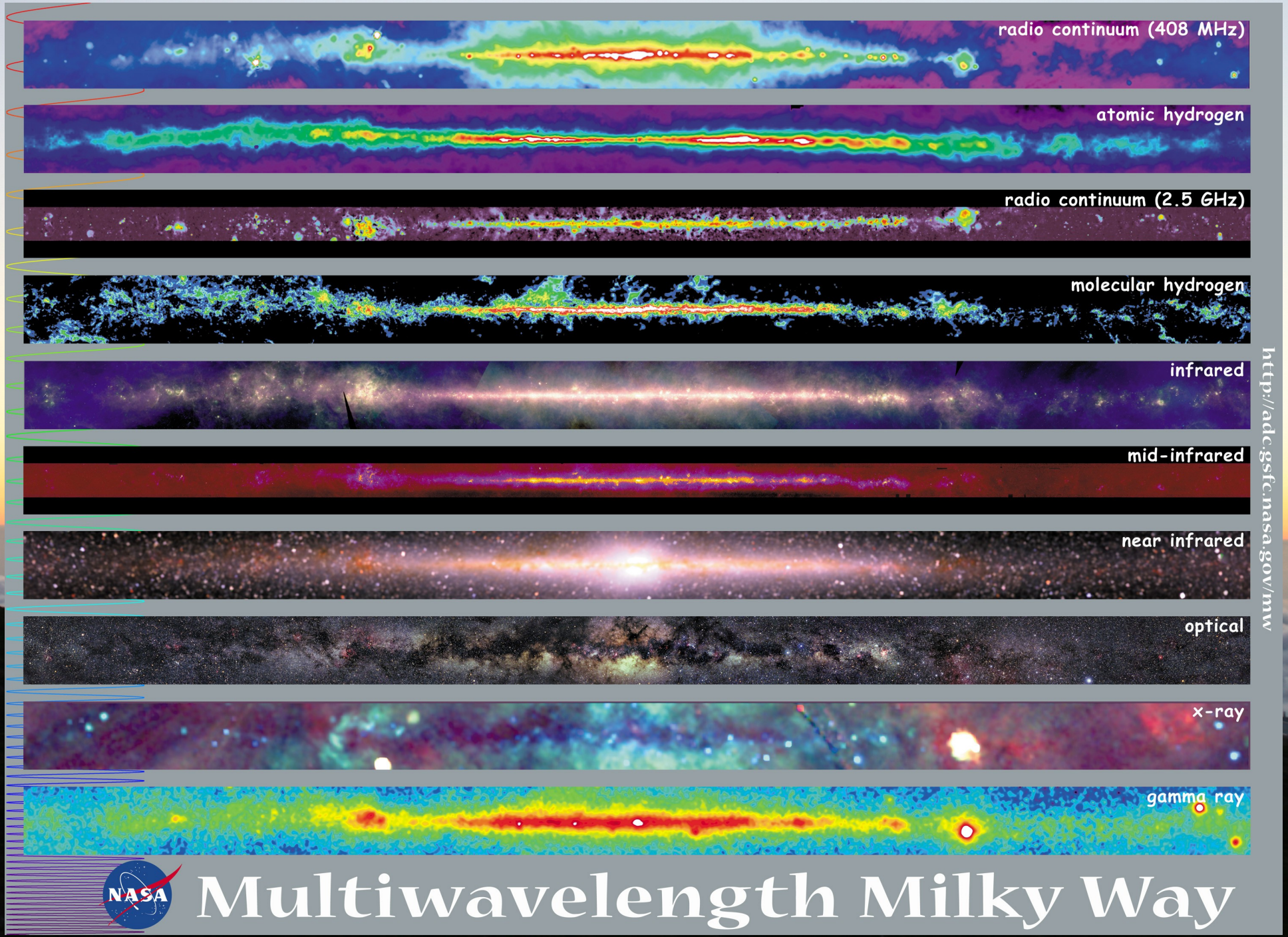
MAGIC...

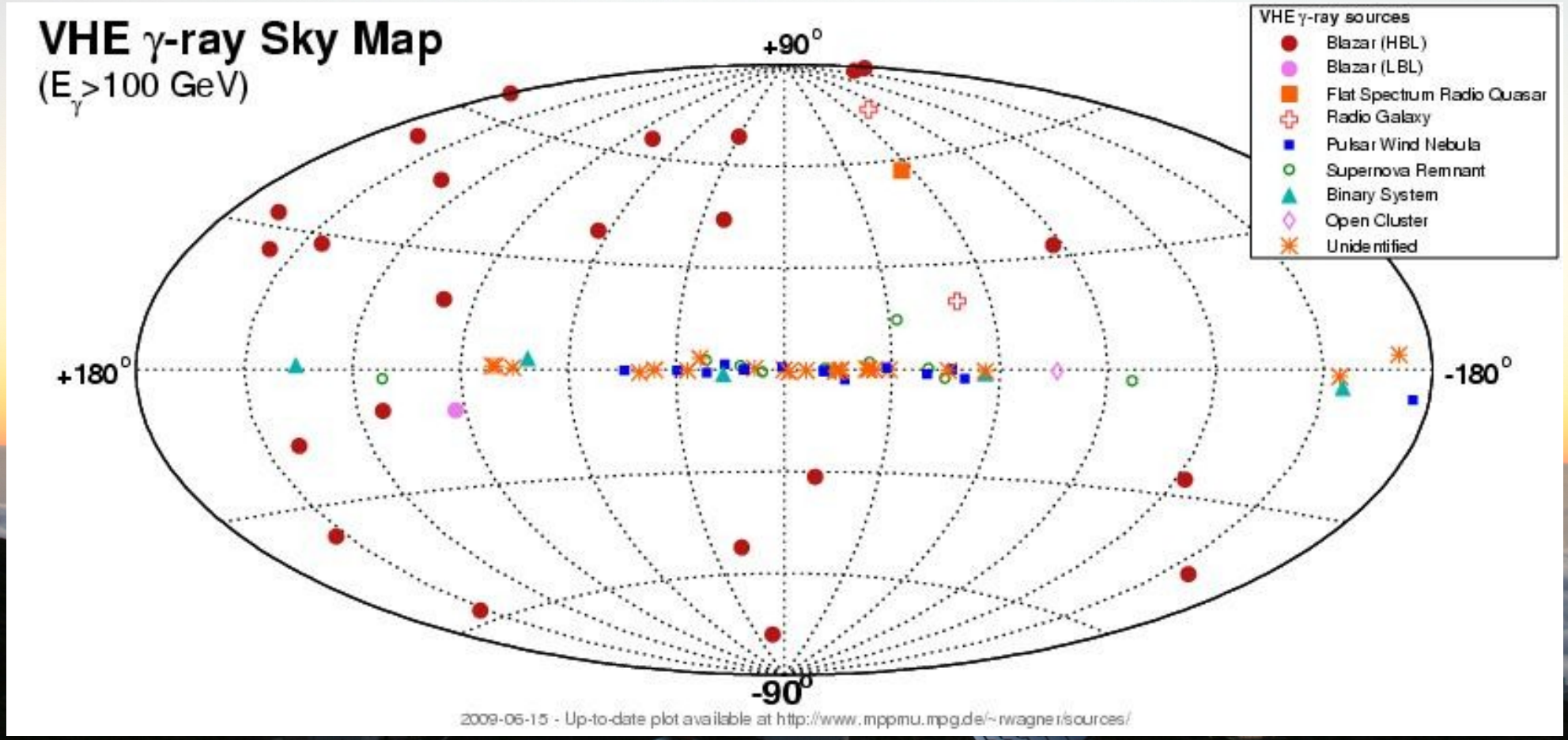
...una finestra sull'Universo

"seconda parte"

L'emissione della Via Lattea



Il cielo ad altissima energia



Come sono prodotti i raggi gamma?

Emissione termica (equilibrio) --> esempio luce (IR) di un corpo caldo, la luce delle stelle

Emissione non termica (condizioni di NON equilibrio, spesso dovute a fenomeni relativistici, tipo alta velocità delle particelle)

I RAGGI GAMMA PROVENGONO DA OGGETTI ASTROFISICI CON CONDIZIONI MOLTO PARTICOLARI (intensi campi magnetici, flussi di particelle ultra-relativistiche)

Come sono prodotti i raggi gamma?

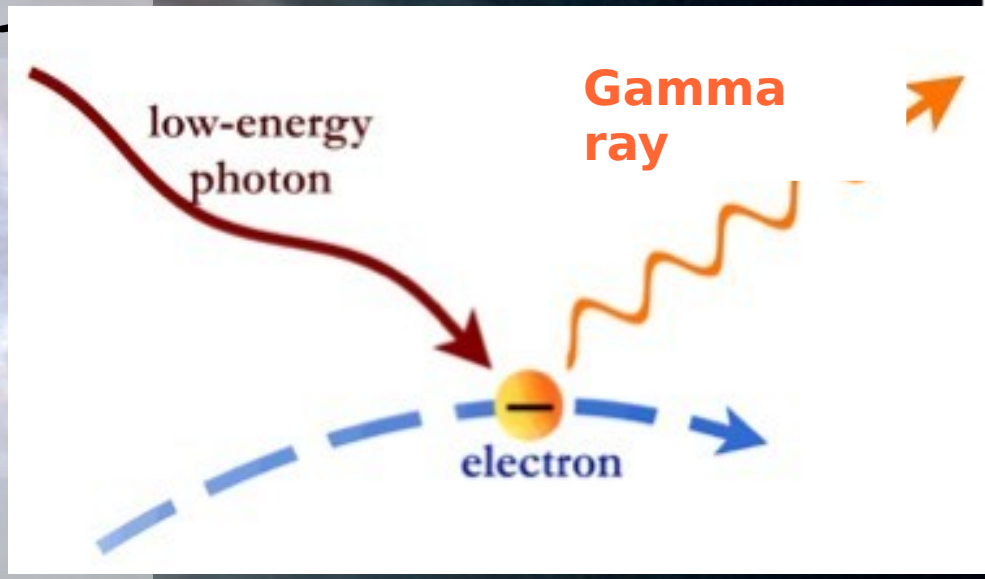
INVERSE COMPTON SCATTERING

Particella carica veloce +
campo magnetico

emissione (onde radio):
sincrotrone

onda radio urta particella

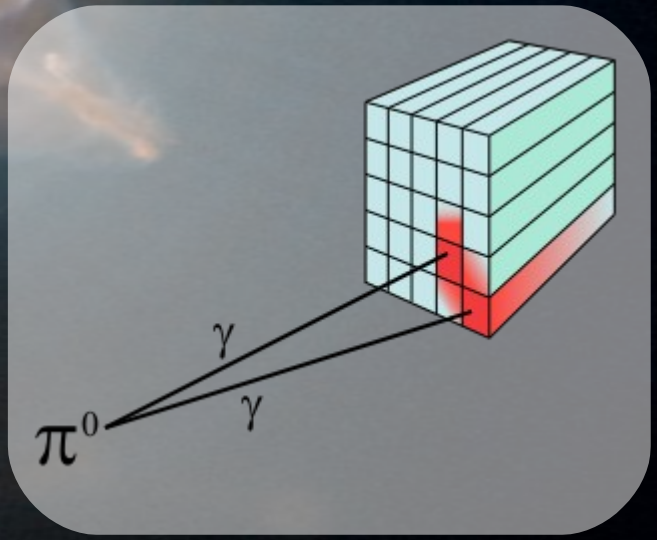
RAGGIO GAMMA



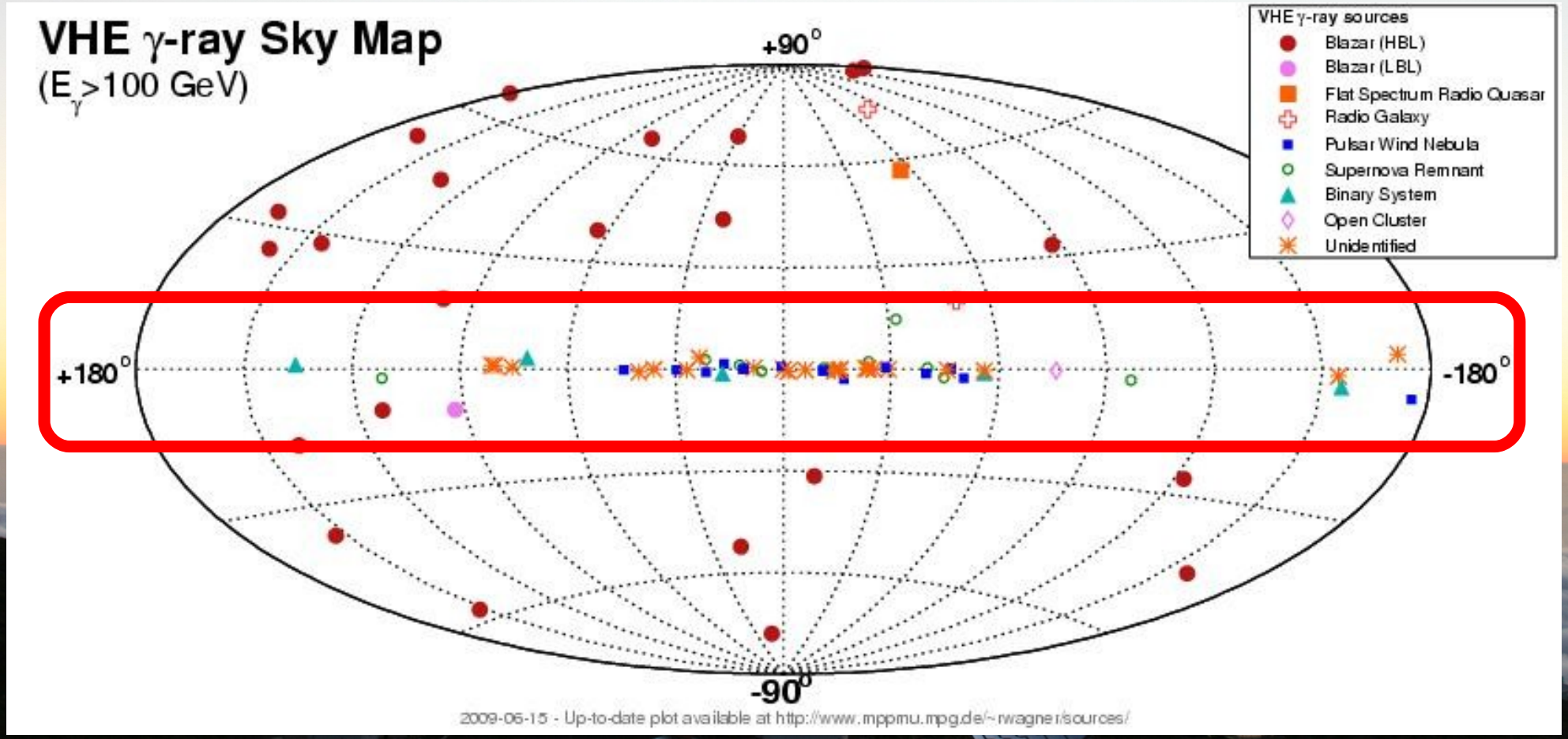
Come sono prodotti i raggi gamma?

NEUTRAL PION DECAY

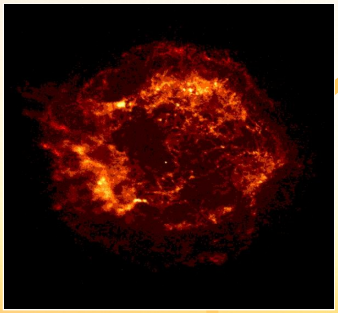
Pione Neutro (particella SUBATOMICA) ha una vita media molto breve e decade principalmente gamma-gamma



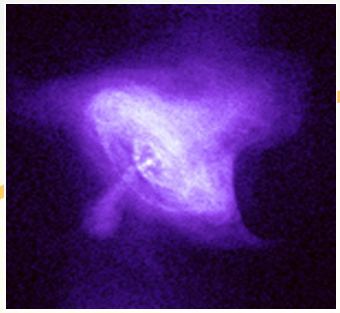
Il cielo ad altissima energia



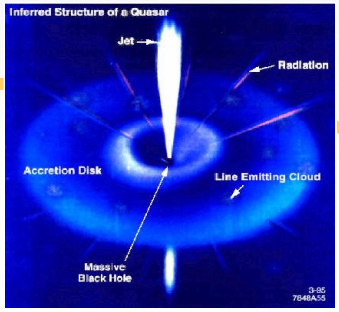
Possibili Sorgenti per il Telescopio MAGIC



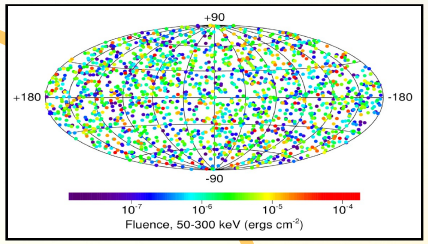
SNRs



Pulsars

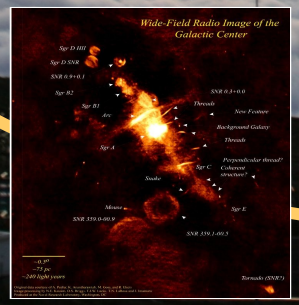


AGNs

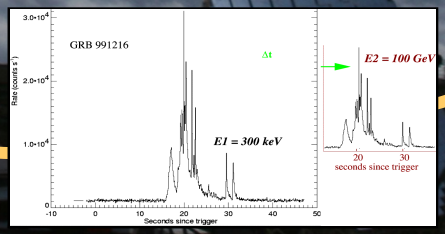


GRBs

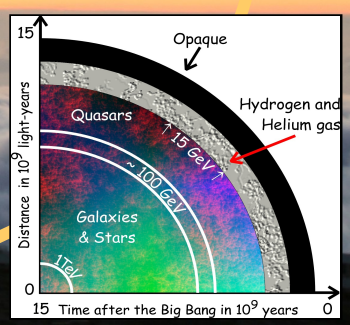
Origin of Cosmic Rays



Cold Dark Matter

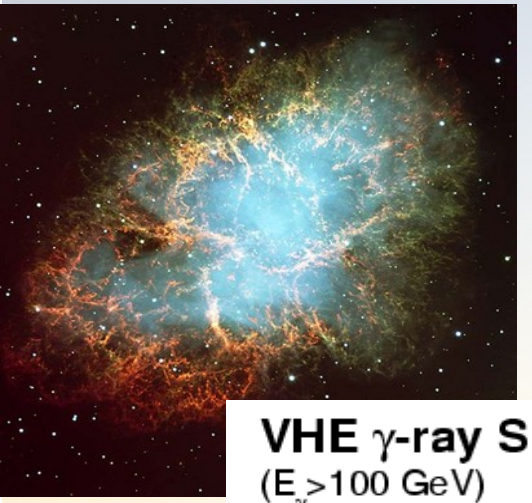


Quantum Gravity effects

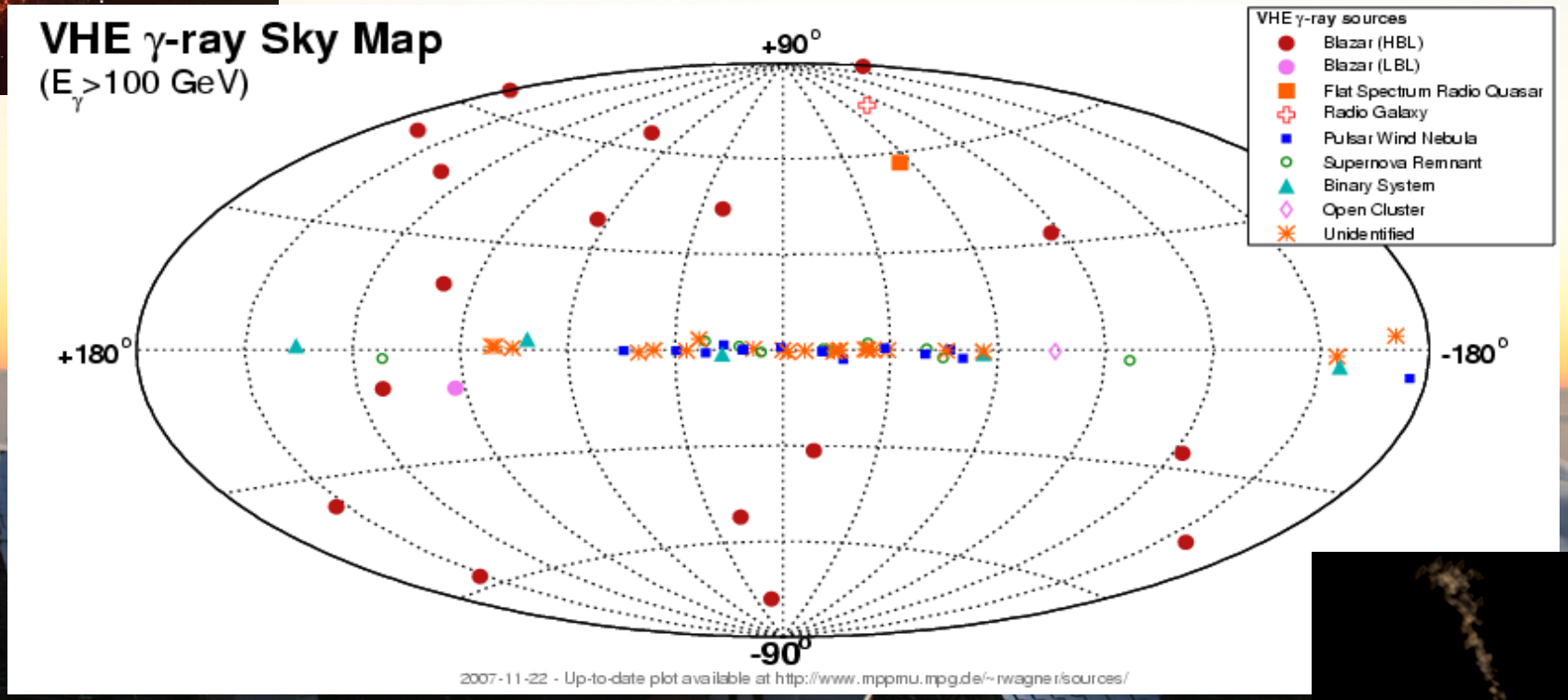


cosmological γ-Ray Horizon

Sorgenti gamma osservate

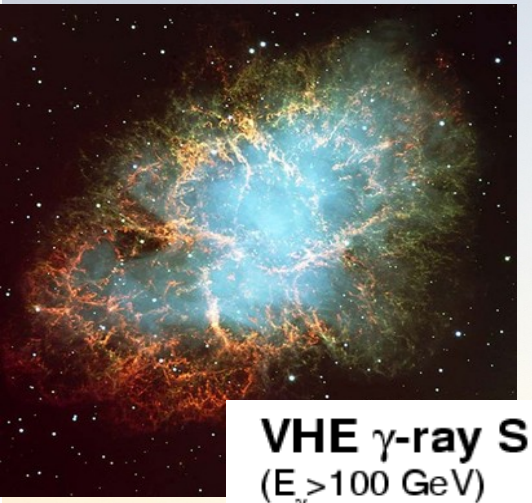


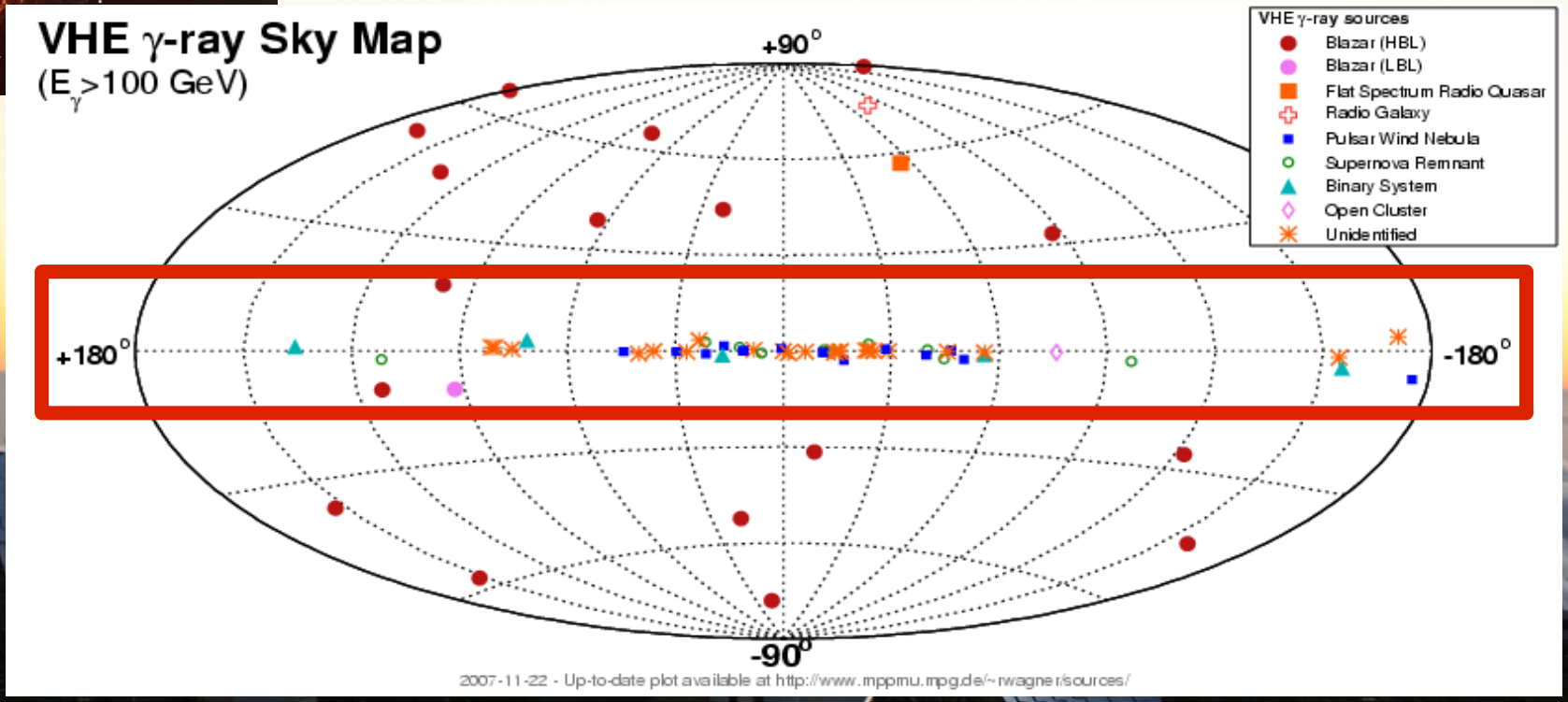
galattiche...



... ed extragalattiche

Le Sorgenti Galattiche

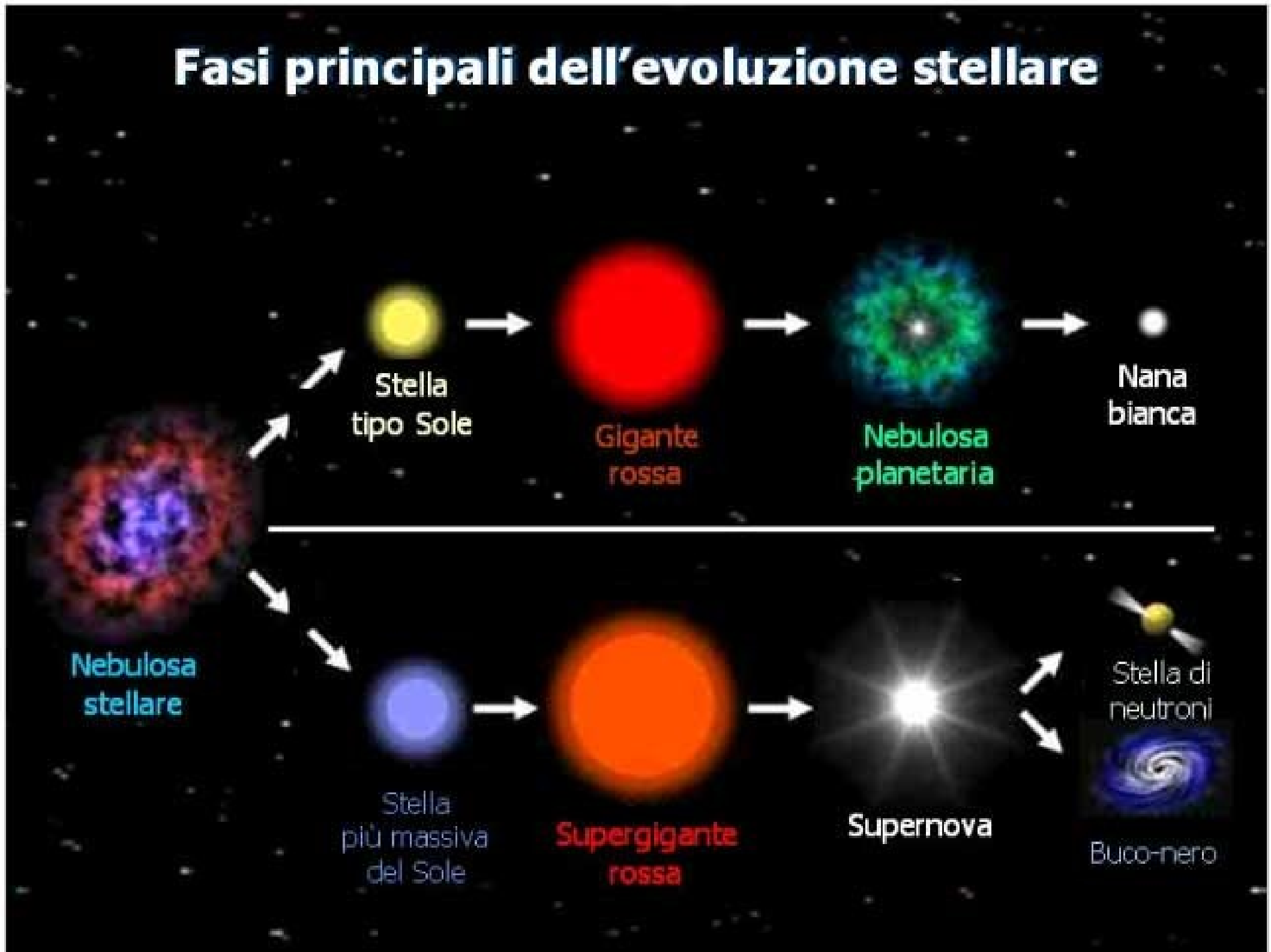




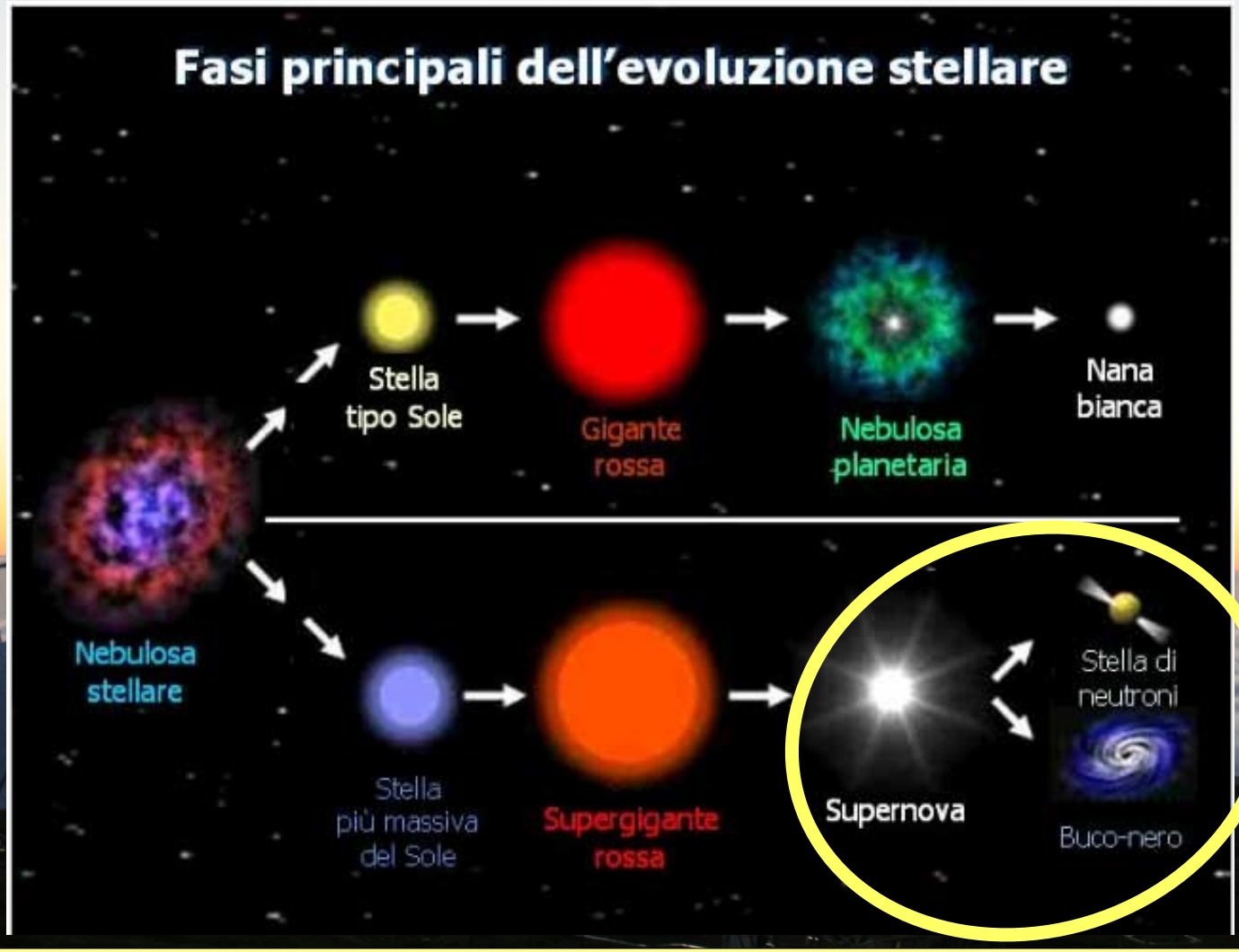
Via Lattea

Att! Ricostruzione immaginaria!!

Fasi principali dell'evoluzione stellare



Raggi gamma ultra-energetici dalle stelle



Particelle accelerate --> raggi gamma!

Supernova remnants (SNRs)

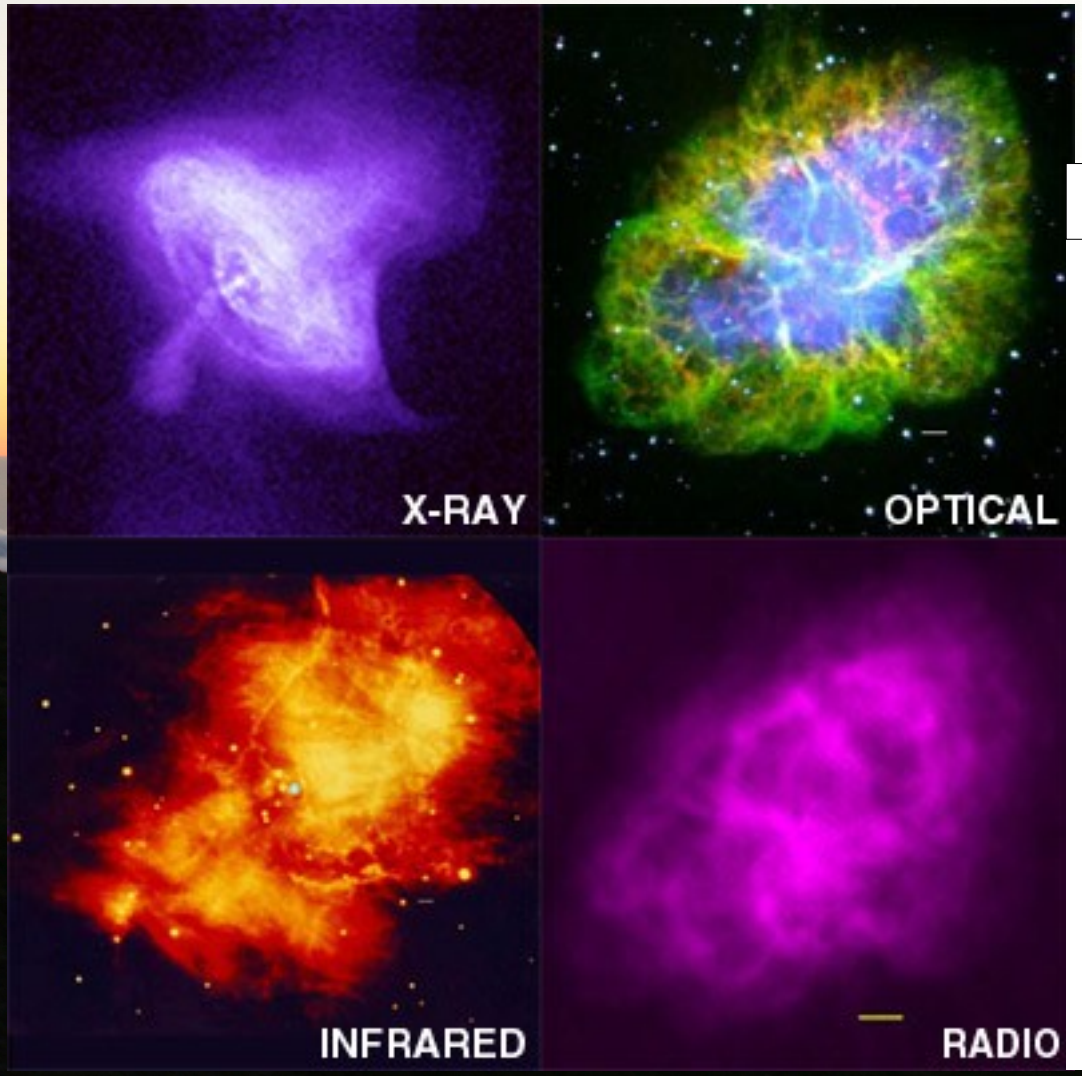
Tycho Nebula

Crab Nebula

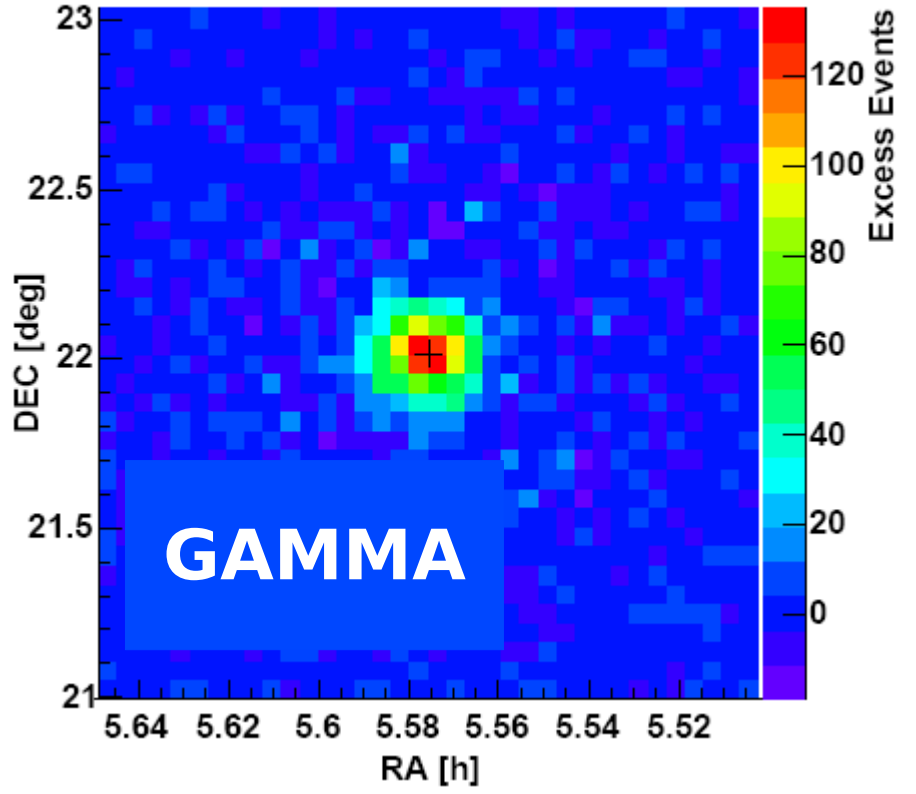
- Sono cio' che rimane da un'esplosione stellare
- Catalogate in "shell type" e "plerions (pulsar wind nebulae)"
- Onde di shock molto energetiche accelerano le paricelle cariche

Crab Nebula: check up completo!

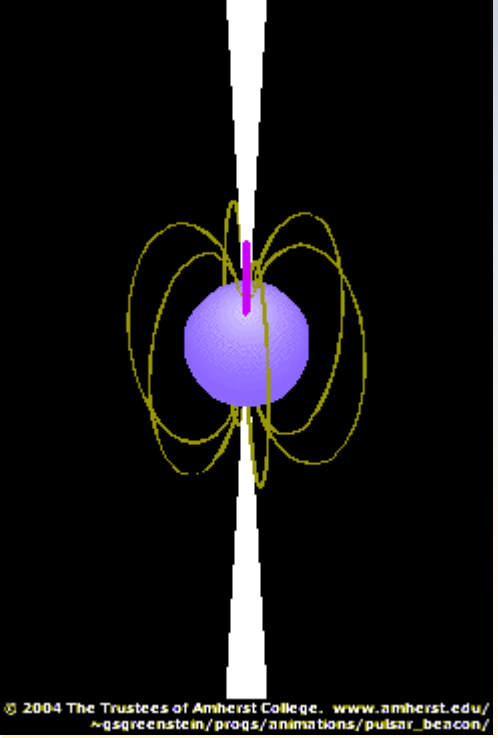
Ognuno fa la sua parte! Così possiamo studiare cosa avviene



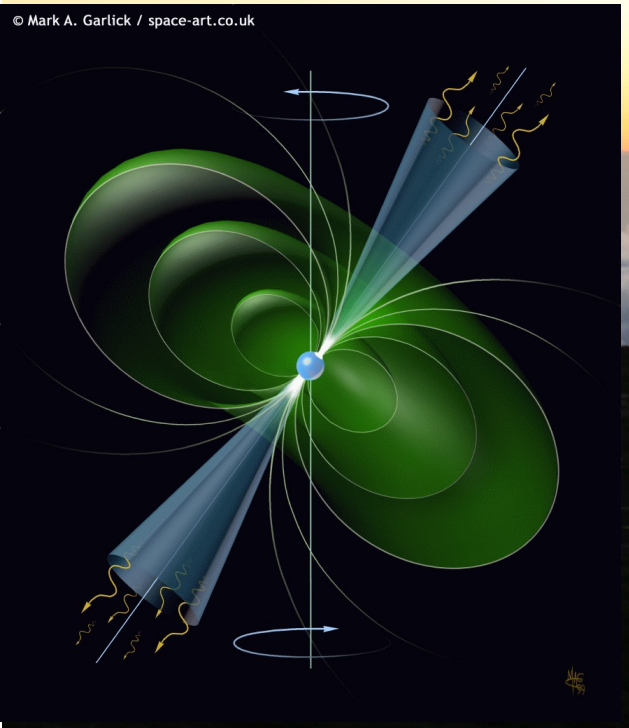
Gamma ray



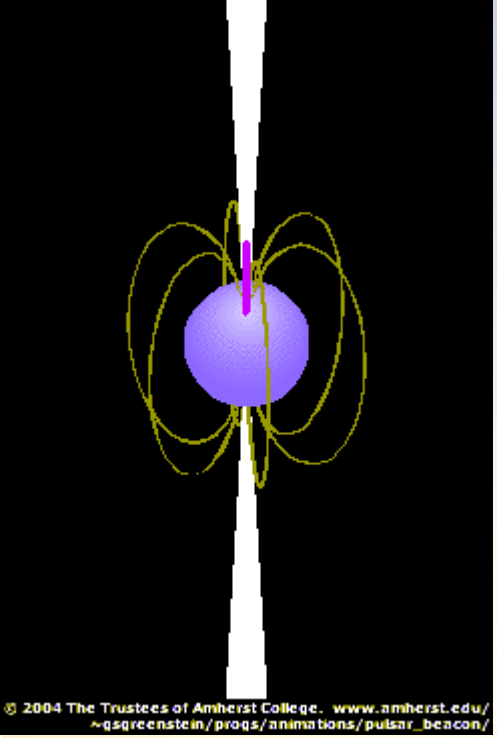
Pulsar

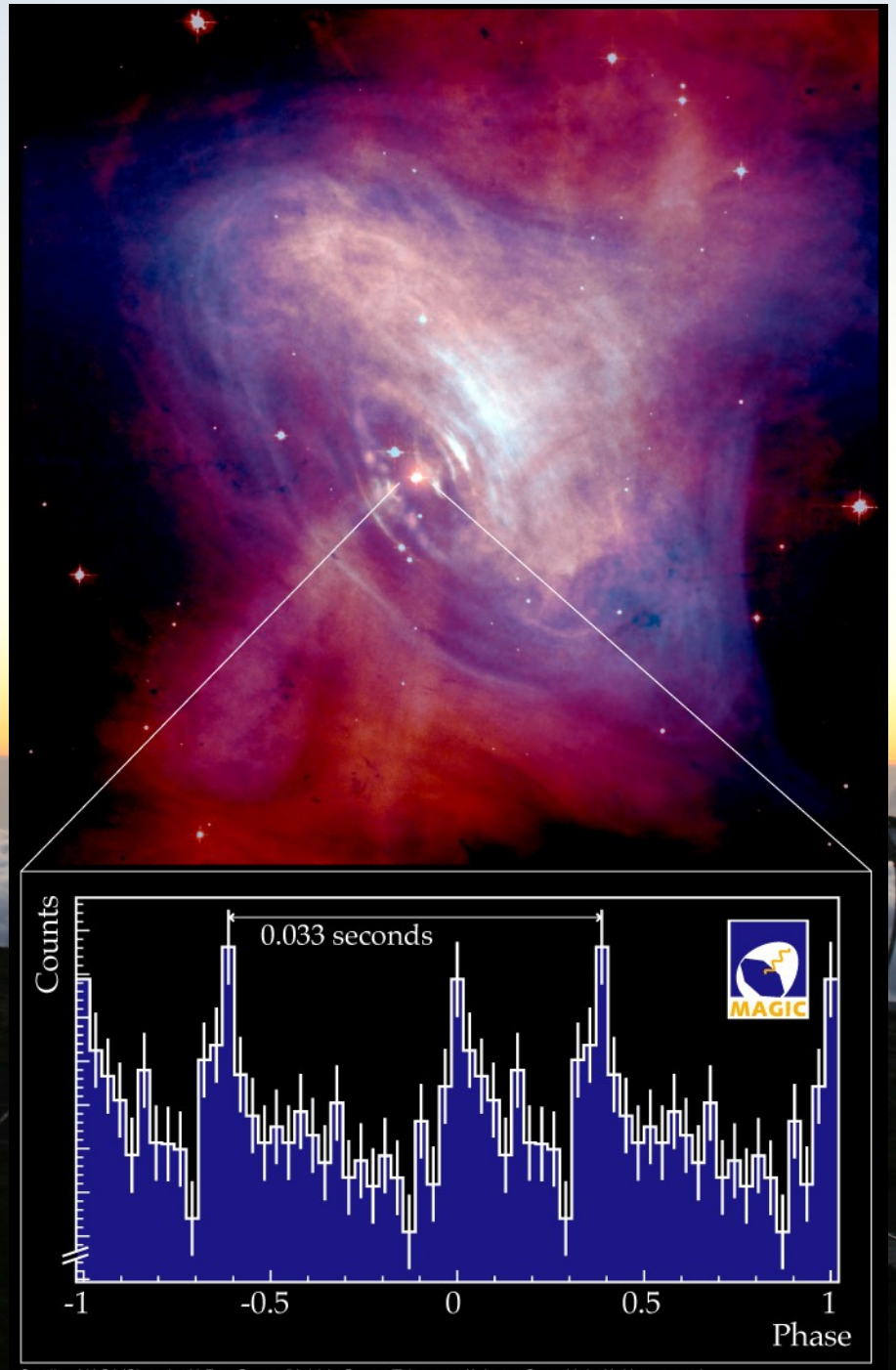


- All'interno delle SNRs in alcuni casi ci sono Stelle di Neutroni che ruotano rapidamente emettendo un segnale pulsato molto rapido
- MAGIC ha scoperto un segnale gamma VHE (40 GeV) da una di queste sorgenti



Pulsar





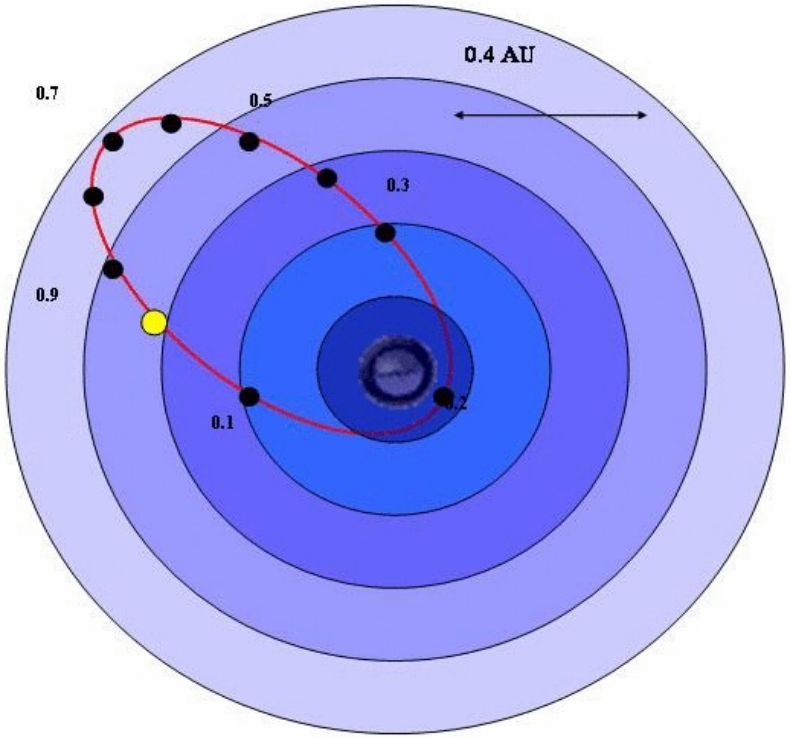
Credits: NASA/Chandra X-Ray Center/Hubble Space Telescope/Arizona State Univ./J. Hester et al.

Microquasars

- Sistemi binari formati da un buco nero (generato dalla morte di una stella massiva) e da una gigante rossa che lo alimenta

- I buchi neri sono circondati da un disco di accrescimento e da due jet in cui vengono accelerate particelle ad energie ultrarelativistiche

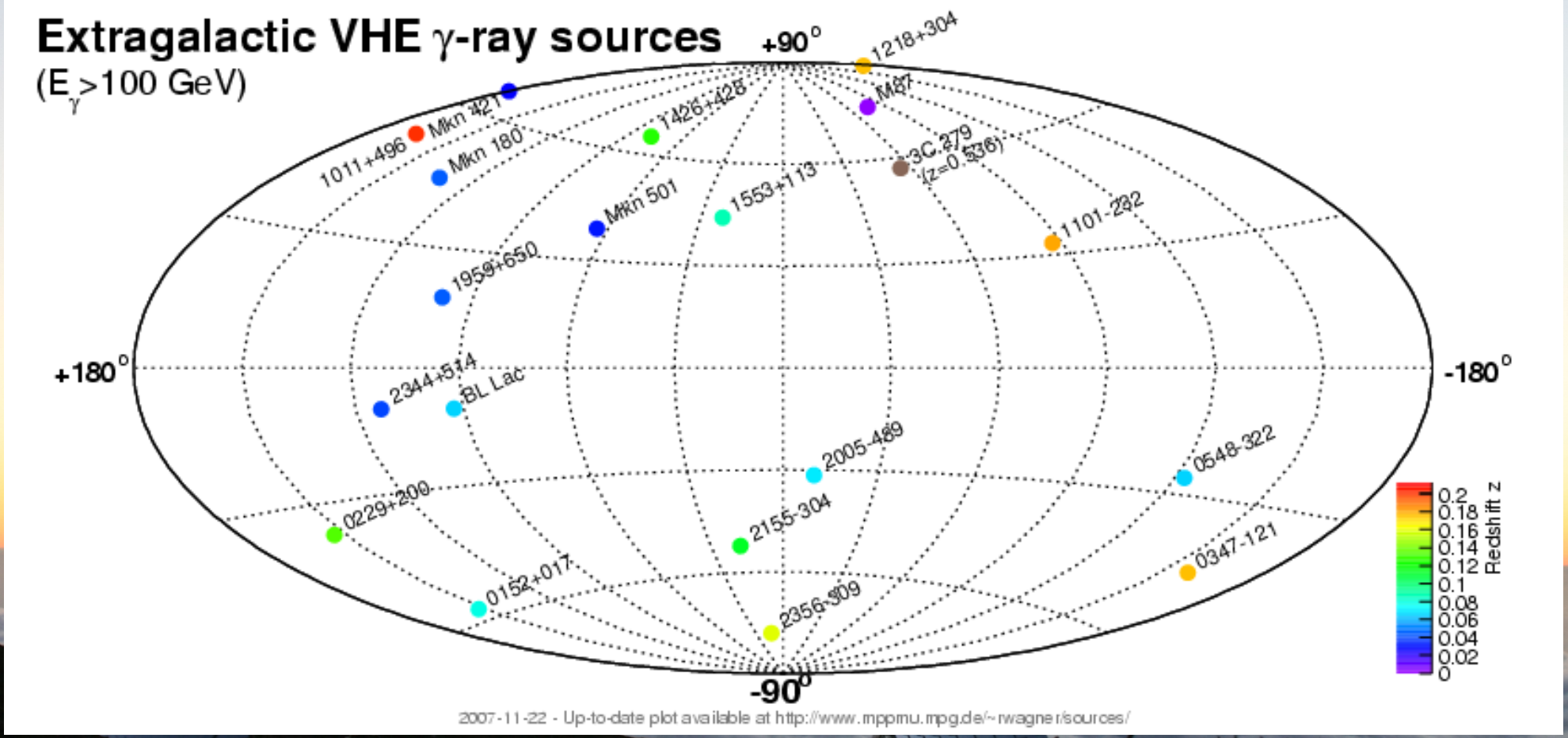
La Sorgente LSI 61+303



Fermiamoci un attimo e ricapitoliamo!

Fotografia in ottico del telescopio Hubble

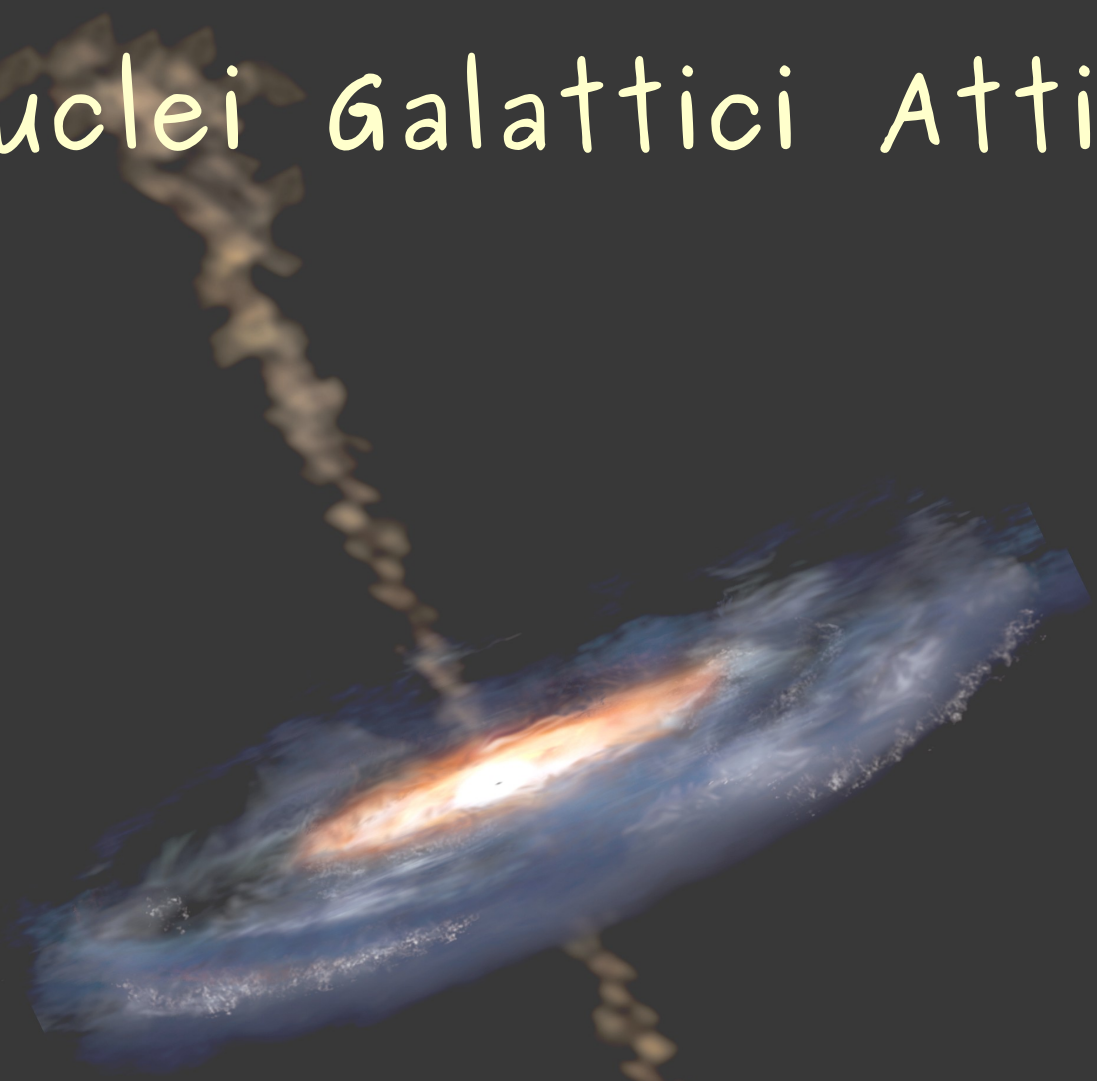
Sorgenti Extragalattiche



TUTTE LE SORGENTI EXTRAGALATTICHE SONO NUCLEI GALATTICI ATTIVI (AGN)

Redshift ---> In astrofisica è un indicatore della distanza

Nuclei Galattici Attivi



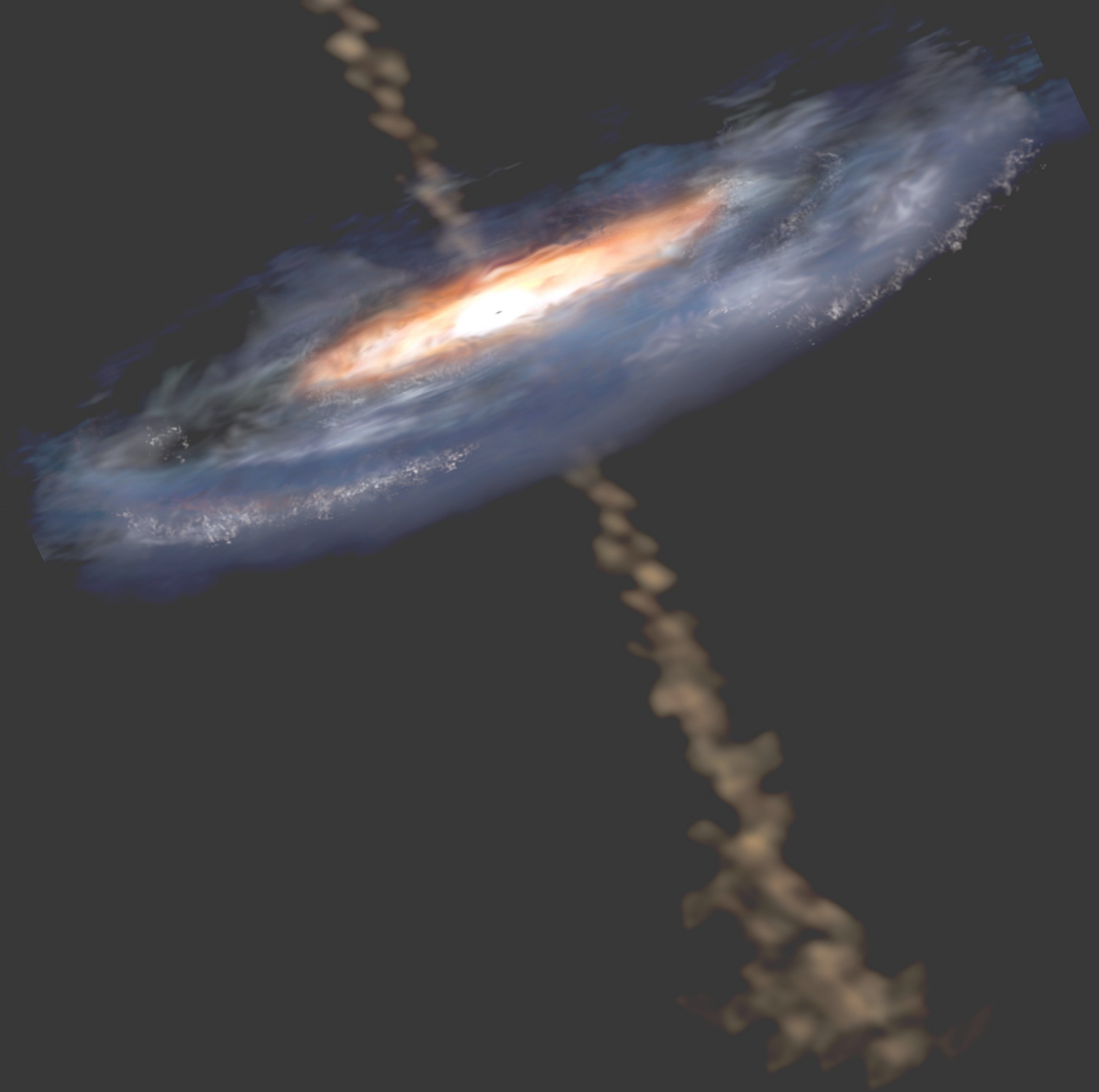
- BUCO NERO SUPERMASSIVO
- Disco di accrescimento
- Due jet di particelle ultra-relativistiche

Nuclei Galattici Attivi

- Si pensa che questi oggetti estremi esistano al centro di ogni galassia...

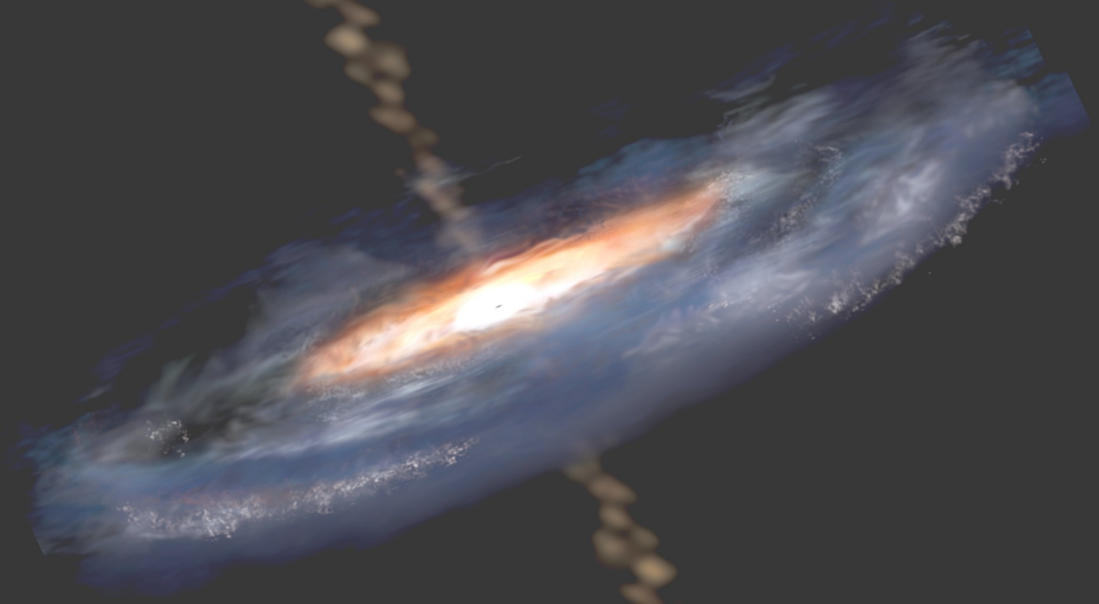
Nuclei Galattici Attivi

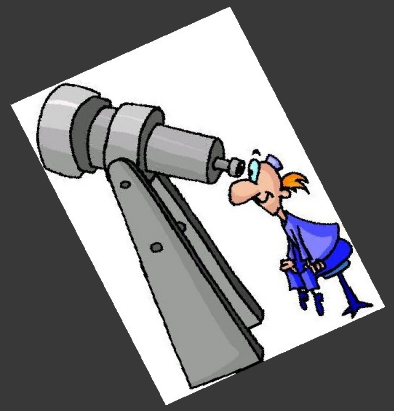
- Quello che osserviamo dipende dall' orientazione che il Nucleo Attivo ha rispetto a noi!



Nuclei Galattici Attivi

- Quello che osserviamo dipende dall' <u>orientazione</u> che il Nucleo Attivo ha rispetto a noi!

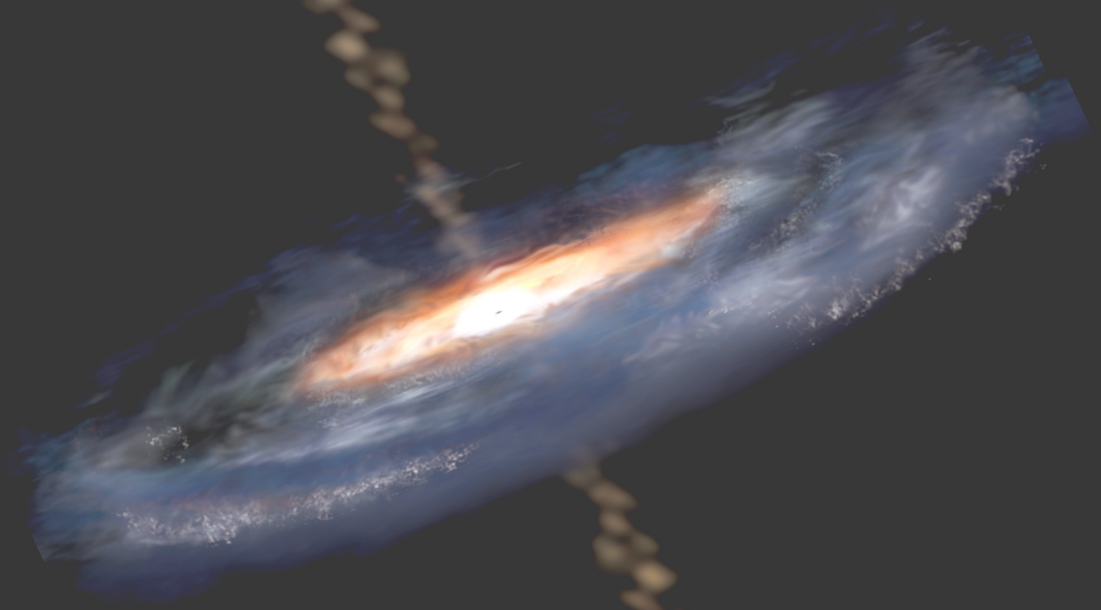




- RADIOGALASSIE!

Nuclei Galattici Attivi

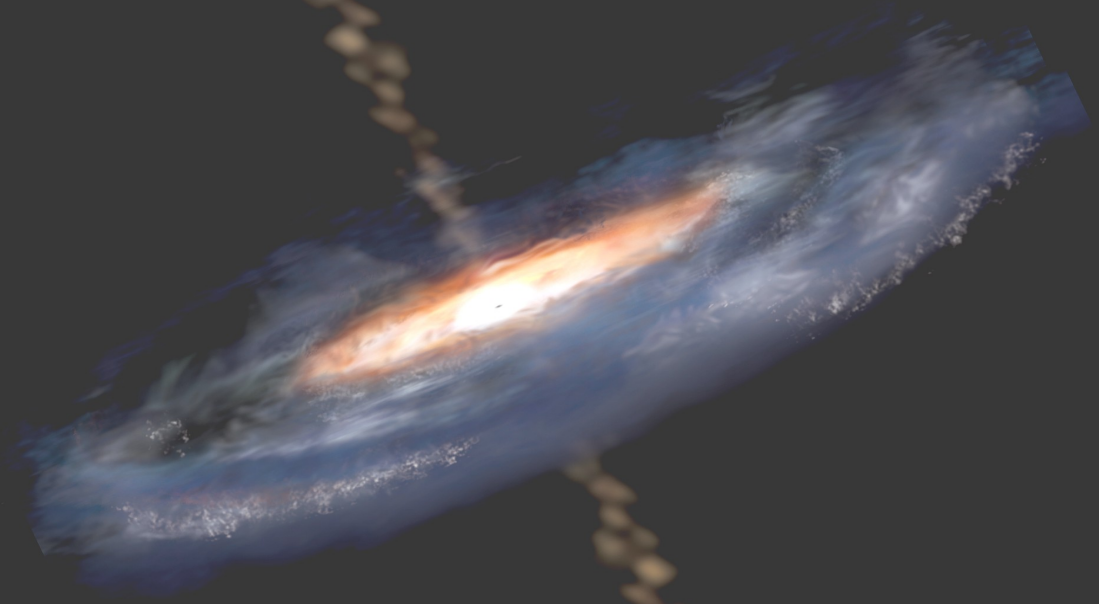
- Quello che osserviamo dipende dall' orientazione che il Nucleo Attivo ha rispetto a noi!



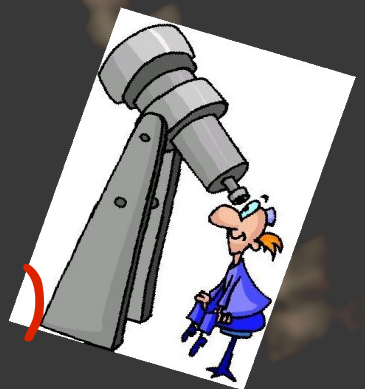
- QUASAR (QUAsi StellAR object)

Nuclei Galattici Attivi

- Quello che osserviamo dipende dall' orientazione che il Nucleo Attivo ha rispetto a noi!

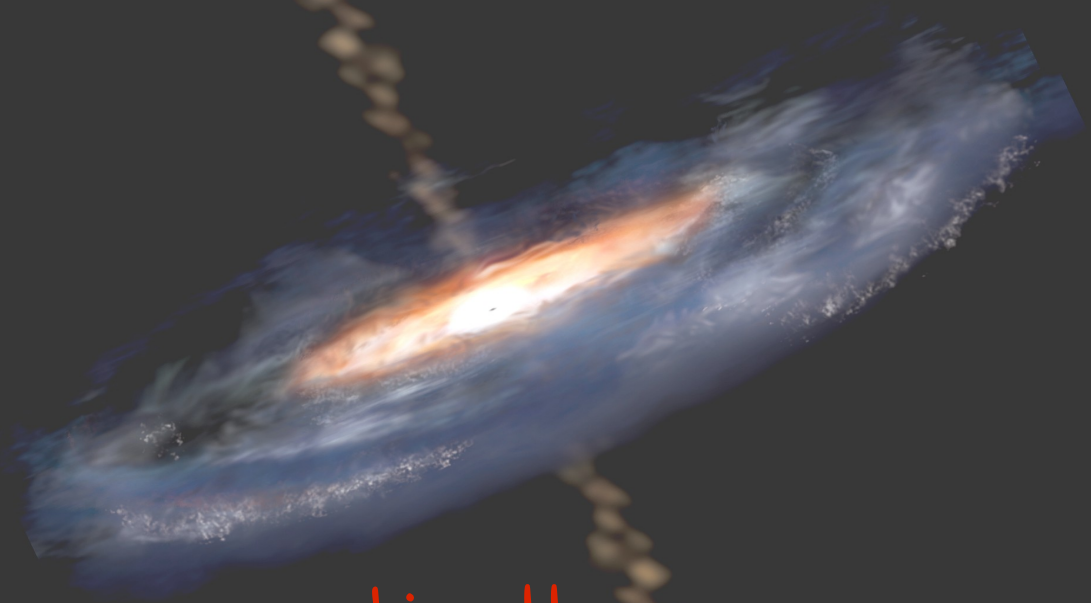


- BLAZAR! --> particelle del jet emettono raggi gamma (anche ultraenergetici!)

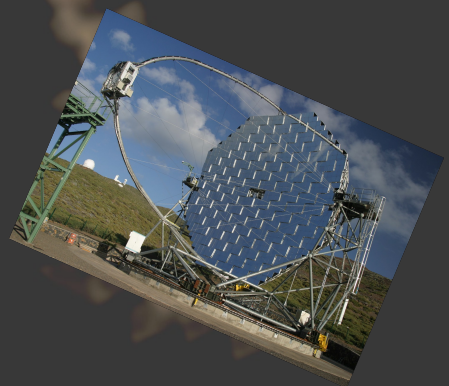


Nuclei Galattici Attivi

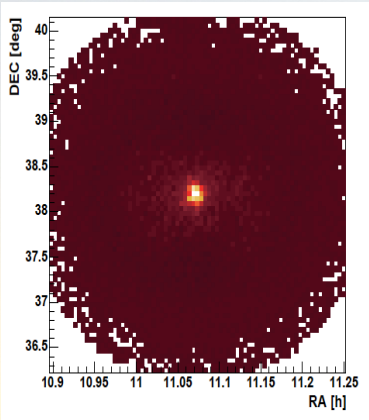
- Quello che osserviamo dipende dall' <u>orientazione</u> che il Nucleo Attivo ha rispetto a noi!



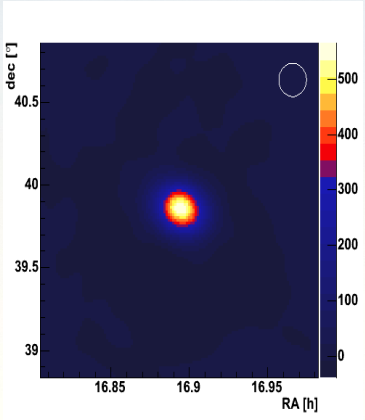
- BLAZAR: --> particelle del jet emettono raggi gamma (anche ultraenergetici!) -> MAGIC



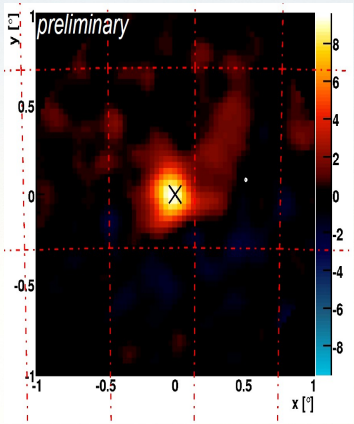
AGN osservati alle VHE



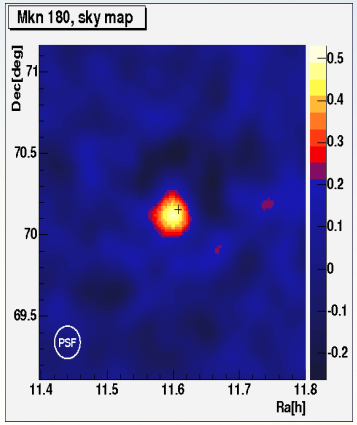
Mrk421 (0.031)



Mrk501 (z=0.034)

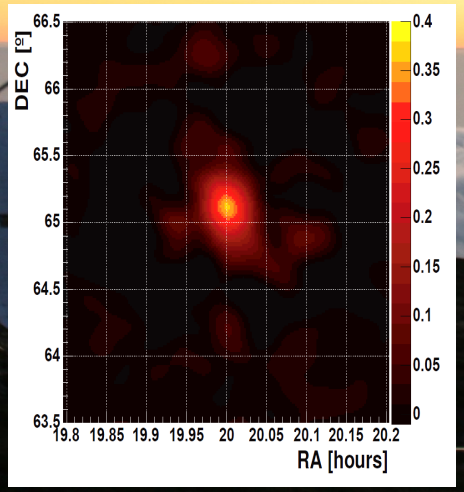


1ES2344 (z=0.044)

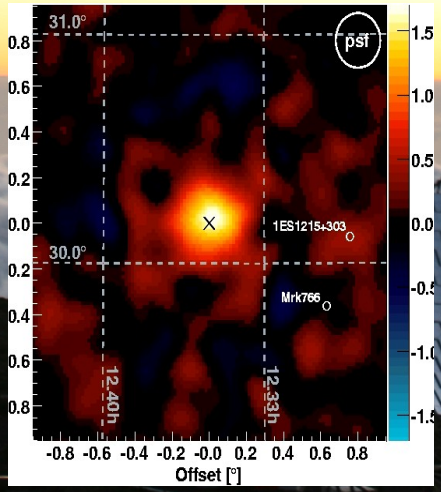


Mrk180 (0.045)

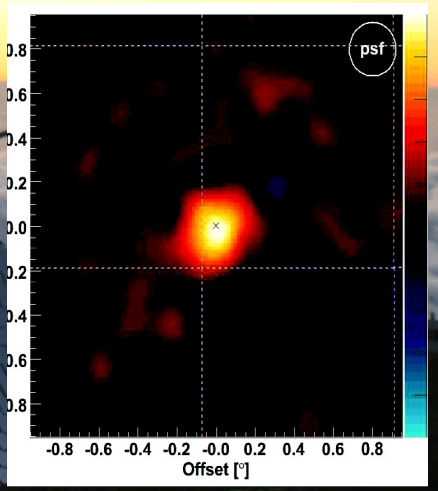
New source



1ES1959 (0.047)



1ES1218 (z=0.18)
New Source

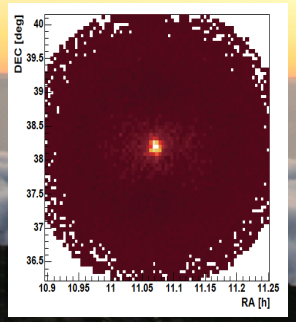


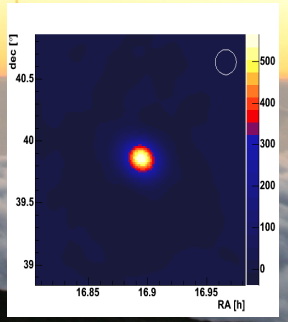
PG 1553 (Z>0.25)
New source

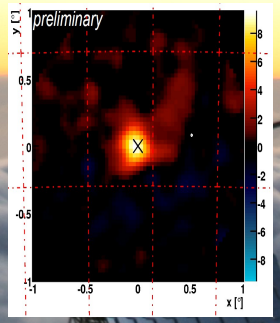
AGN osservati alle VHE

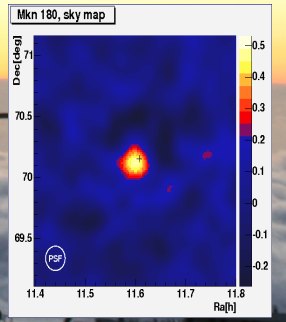
Grazie a queste osservazioni abbiamo iniziato a comprendere la natura dei jet negli AGN, anche se ancora esistono molti modelli diversi e quindi servono altre osservazioni per capire qual'è il **modello giusto**

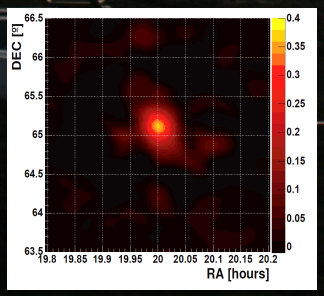
MA... lo studio è appena iniziato... c'e' ancora moltissima strada da percorrere...

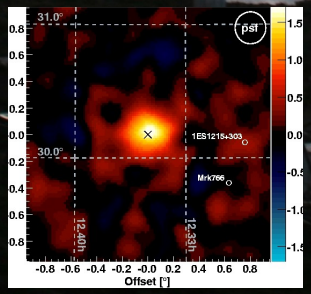


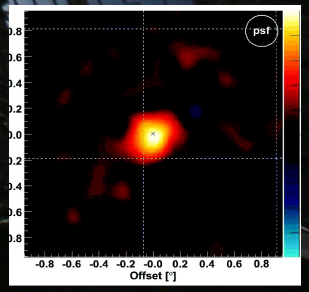








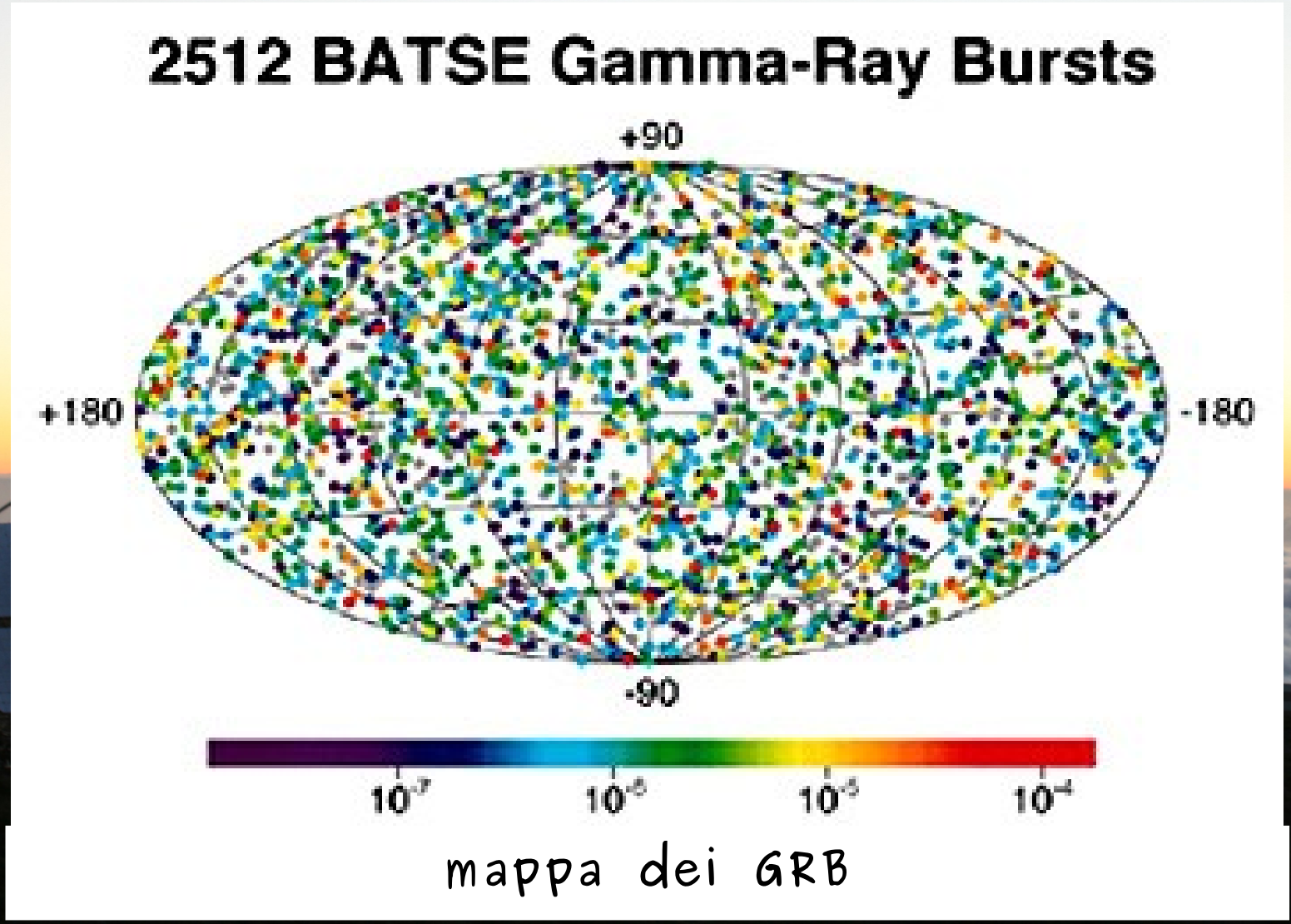




Ricerca di frontiera...

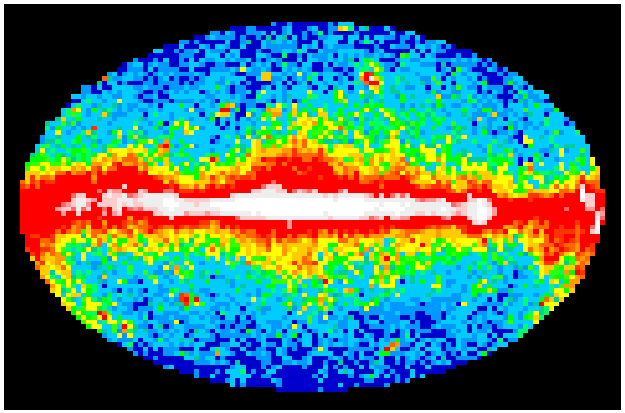
... ovvero dove si cercano raggi gamma VHE ma finora non si sono osservati

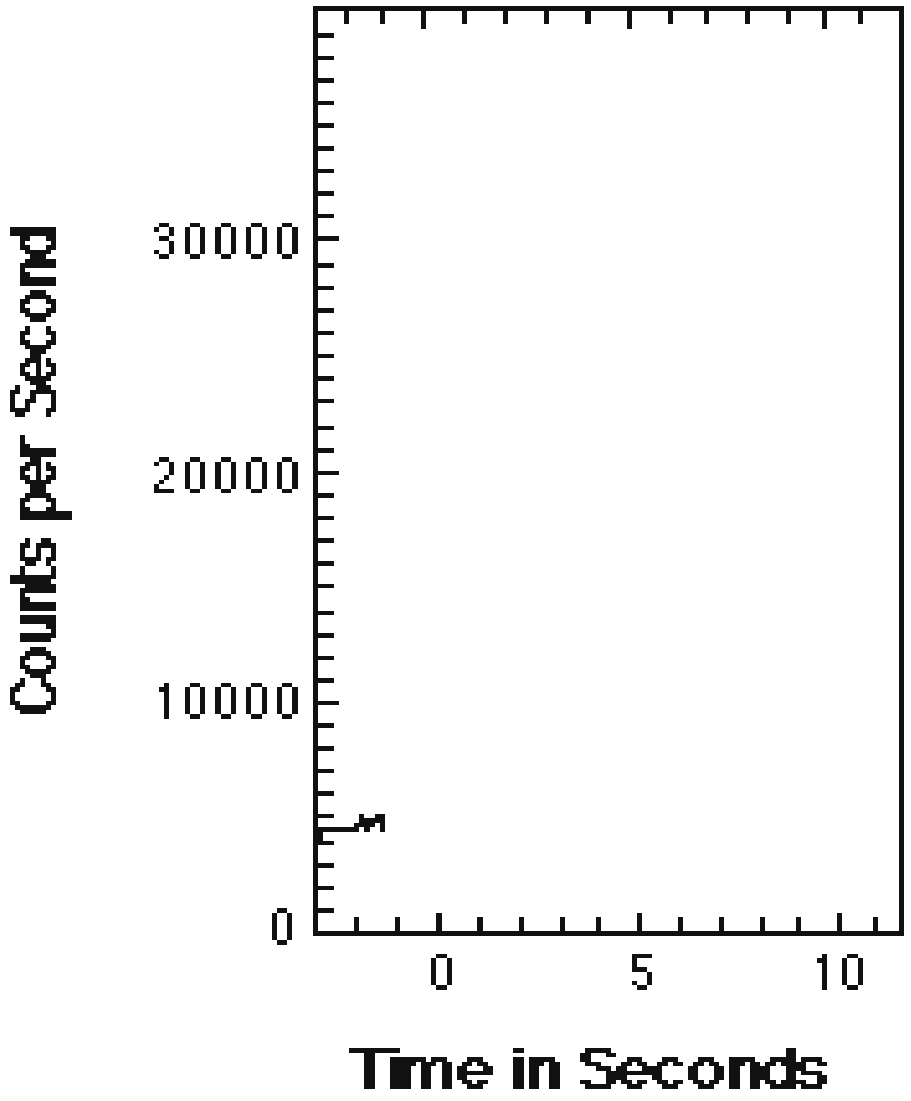
Lampi Gamma-soft dalle profondita' dell'Universo... Gamma Ray Bursts



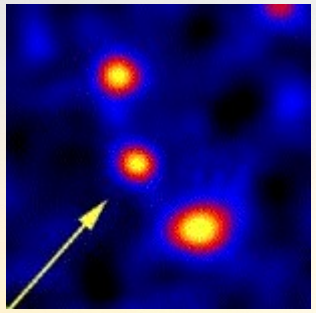
mappa dei GRB

Lampi Gamma-soft dalle profondita' dell'Universo... Gamma Ray Bursts

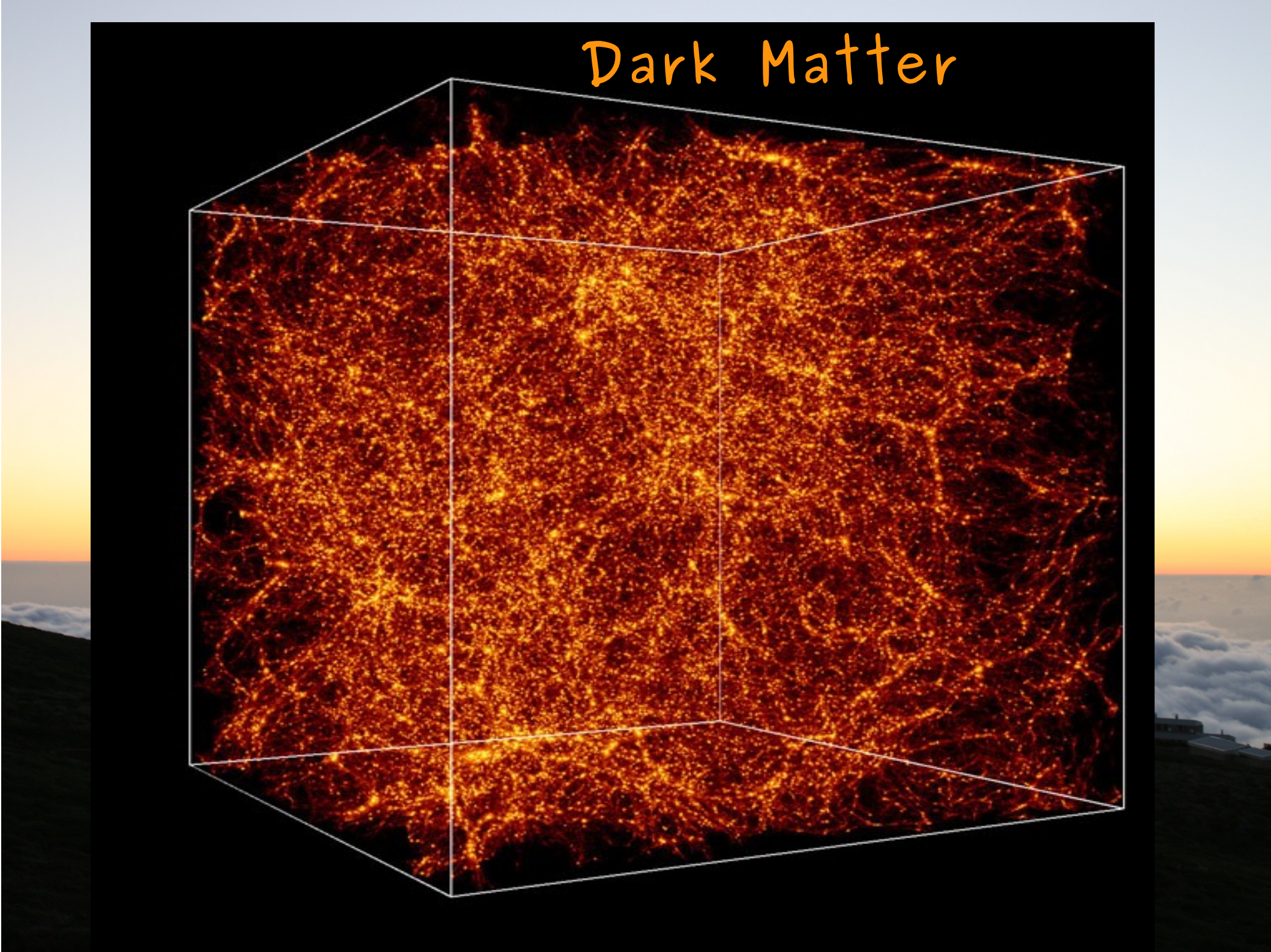




Lampi Gamma-soft dalle profondita' dell'Universo... Gamma Ray Bursts



l'origine di questi fenomeni e' tuttora sconosciuta!
domanda aperta: emettono VHE??
--> e' quello che MAGIC vorrebbe scoprire!


Dark Matter

Dark Matter

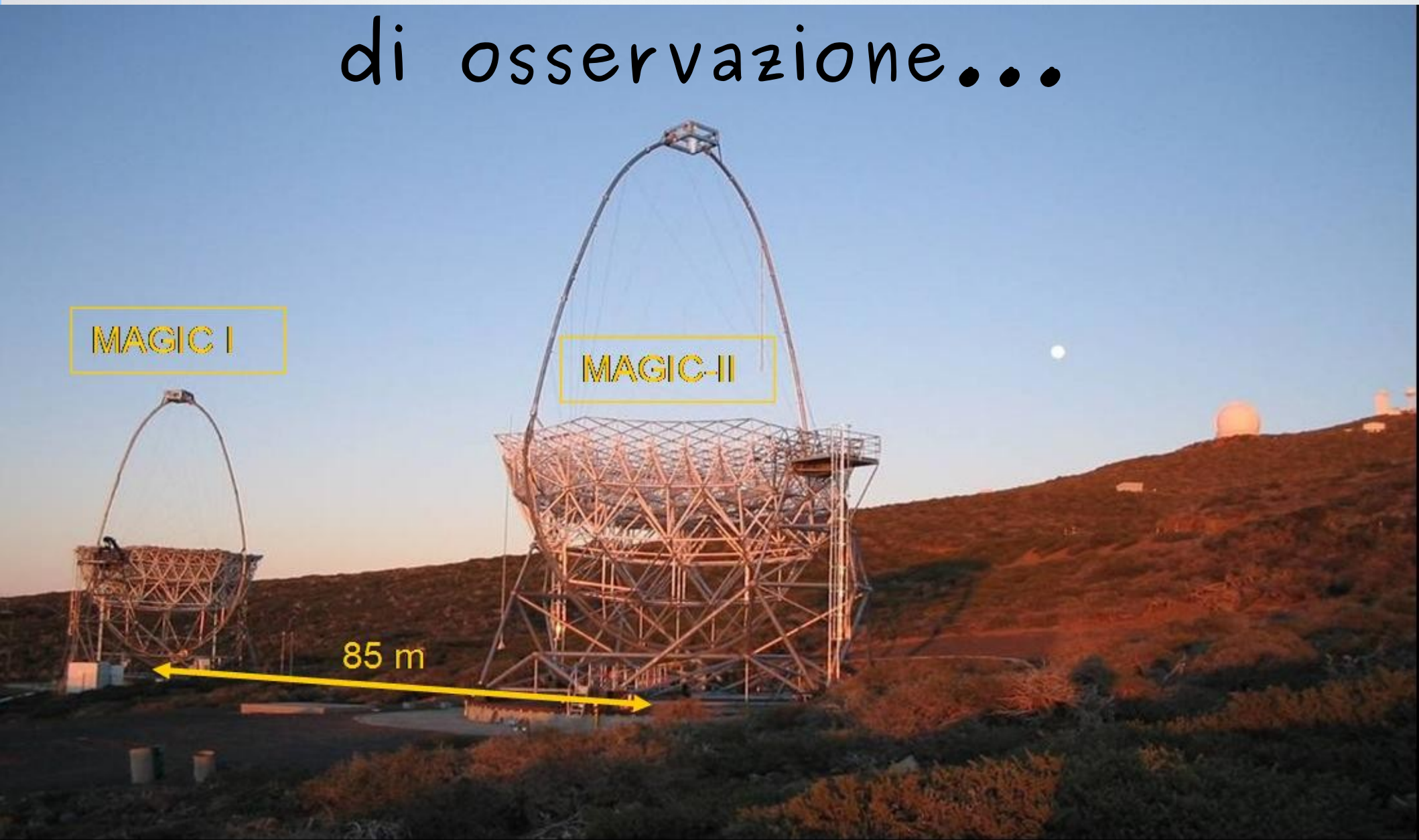
SAPPIAMO CHE ESISTE

NON sappiamo quale sia pero' la particella...
?neutralino?
?assione?

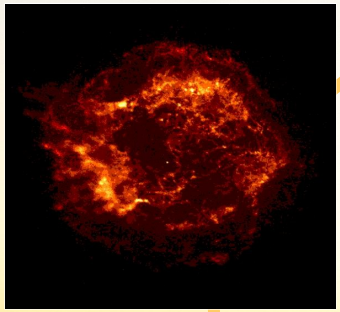
E' possibile, secondo alcune teorie, che la dark matter crei dei fotoni VHE...
... allora noi la cerchiamo!!!


Ora non ci resta che
continuare la ricerca...

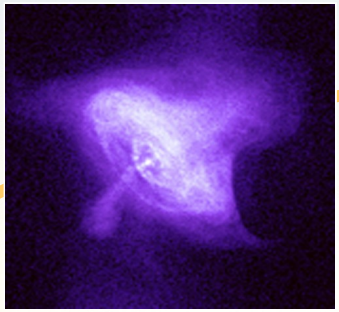
...cercando di migliorare sempre di piu' gli strumenti di osservazione...



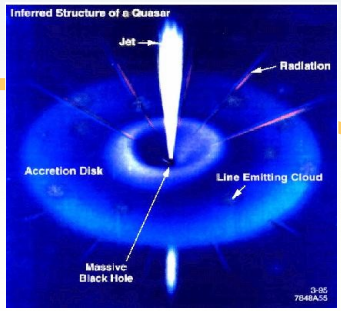
...e riuscire a "popolare" l'universo gamma!



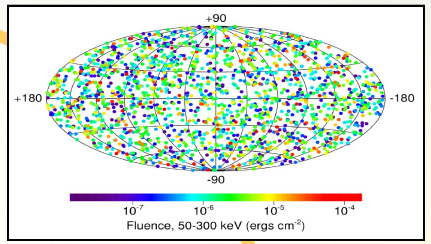
SNRs



Pulsars

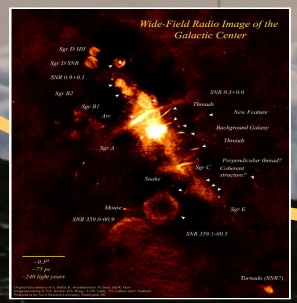


AGNs

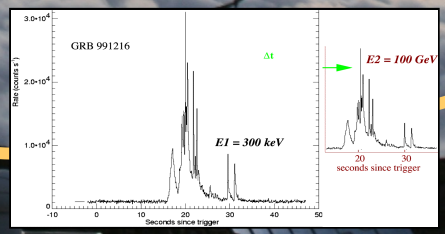


GRBs

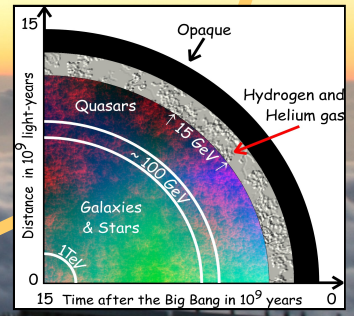
Origin of Cosmic Rays



Cold Dark Matter



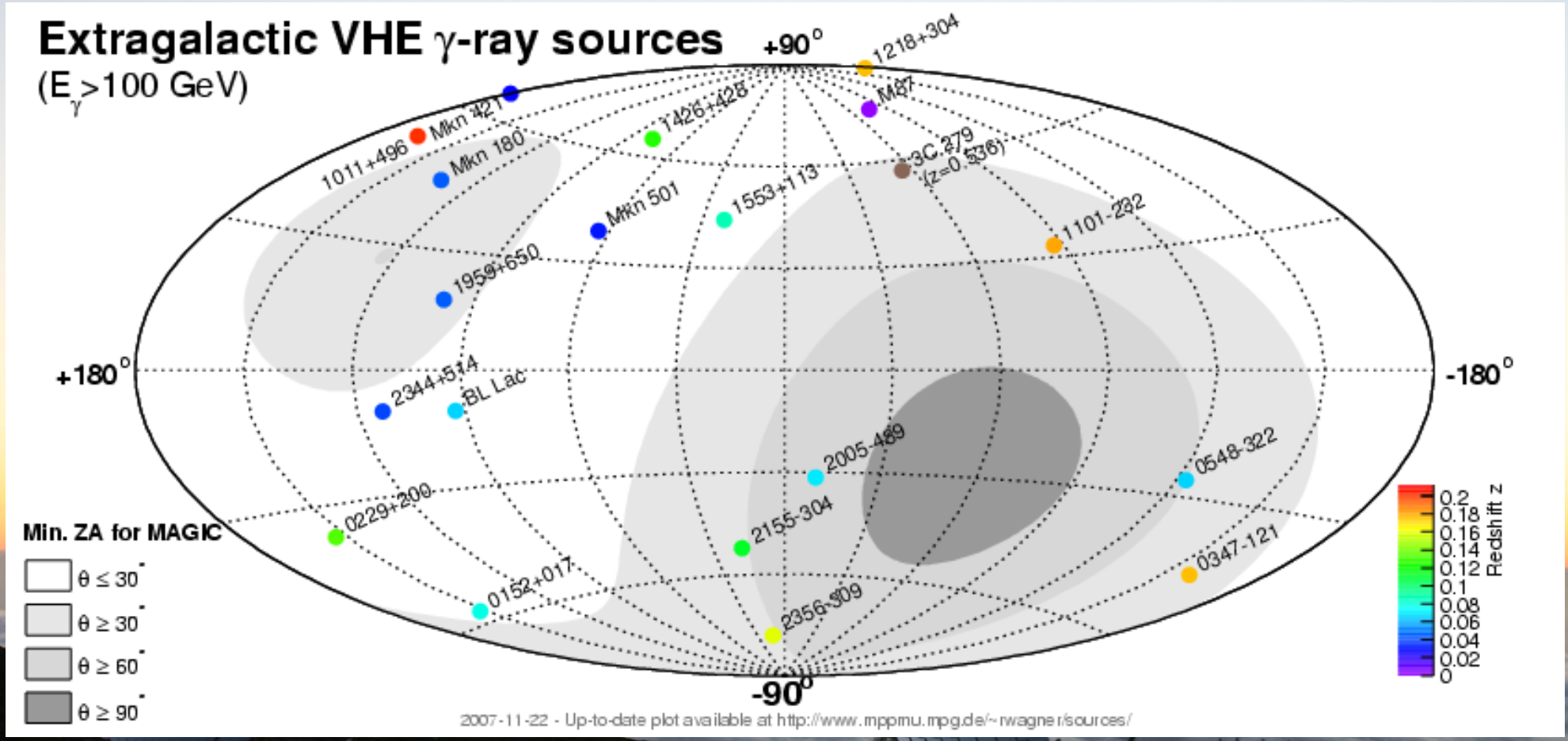
Quantum Gravity effects



cosmological γ-Ray Horizon

BACKUP SLIDES

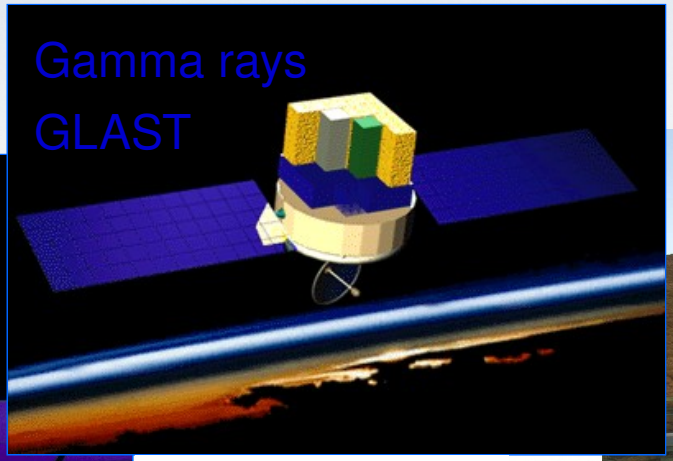
Sorgenti Extragalattiche

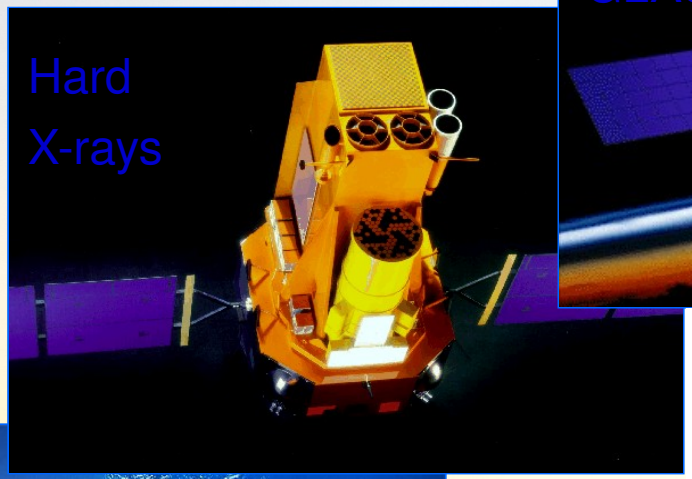


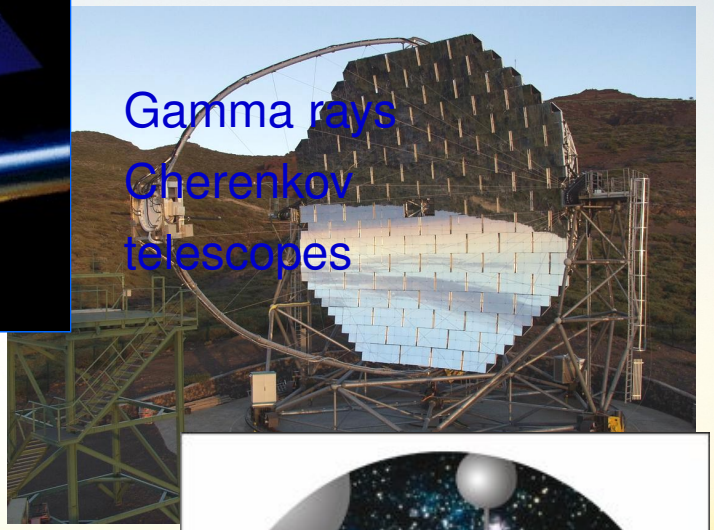
TUTTE LE SORGENTI EXTRAGALATTICHE SONO NUCLEI GALATTICI ATTIVI (AGN)

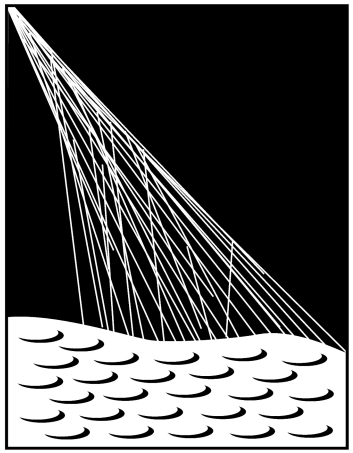
Redshift --> In astrofisica è un indicatore della distanza

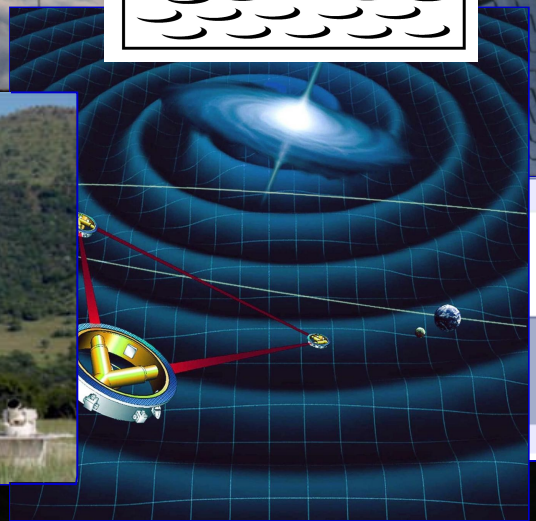
Multiwavelength / multimessenger astronomy

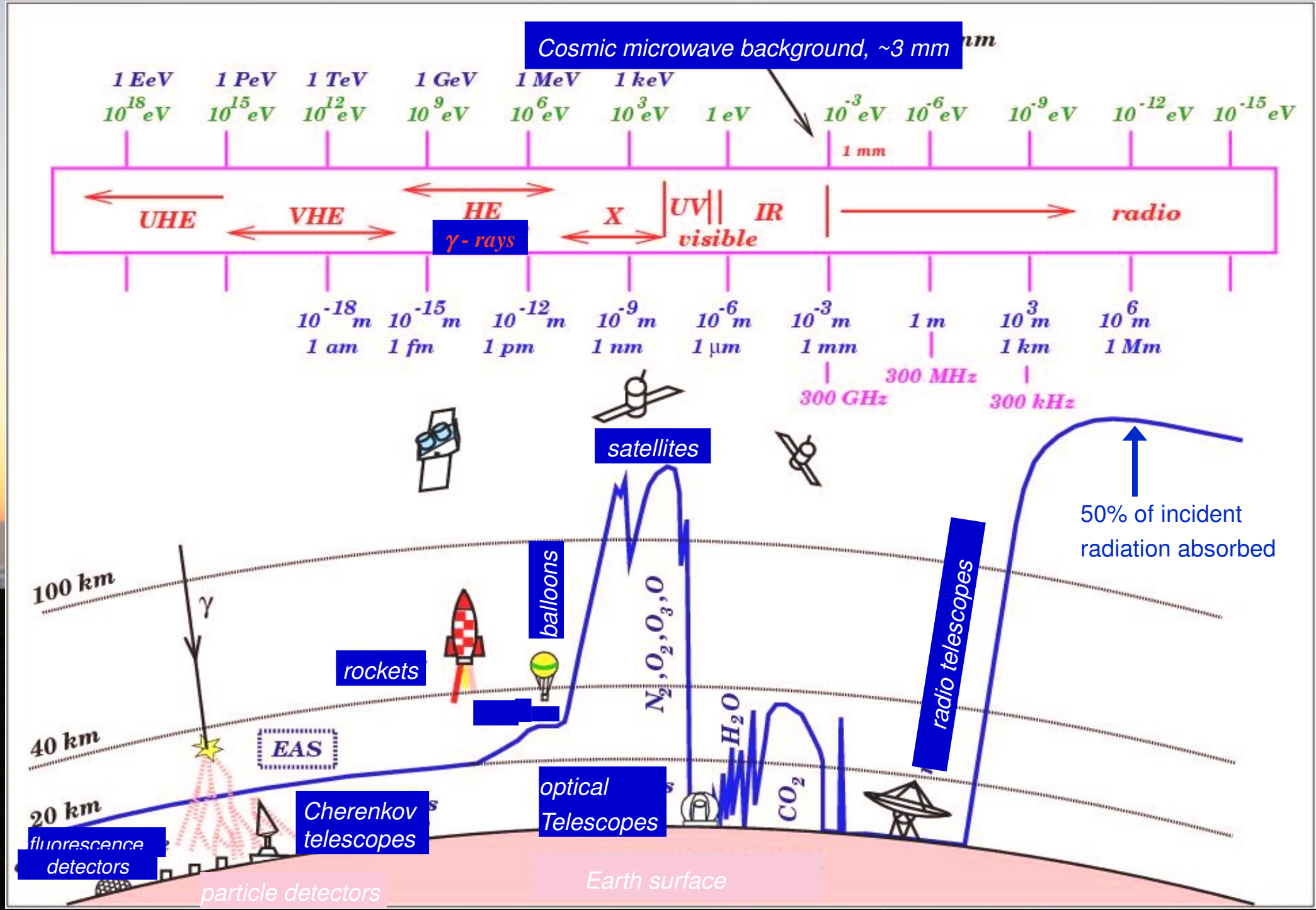











Cosmic microwave background, ~3 mm
1 EeV
10^18 eV
1 PeV
10^15 eV
1 TeV
10^12 eV
1 GeV
10^9 eV
1 MeV
10^6 eV
1 keV
10^3 eV
1 eV
10^-3 eV
10^-6 eV
10^-9 eV
10^-12 eV
10^-15 eV
1 mm
UHE
VHE
HE
γ - rays
X
UV
visible
IR
radio
10^-18 m
1 am
10^-15 m
1 fm
10^-12 m
1 pm
10^-9 m
1 nm
10^-6 m
1 μm
10^-3 m
1 mm
1 m
10^3 m
1 km
10^6 m
1 Mm
300 GHz
300 MHz
300 kHz
satellites
50% of incident radiation absorbed
100 km
γ
balloons
rockets
N2,O2,O3,O
H2O
CO2
radio telescopes
40 km
EAS
optical Telescopes
20 km
fluorescence detectors
Cherenkov telescopes
particle detectors
Earth surface

La risoluzione angolare...