Recent results of the CANGAROO project (Extra-galactic objects)

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CANGAROO collaboration

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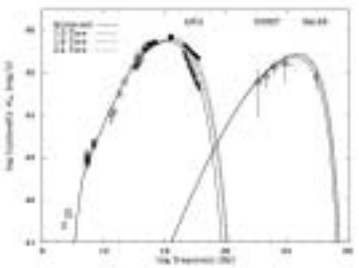
Recent CANGAROO extra-galactic source observations

- Search for new TeV γ-ray AGNs in southern hemisphere
  - PKS2155-304
- Evidence for new type of TeV γ-ray source
  - NGC253
- Observation of E>10TeV γ-ray from extra-galactic source
  - Mrk421

AGN observations in southern hemisphere

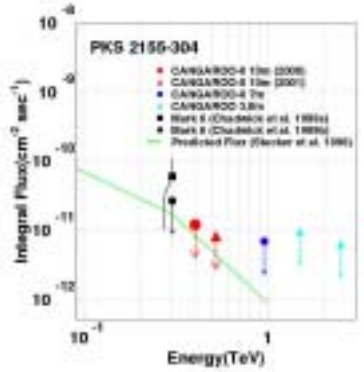
target	type	z	obs. time (hrs) 2000	obs. time (hrs) 2001	TeV-γ Detection
PKS2005-489	HBL	0.031	17	---	
PKS0548-322	HBL	0.069	3	---	
PKS2155-304	HBL	0.116	18	20	○

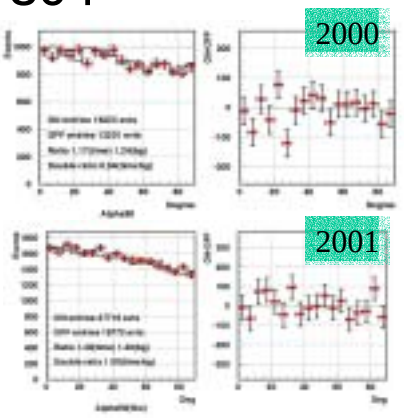
Result presented in this talk



PKS2155-304
multi-wavelength spectrum
J.Kataoka et al. (1999)

PKS2155-304

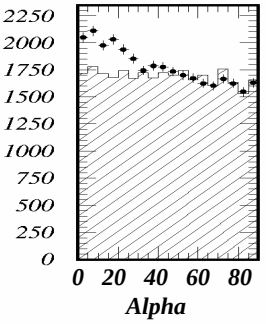




- No γ-ray signals were detected from PKS2155-304 (z=0.116) in 2000 and 2001 observations

Poster presented
Nakase et al. S34

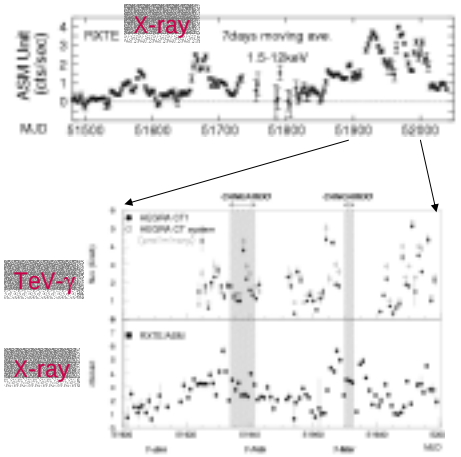
NGC253



- Normal-sized spiral galaxy (starburst)
  - distance ~2.5Mpc
  - high supernova rate 0.1~0.3/1yr
- ~50 hours on-source observation in 2000 and 2001
- γ-ray signals detected at a high confidence level (>10σ)

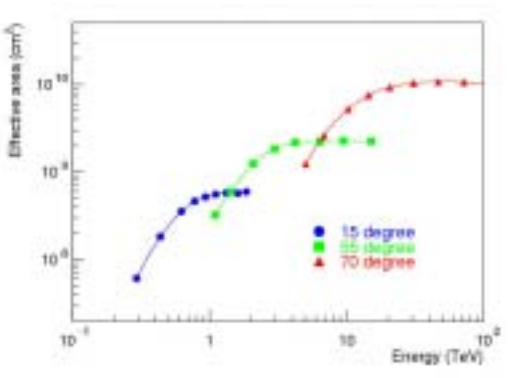
Poster presented
Itoh et al. S26

Markarian 421 observation in high state of 2001



- 10 nights observation during extremely strong flaring period
  - Jan.-Mar. in 2001
  - 14 hrs observation
- Possible observation by CANGAROO telescope ?
  - Mrk421 (J1104+3812) in northern hemisphere
  - CANGAROO in Australia
  - culmination zenith angle ~70°

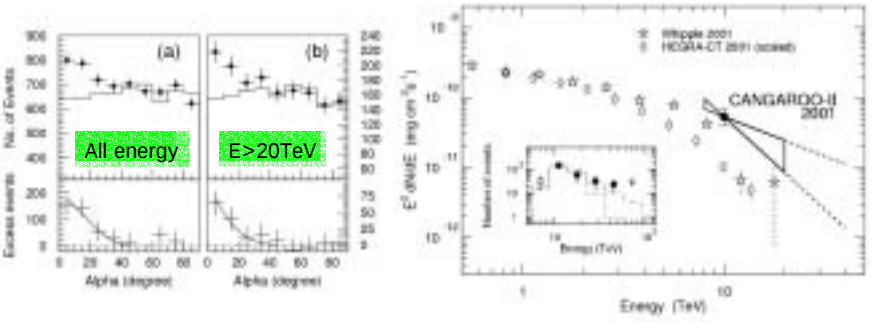
Large zenith angle observation



- Mrk421 observed at a zenith angle of 70°
  - shower develops ~3 times farther ($\cos^{-1}\theta \sim 2.9$)
- Effective area increased by factor of ~10 ($\sim 10^{10}$ cm^2)
- Also energy threshold increased to ~10 TeV

Mrk421 results

Poster presented
Okumura et al. S15



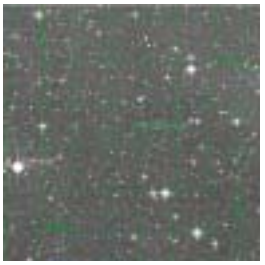
- ~300 events (5.7σ) observed from 14 hrs observation
- Energy spectrum steeper than that observed at E<10TeV ($\propto E^{-4.0}$)
  - support Mrk421 cutoff spectrum
- However, marginally significant excess (4.0σ) observed at E>20TeV
  - higher cutoff energy of ~8TeV favored rather than 4TeV

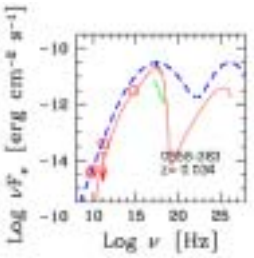
Future plan

- Further search for new TeV γ-ray source
  - EXO0556.4-3838 (z=0.034)
  - cluster of galaxies (3EGJ1234-1318), Small Magellanic Cloud (SMC)
- TOO observation from X-ray/TeV-γ flare information
- Stereo observation with CANGAROO-III

EXO 0556.4-3838

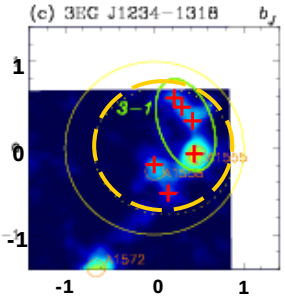
- High Energy Peaked BL Lac (HBL)
  - RA=89.526 deg, Dec=-38.641 deg (J2000)
  - z=0.034
- Theoretical flux prediction:
  - F(>300GeV) = 5.84/0.42 x 10^{-11} cm^{-2} sec^{-1}





3EG J1234-1318 / SMC

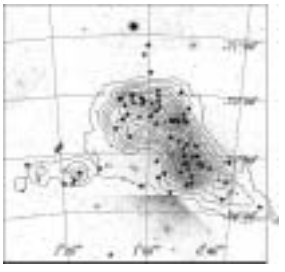
3EG1234-1318



- Clusters of galaxies in error circle of EGRET un-ID
- GeV spectrum $\propto E^{-2.1}$
- ~20 hrs obs. In 2002

Poster presented
Hattori et al. S35

SMC



- SMC
  - High Mass X-ray Binary
  - Star Formation region 30times of our Galaxy
  - Gas density; 3times of Galaxy
- Now observing

Summary

- No significant γ-ray signals observed from PKS2155-304 during 2000-2001 observations

  Poster presented by T.Nakase S34

- TeV γ-rays detected from NGC253

  Poster presented by C.Itoh S26

- E>10TeV γ-rays observed from Mrk421 at LZ angles of 70° during strong flaring period in 2001
  - *to appear in ApJ Letters (astro-ph/0209487)*

  Poster presented by K.Okumura S15