the jets from SS433. At ~1° east of SS433, soft X-ray emission coincident with the radio "ear", which is associated with the terminal shock of the SS433 jets.

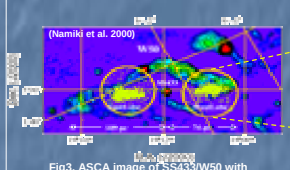

Fig3. ASCA image of SS433/W50 with RADIO contour map

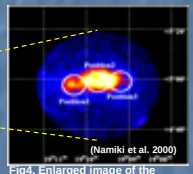

Fig4. Enlarged image of the western X-ray lobe

According to the results of ASCA (Yamauchi et al. 1994), it was found that the spectrum of each X-ray lobe becomes harder as distance from SS433 decreases. Moreover, the western region, closer to SS433, has a harder spectrum than the east region, and the surface brightness of X-ray lobes are almost the same as each other. The spectra of the western lobe divided into three regions are reported by the latest analysis of ASCA (Fig4. Namiki et al. 2000).

3. Analysis of Eastern Lobe by HEGRA (Rowel et al. 2001)

The HEGRA CT-System searched for TeV gamma-rays from the eastern lobe over the 1998 and 1999 observing seasons. They concentrated on the jet termination region of the eastern X-ray lobe, a total 19.3 hours observations (without bad weather) were accepted for analysis.

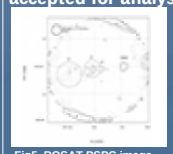
Fig5. ROSAT PSPC image (0.1 to 2.4 keV) of the eastern lobe (Safi-Harb and Ogelman, 1997)

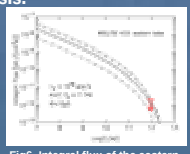
Fig6. Integral flux of the eastern lobe e3 region.

An analysis of eastern lobe by the HEGRA CT-System revealed no evidence for TeV emission at photon energies above 1 TeV, with resulting 99% upper limits in the range 8 to 10% of the Crab flux.

4. CANGAROO Observations

Observations of the western X-ray lobe region were performed by the CANGAROO-II 10m telescope in August and September, 2001, and in July and September 2002. The tracking position was the center of the region named position 1 of ASCA map which was the closer region to SS433. Also the region is closer to the galactic plane, then the density of matter is expected to be higher than that of the eastern lobe. The total observation time in 2001 was ~51 hours and ~50 hours for ON and OFF source run, respectively. After selecting good weather condition, ~66 % of the total observation time was accepted.

☐ Tracking Position
- Western lobe Position1 (ASCA)
- RA: 19h10m17s (287.57 deg)
- Dec: +4°57'46" (4.963 deg)

☐ Observation Time

	Observed ON	Observed OFF	Selected ON	Selected OFF
2001 Aug	35.3h	32.8h	29.1h	21.2h
2001 Sep	16.1h	16.7h	7.2h	9.2h
TOTAL	51.4h	49.5h	36.3h	30.4h
2002 Jul	5.6h	4.1h		
2002 Sep	28.2h	27.2h		
TOTAL	33.8h	31.3h		

Conditions of event selection
- Shower rate > 1.5Hz
- Elevation > 40 deg

5. Analysis and Preliminary Result

At first we selected the data using the following processes to reduce night sky background noise and so on.
- ADC threshold: ADC > 300 counts (~3.3 p.e. / PMT)
- Cluster cut: T4a (at least 4 adjacent pixels)
- Timing cut: |TDC mean – TDC| < 30 (nsec)
- Rejection of noisy PMTs: 8 PMTs

Next, using Monte-Carlo simulation, we determined the shape parameters. Each parameters are shown in Figure 7.

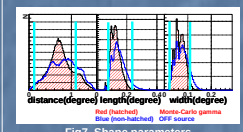

Fig7. Shape parameters

0.1 < distance < 1.1
0.07 < length < 0.23
0.02 < width < 0.11

Very preliminary result is shown in Figure 8. The distribution of ON source was normalized by the ratio N_{OFF}/N_{ON} (alpha > 30 degree).

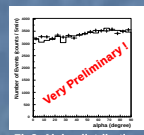

Fig8. Alpha distribution

6. Summary

The western X-ray lobe region of SS433/W50 was observed with CANGAROO-II 10m telescope. In this presentation, we show very preliminary results of analyzed data for the tracking position (Position 1 of ASCA map). We will further analyze the data by adding 2002 observation data.

Reference

- Brinkmann W. et al. 1996, A&A, 312, 306
- Namiki M., Kawai N., Kotani T. 2000, private communication
- Rowel G.P. et al. 2001, Astro-ph/0104288
- Safi-Harb S. and Ogelman H. 1997, ApJ, 483, 868
- Yamauchi S. et al. 1994, PASJ, 46, L109