## Introduction to MAGIC Telescopes



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#### Outline

- High energy astronomy
- High energy sources (Pulsar, AGN, GRB)
- Detection Technique
- Current status
- Future plan



# Limitation of space satellite in the VHE range (> 100GeV)

Small effective area results in low detection rates at E>100GeV, even for strong sources: For Crab is around 100 photons/m<sup>2</sup>/year



A detector in space has collection area ~1m<sup>2</sup> A detector on the ground has collection area ~10000m<sup>2</sup>





#### ~200 emit even higher energy (TeV)



Sky map in galactic coordinate The sources are detected by IACT: "Imaging Atmospheric Cherenkov Telescopes"

#### Pulsar-Galactic Source



- A highly magnetized, rotating neutron star.
- Neutron stars are very compact objects with the mass of the sun but a diameter of about 20 km.
- Emitting a beam of electromagnetic radiation.
- Radiation can be observed only when the beam of emission is pointing toward the Earth.
- Emission regions and mechanism remains unclear (Giovanni's talk)

### AGN (Active Galactic Nuclei )-Extragalactic



Urry, C. Megan and Paolo Padovani 1995.

- Galaxies hosting a supermassive BH in their center.
- Blazars: One jet points towards the earth.
- Flare: Rapidly varying-activity of blazars.
- Acceleration models are needed to explain the fast evolution of flares.

#### GRB (Gamma Ray Burst)-Extragalactic



Fermi GRBs from 08/2008 to 05/2016

Transient extragalactic sources (a second to a ferminutes ) that occur randomly and unpredictably MISSING in TeV

#### MAGIC telescopes



- Located on La Palma, Canary Islands, Spain (28.8°, 17.9°, at 2225m)
- Distance between two telescopes is 85m
- The first telescope started to take data in 2004, and stereo observations with both telescopes commenced in 2009.
- Energy threshold of ~ 50GeV
- Diameter D = 17mof the parabolic reflector dish
- Field of View of 3.5°

#### Extensive Air Showers (EAS)



#### The Imaging Atmospheric Cherenkov Technique (IACT)





Different views of the shower geometry

#### The Imaging Atmospheric Cherenkov Technique (IACT)



Parameterisation

For each event:

A vector value is stored with many components

- -For gamma/hadron separation
- -For direction reconstruction
- -For energy reconstruction



Example of an image of a  $\gamma$  -ray (*left panel*) and hadron (*right panel*) showers

#### MAGIC Performance



#### Current Status (Pulsars)

- 2008 MAGIC detected pulsed emission from Crab pulsar from 25GeV to nearly 100GeV.
- 2015 MAGIC detected pulsed emission from Crab pulsar from 100GeV to 400GeV.



<sup>(</sup>MAGIC, Science, 322, 1221)

(MAGIC,A&A,2585,A133)

#### Current Status(AGNs)

• 2017 MAGIC reported evidence for gamma-ray emission from the IceCube high-energy neutrino candidate event TXS 0506+056 (AGN).



Science 361, eaat1378 (2018)

#### 15th year's birthday of MAGIC





- To improve the sensitivity at lower energy range (Sum-Trigger-II) and higher energy range (Very High Zenith-angle observations).
- Based on what we have learned from MAGIC, the Cherenkov Telescope Array (CTA) is expected to start operation in the near future.

Calibration for CTA SiPMT test for CTA

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- CTA will employ three different-sized telescopes: a Large Size Telescope (LST, 23 m diameter), a Medium Size Telescope (MST, 10–12 m) and a Small Size Telescope (SST, 4–6 m).
- What is the CR content of SNRs or of galaxy clusters? Up to what energies do GRBs accelerate particles? What is the particle nature of DM?

#### Thank you very much!