

Sorry for not being able to  
attend this meeting!



# Astrophysical Aspect of ASHRA

Naoshi Sugiyama



National Astronomical Observatory Japan

# ASHRA



- Detect both fluorescence & Cherenkov
  - Simultaneous observations of EHE cosmic rays (p/  $\gamma$ ), TeV  $\gamma$ , VHE  $\nu$ , optical photon
- Superb angular resolution: 1 arcmin
- Wide field of view
- Relatively cheap cost: phase 1, \$ 5mil: **Funded!**

**What are the major scientific outcomes?**

**What can we learn about astrophysics?**

# Scientific Cases

- (1) High Energy Neutrinos
- (2) High Energy Gamma Rays
- (3) Ultra High Energy Cosmic Rays
- (4) Optical Photons

# (1) High Energy Neutrinos

**ASHRA has unique capability to detect  $\nu$ 's**

$$E_\nu > 10^{16} \text{eV}$$

- AGN jets

If  $e^-$ -p jets: high energy  $\nu$  emission is generated



**Key question:  $e^-$ -p or  $e^-$ - $e^+$ ??**

- If  $e^-$ -p, protons are accelerated by AGN Jets!

How large can AGNs accelerate protons?

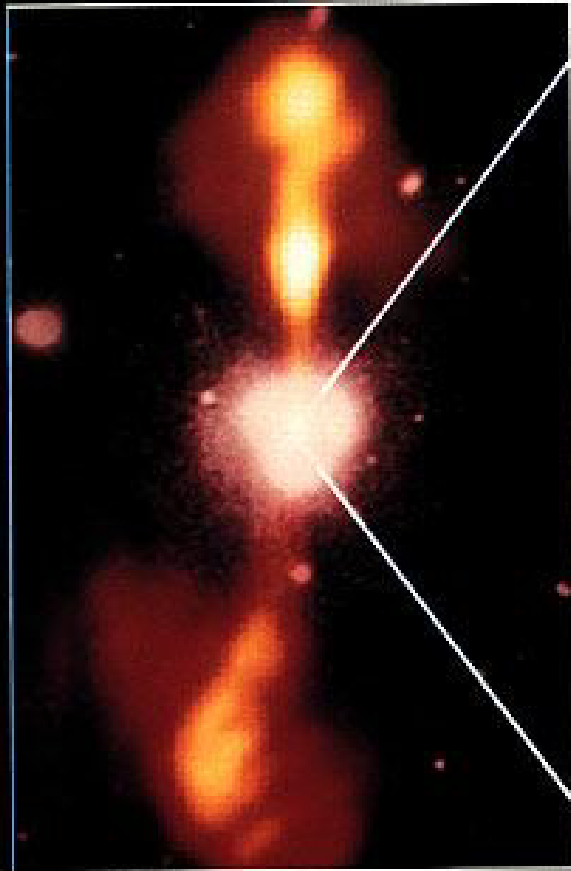
**- Origin of high energy cosmic rays -**

# Core of Galaxy NGC4261

Hubble Space Telescope

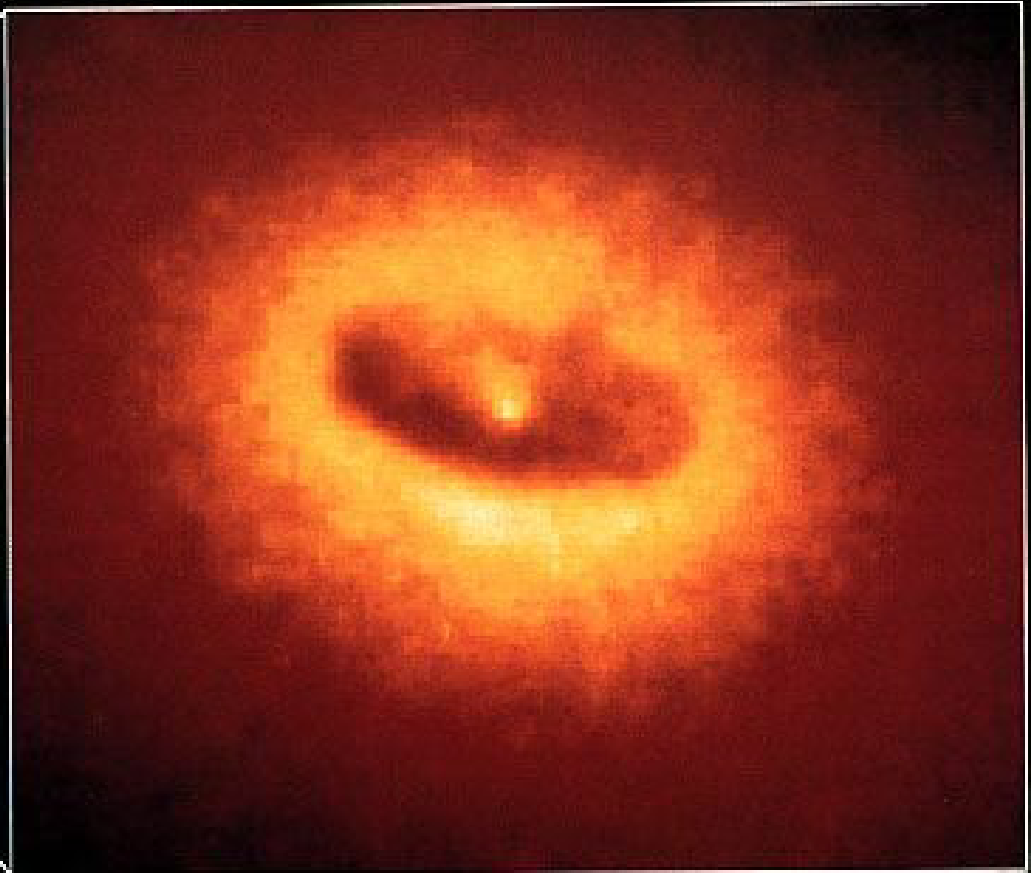
Wide Field/Planetary Camera

Ground-Based Optical/Radio Image



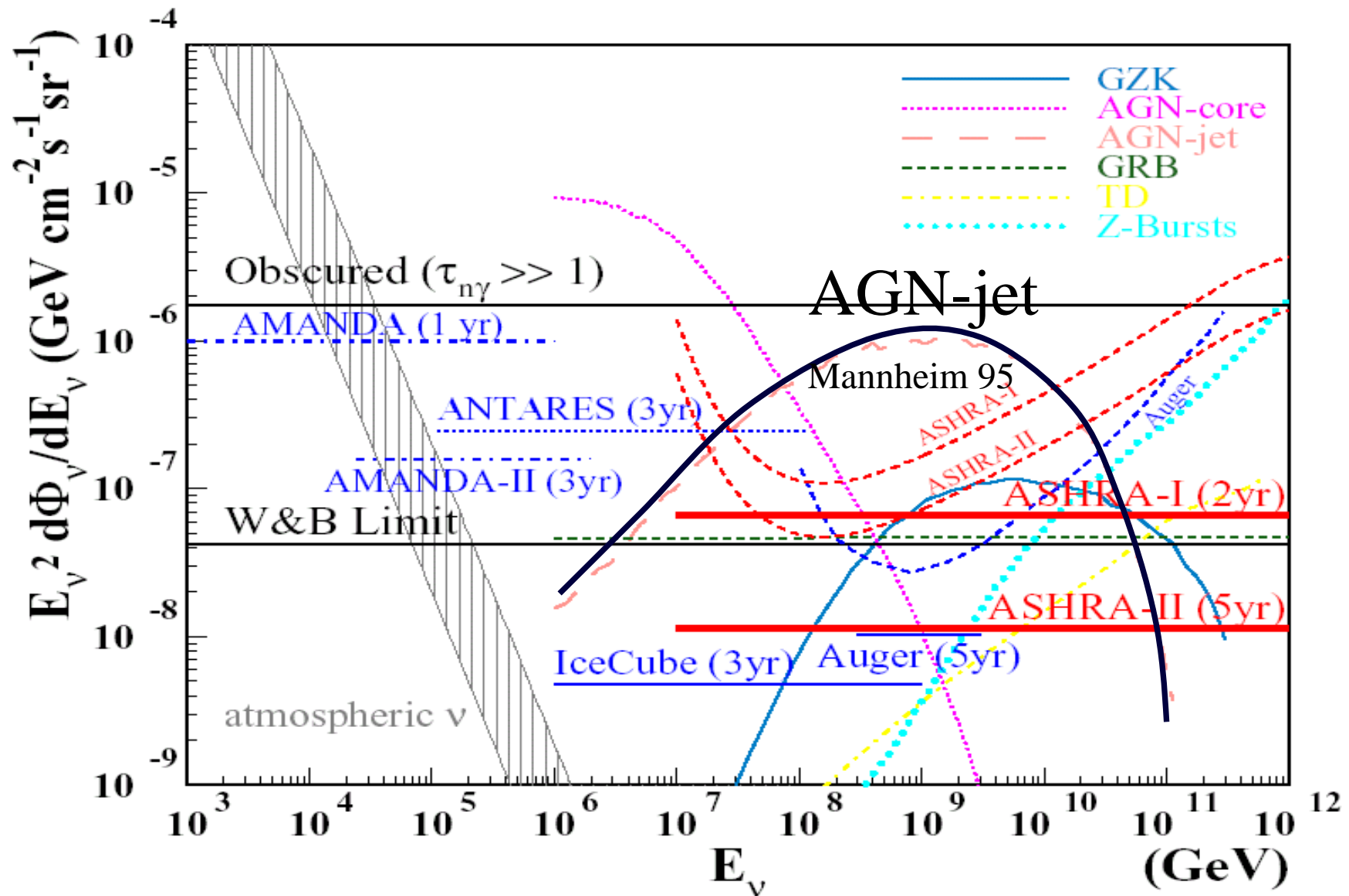
380 Arc Seconds  
88,000 LIGHT-YEARS

HST Image of a Gas and Dust Disk



17 Arc Seconds  
400 LIGHT-YEARS

# Neutrino sensitivity



# • Gamma-ray Bursts

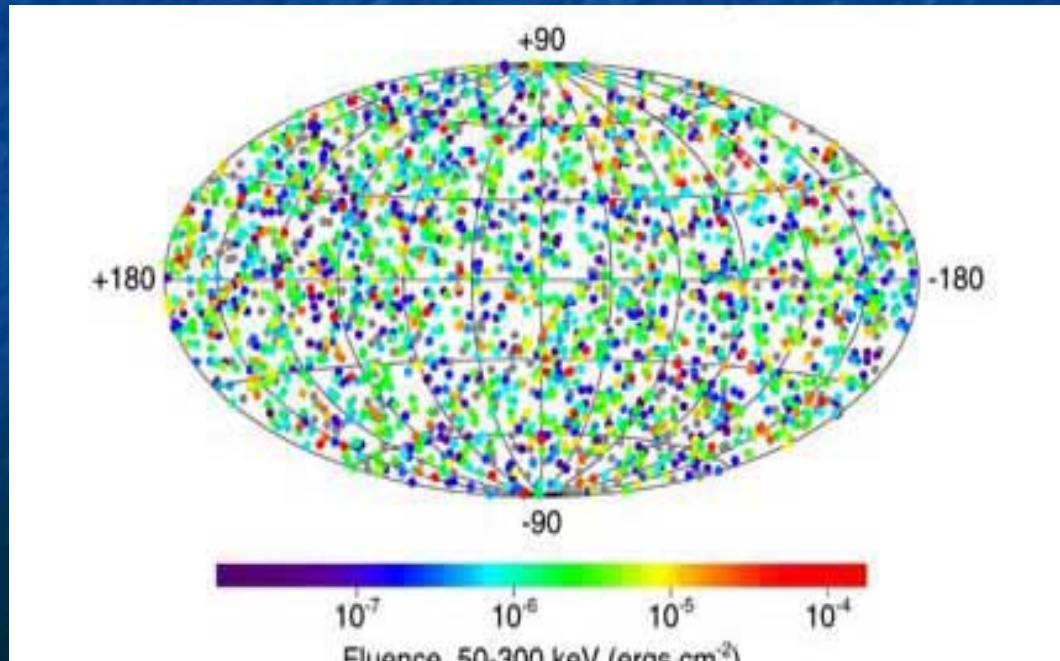
- Photo-pion interactions generate  $\nu$ 's if p is accelerated: internal (reverse) shock
- failed GRBs can be measured by  $\nu$ 's

Coincidence measurements are important:

Gamma-rays, low energy  $\nu$ , gravitational waves,

**optical flash,**  
**high energy  $\nu$**

1000events/yr.



- Other Sources of high energy  $\nu$ 's
  - Ultra high energy CR origin: GZK cutoff
  - Galactic pulsars
  - Galactic Center Black Hole
  - Cosmic String? Z-burst?, Q-ball???

**ASHRA can open the door to the new era of  
 $\nu$  astronomy**



## (2) High Energy Gamma Rays



**ASHRA has unique capability to carry out All-sky**

### **Gamma-ray monitoring**

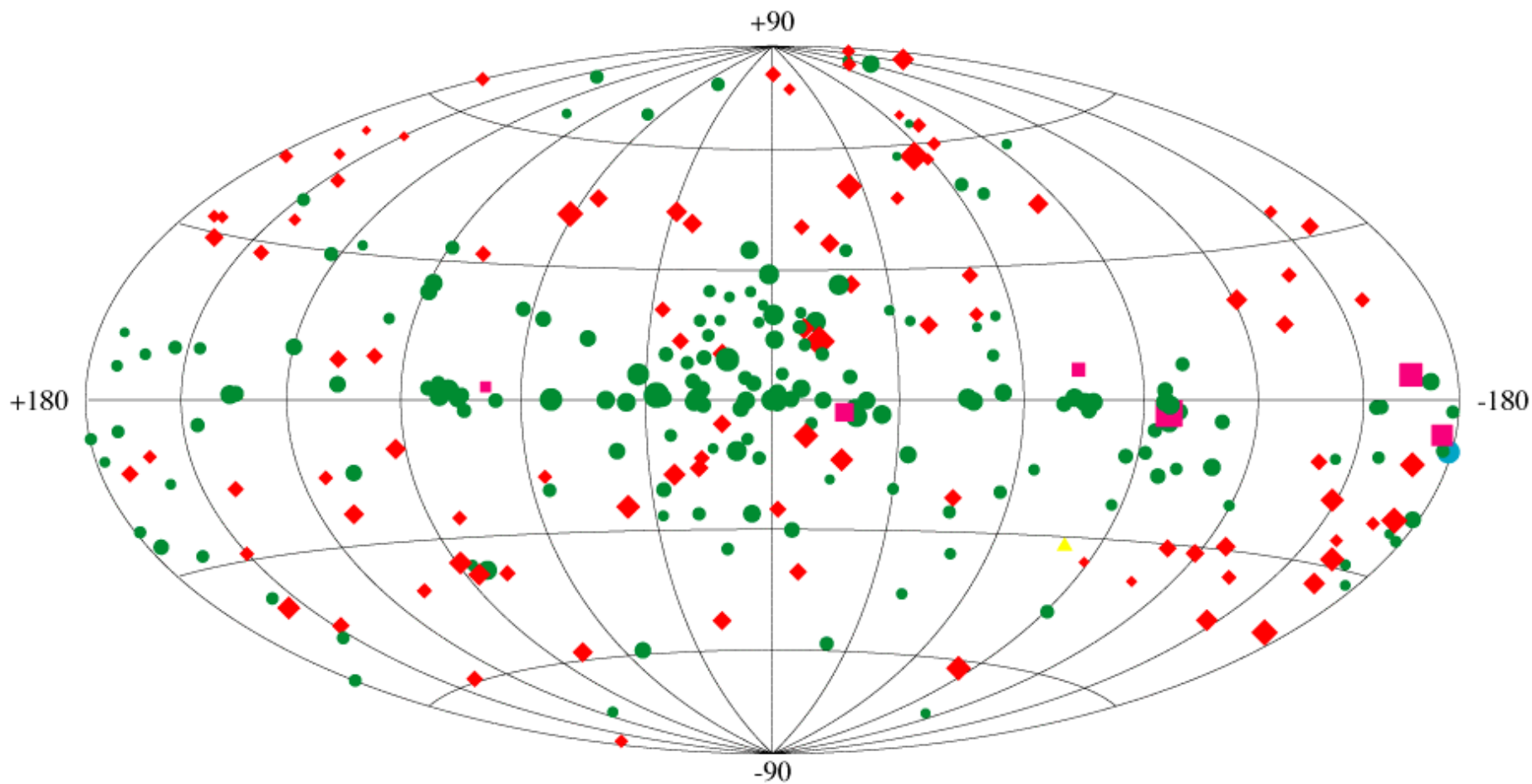
- **Gamma-rays from UHECR sources**
  - Source object identification
  - Energy spectrum provides information of source
- **Monitoring observations of transient objects**
  - TeV gamma-rays associated with GRB?
  - Time variability of Blazars

# • TeV gamma-ray all-sky survey

- Better understanding of known types of gamma-ray sources
- Information of un-identified GeV gamma-ray sources by EGRET
- Determination of IR background
  - TeV  $\gamma$ -IR  $\gamma$  annihilation:  
Constrain IR background, AGNs & GRBs  
TeV gamma

# Third EGRET Catalog

$E > 100 \text{ MeV}$



- ◆ Active Galactic Nuclei
- Unidentified EGRET Sources

- Pulsars
- ▲ LMC
- Solar FLare

### (3) Ultra High Energy Cosmic Ray

**ASHRA is expected to detect 33 events/yr.  $> 10^{20}$ eV**

**Particle Identification is possible (unlike AGASA).**

Together with gamma-rays and neutrinos:

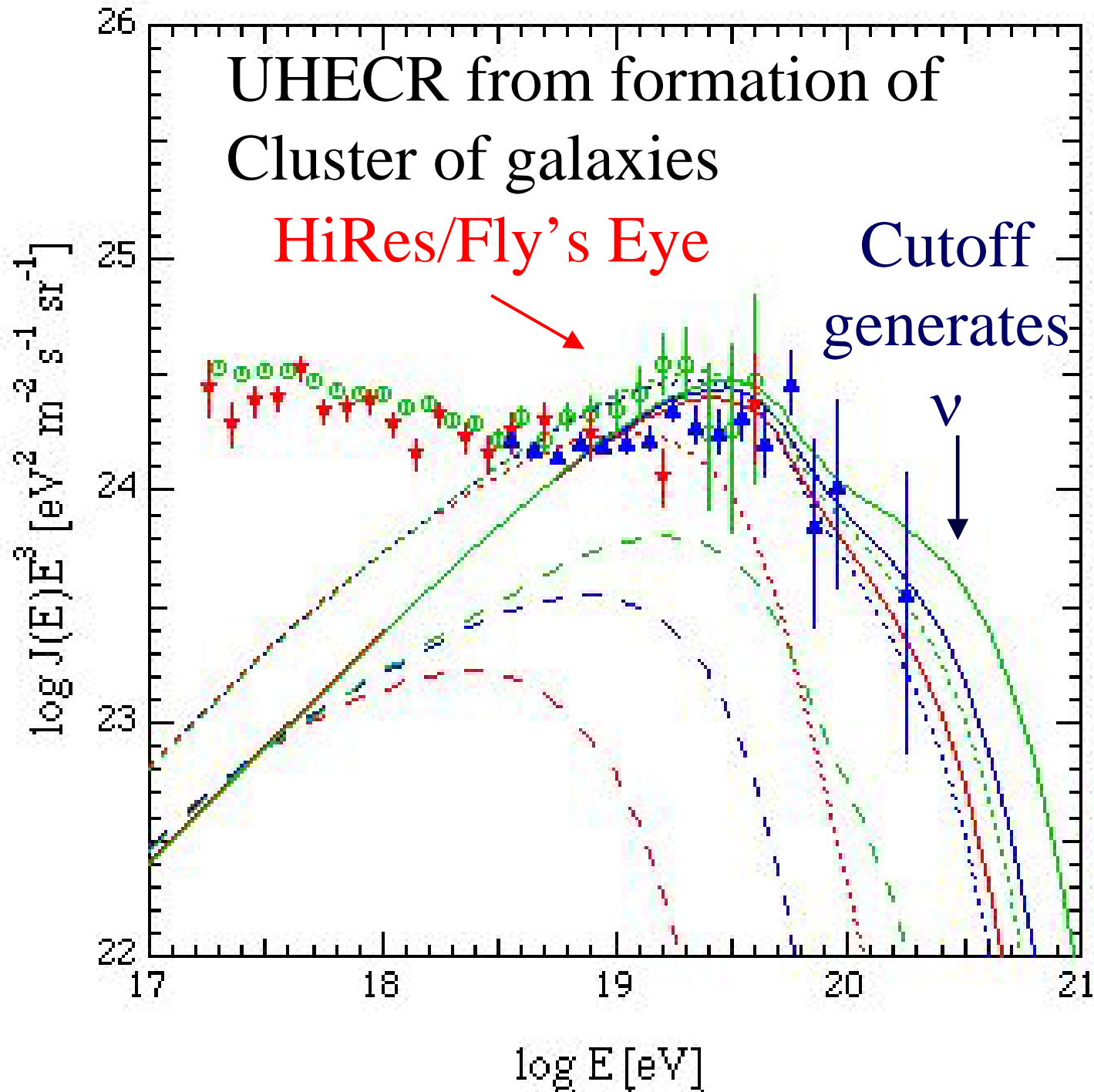
we can clarify the sources of UHECR:

- AGN jets
- GRBs
- Formation shocks of Cluster of galaxies
- Strong magnetic field neutron stars
- ?

# UHECR from formation of Cluster of galaxies

HiRes/Fly's Eye

Cutoff generates



Inoue  
& NS

## (4) Optical Photons

### Optical flash of Gamma-ray bursts

**GRB030329**

12 magnitude: one hour after the burst

18 magnitude: two days after the burst

Observed by 30cm telescope in Tokyo! (TITECH)

**Very Bright BUT only for a couple of hours**

**All sky monitor is needed!**

ASHRA will be ideal to observe this phenomena

- thanks for the wide field of view! -

**Information of central engine?**



2003/3/29 21:57



1 hour after burst

3/30 0:00



3 hours after burst

3/30 2:08



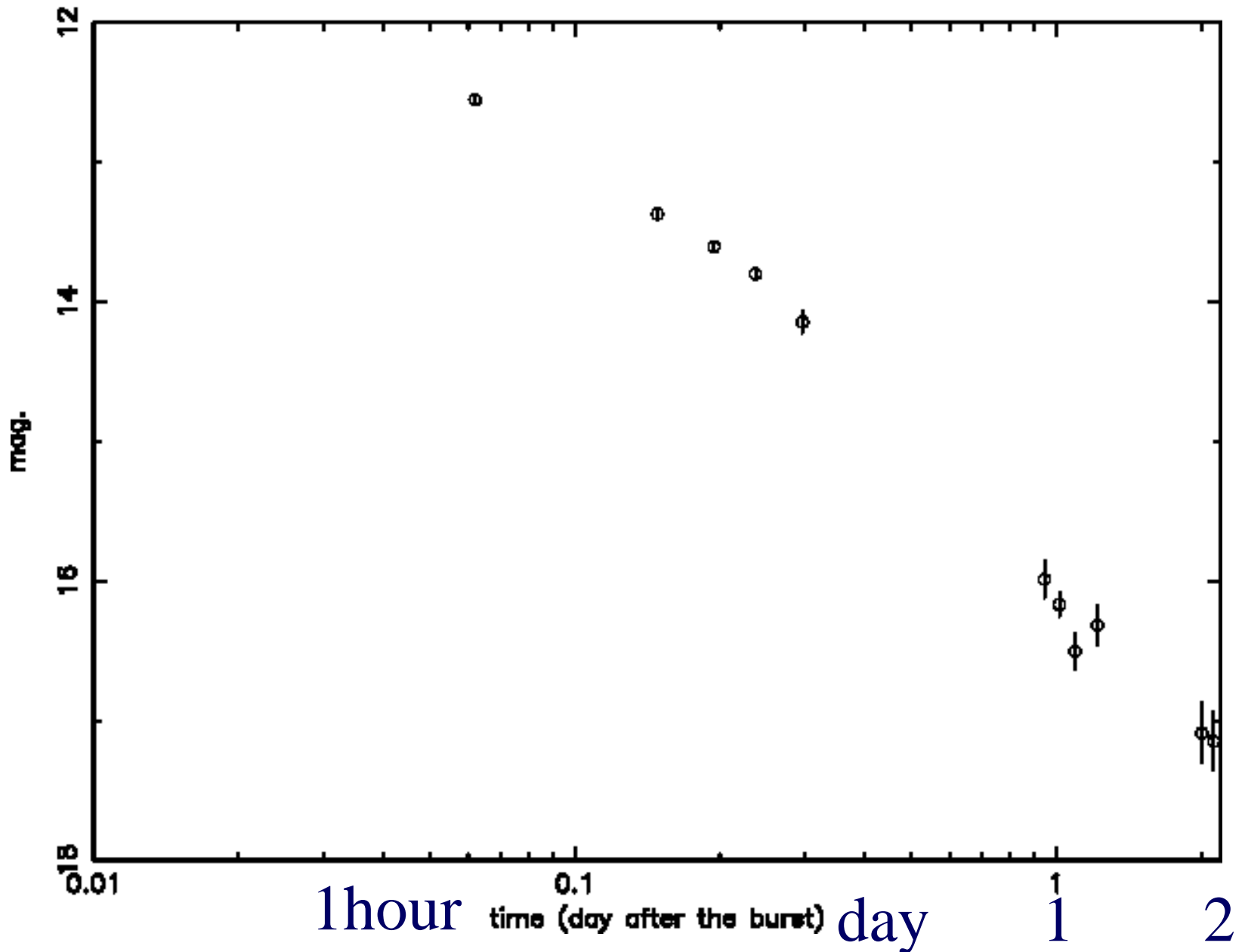
5 hours after burst

3/30 3:32



6.5 hours after burst

# GRB030329





ASHRA is a really unique project to probe  
High energy astrophysics by  
observing both Fluorescence & Cherenkov  
which makes us possible to measure  
**EHE-CR, TeV  $\gamma$ , VHE  $\nu$ , optical light  
simultaneously!**

