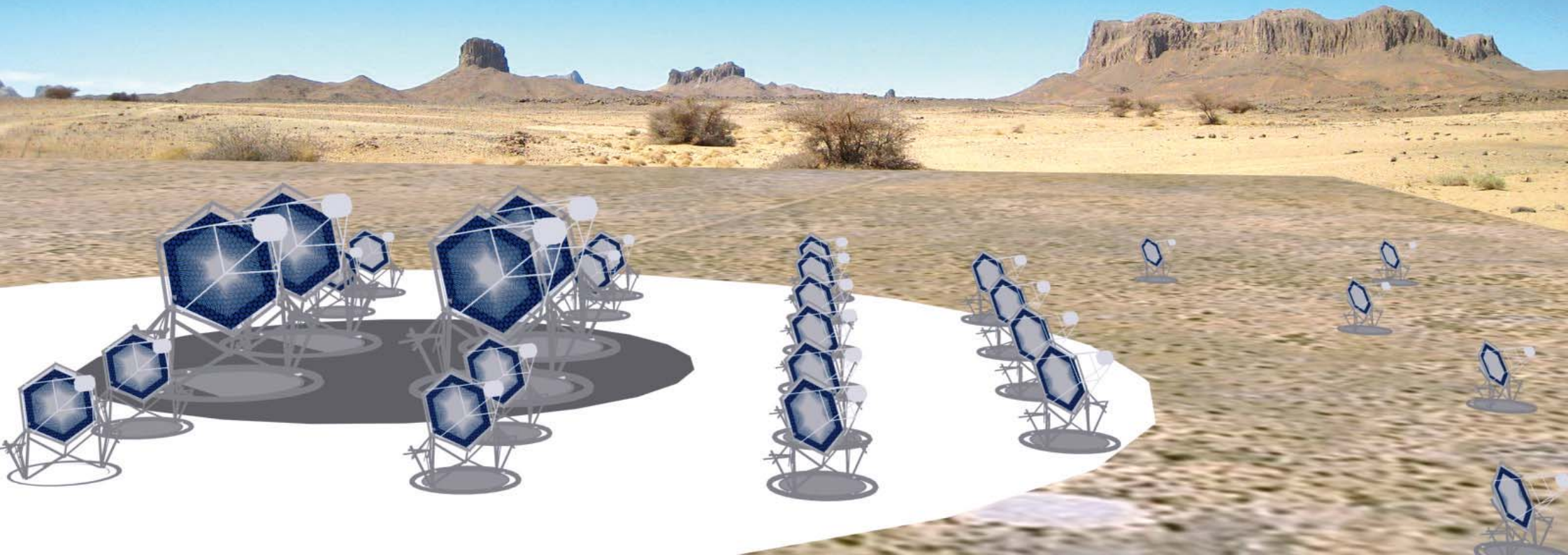
CHERENKOV TELESCOPE ARRAY

Astronomy with photons of Tera-electronvolts

（Our photons are million-million times higher than optical photons – comparable LHC energy）

Masahiro Teshima
Max-Planck-Institute for Physics



VHE Instruments

MILAGRO

MAGIC

TIBET

MILAGRO

STACEE

VERITAS

MAGIC

TIBET
ARGO-YBJ

TACTIC

PACT

GRAPES

VERTAS

TACTIC

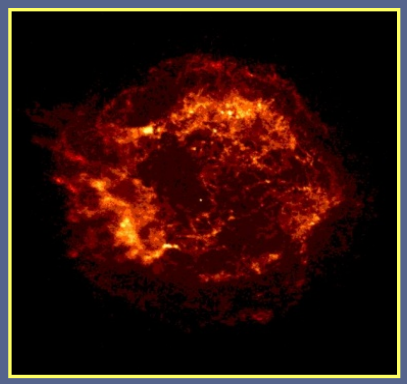
HESS

CANGAROO III

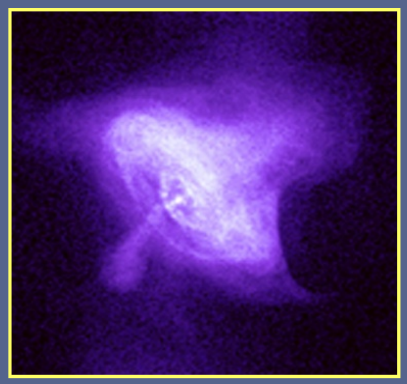
HESS

CANGAROO

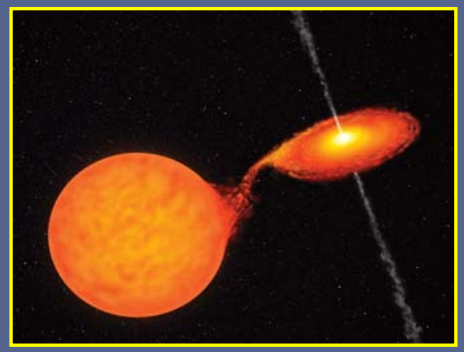
Physics objectives



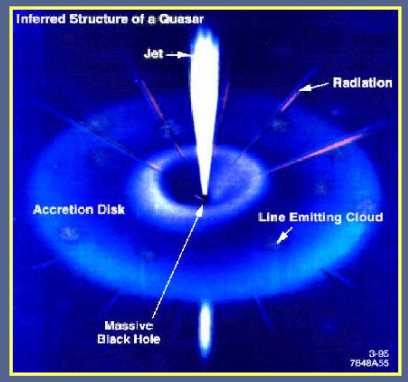
SNRs



Pulsars and PWNe



Micro quasars X-ray binaries

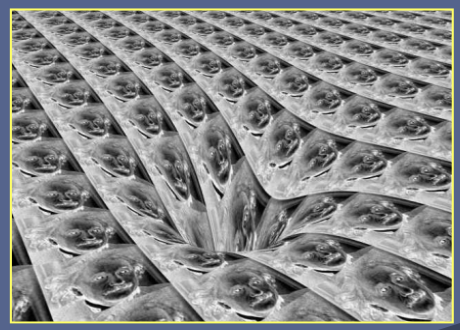


AGNs

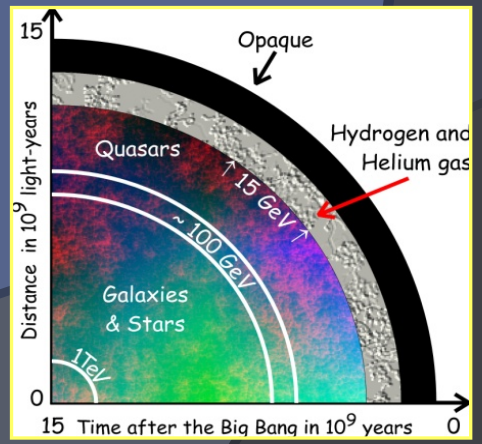
GRBs

Origin of cosmic rays

Dark matter

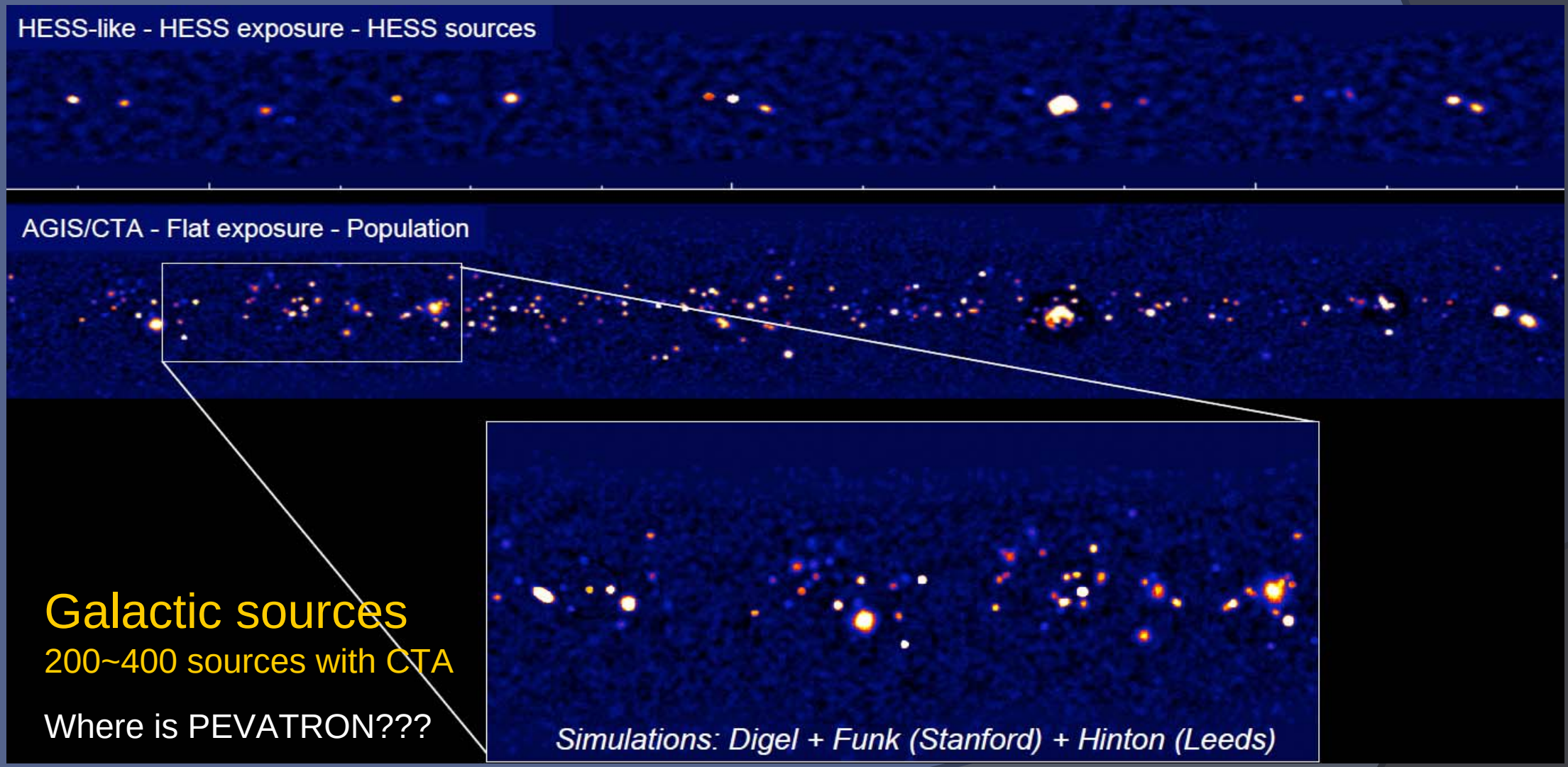


Space-time & relativity



Cosmology

Galactic sources

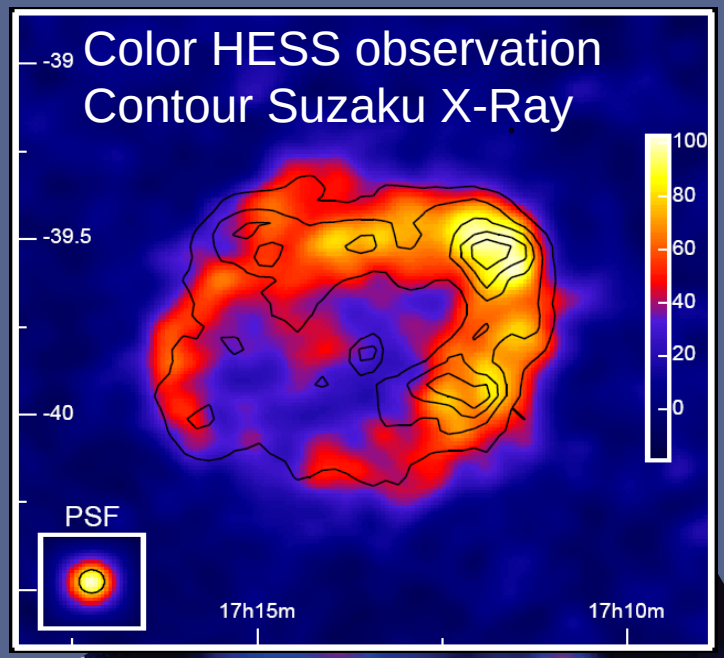


Galactic sources

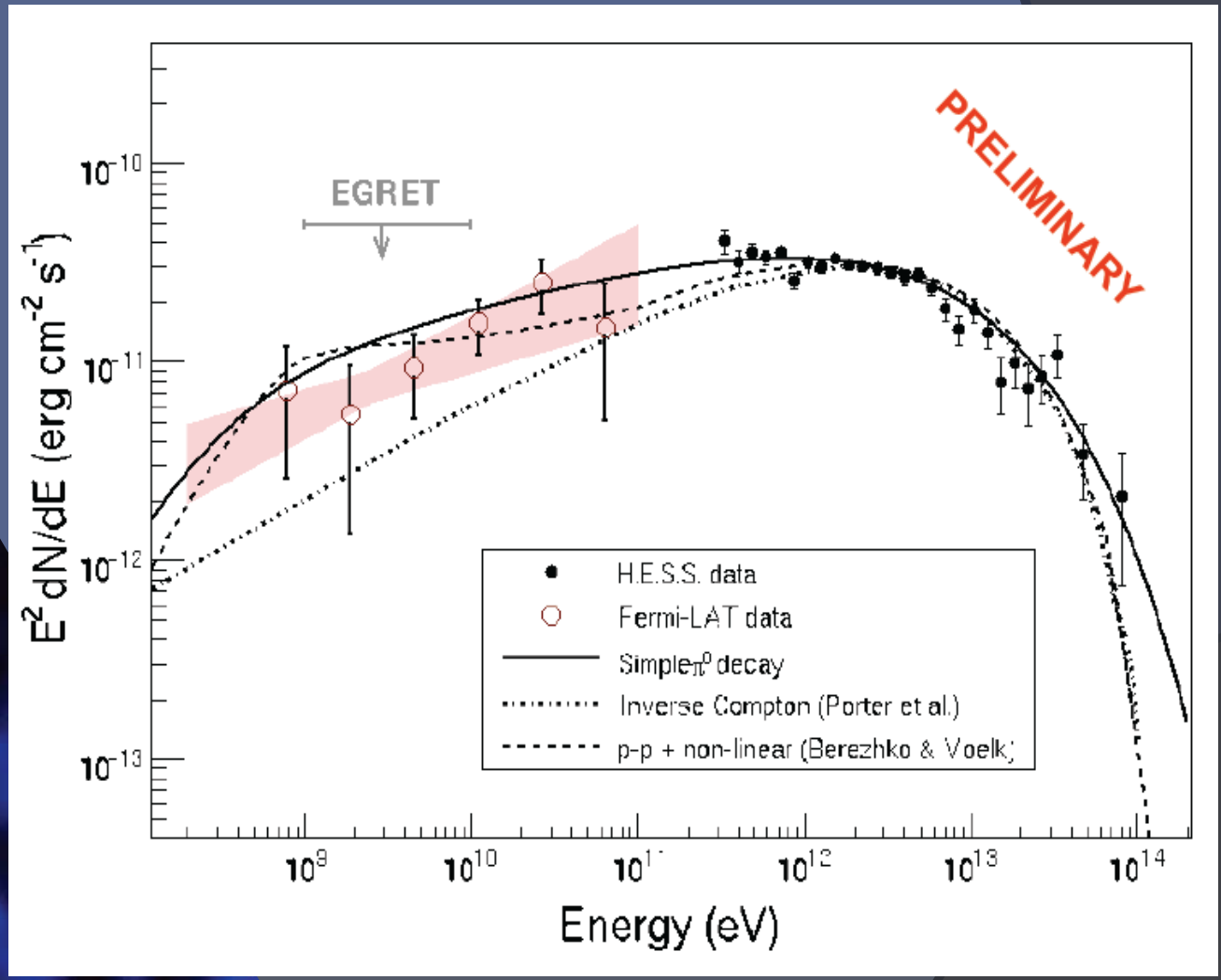
200~400 sources with CTA

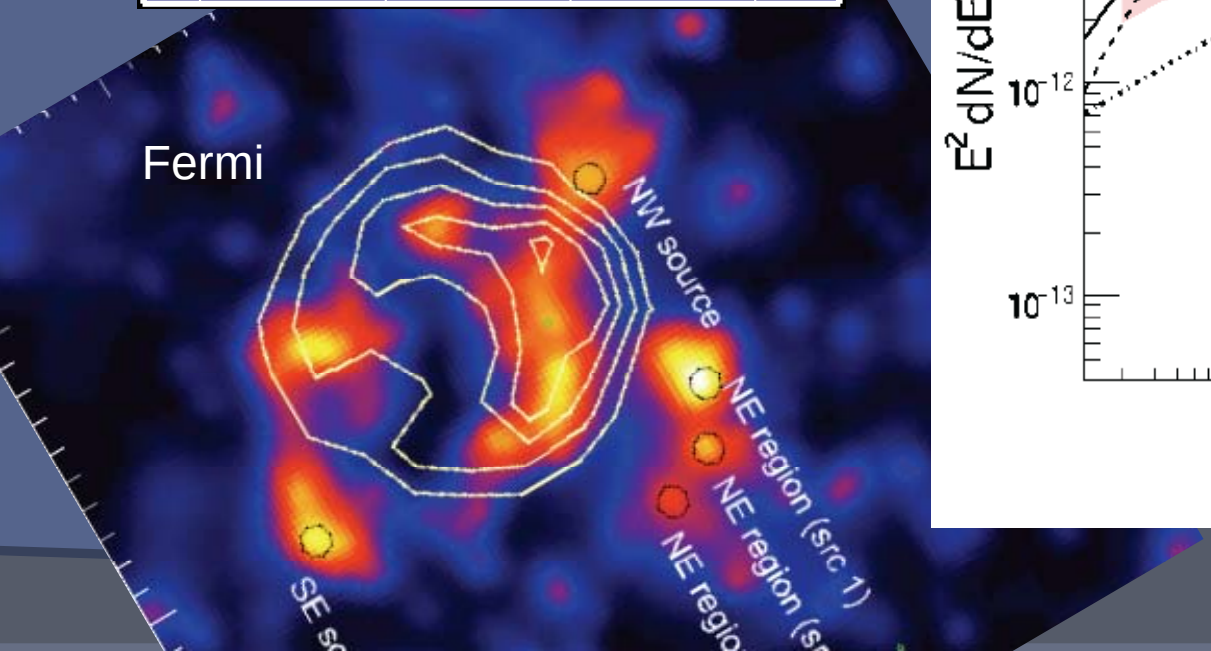
Where is PEVATRON???

Super Nova Remnants
RX J1713 HESS + Fermi

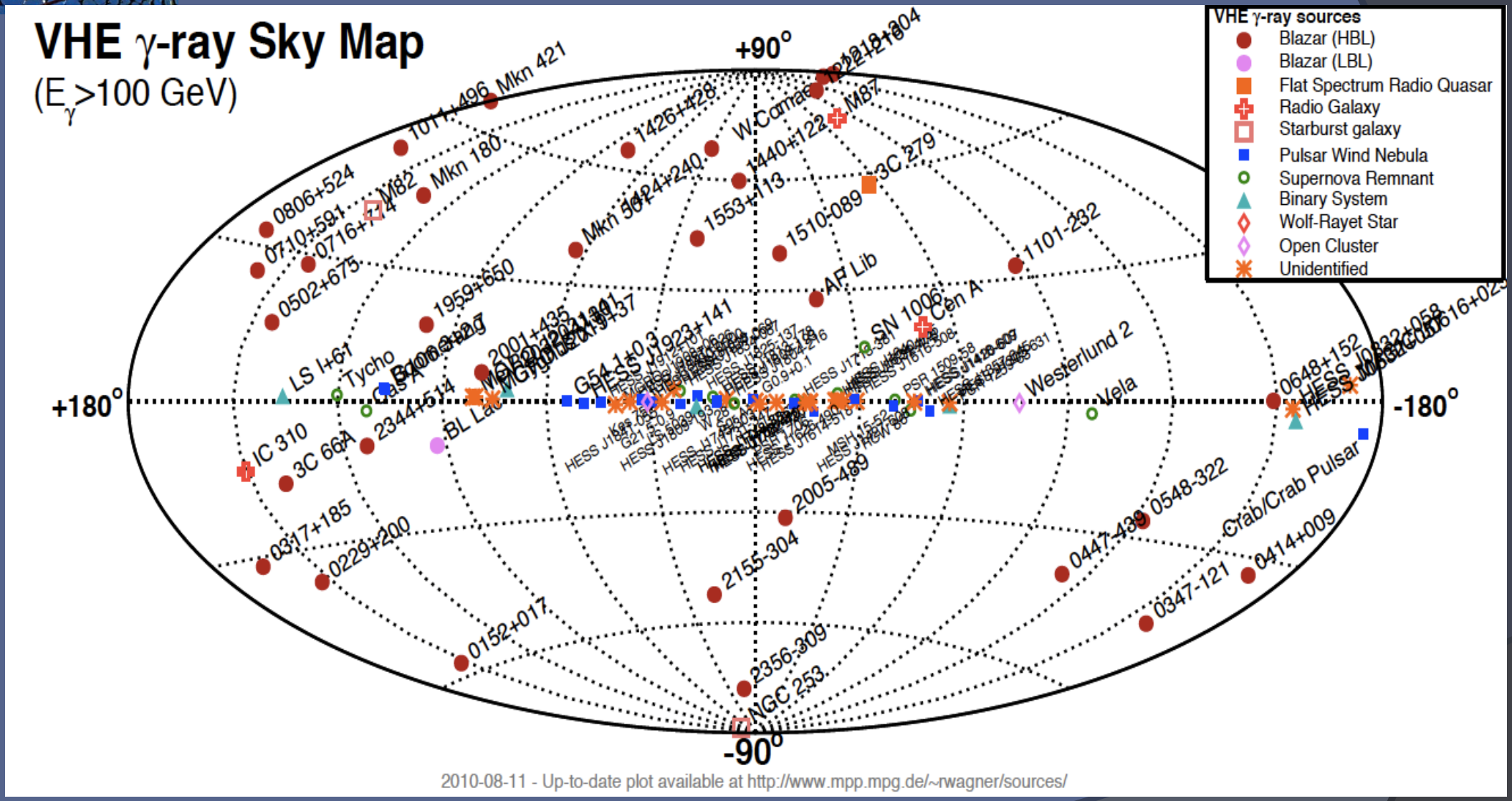


Concaved spectrum (non-linear effect)??





VHE Skymap at present



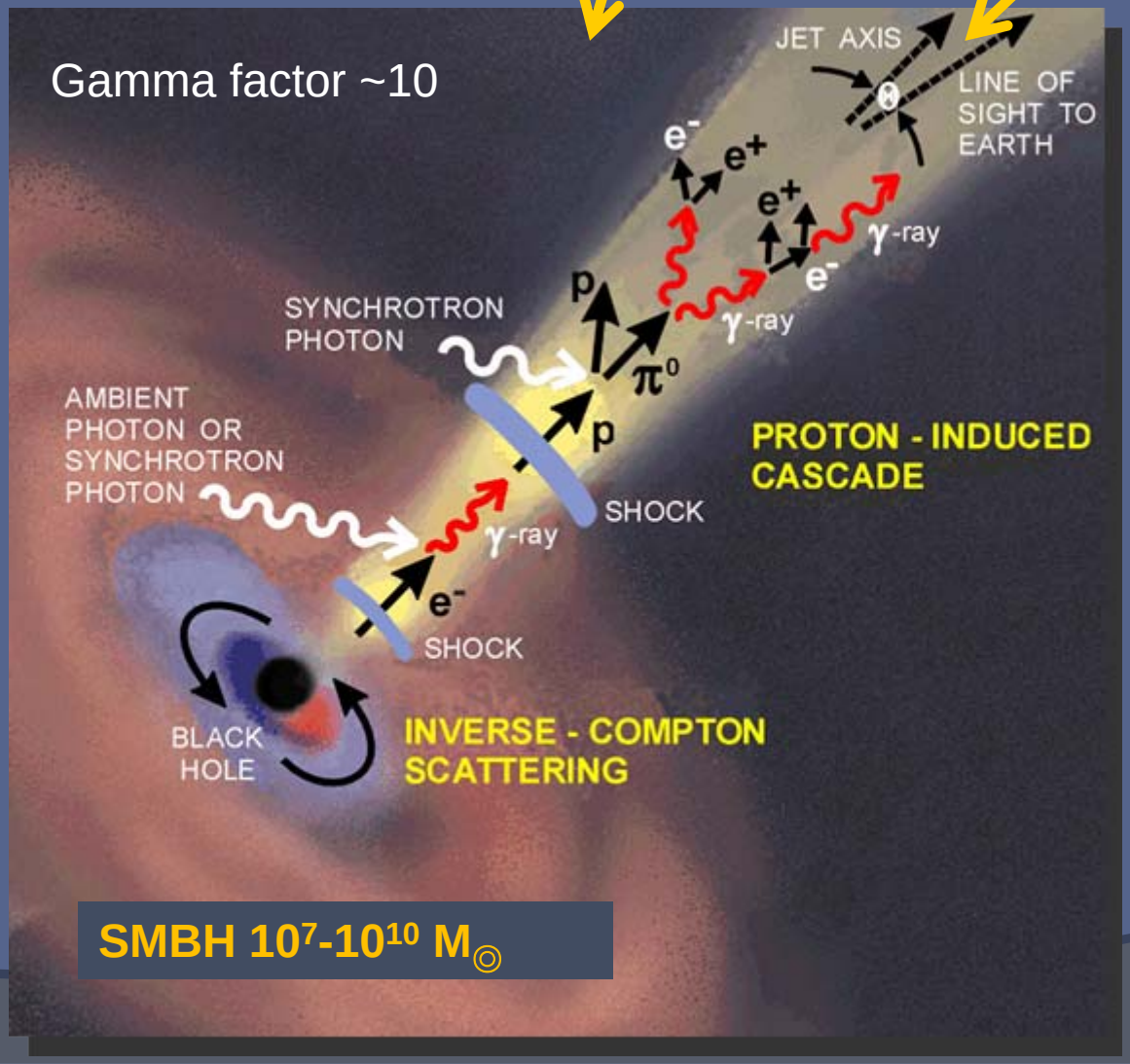
2010-08-11 - Up-to-date plot available at http://www.mpp.mpg.de/~rwagner/sources/

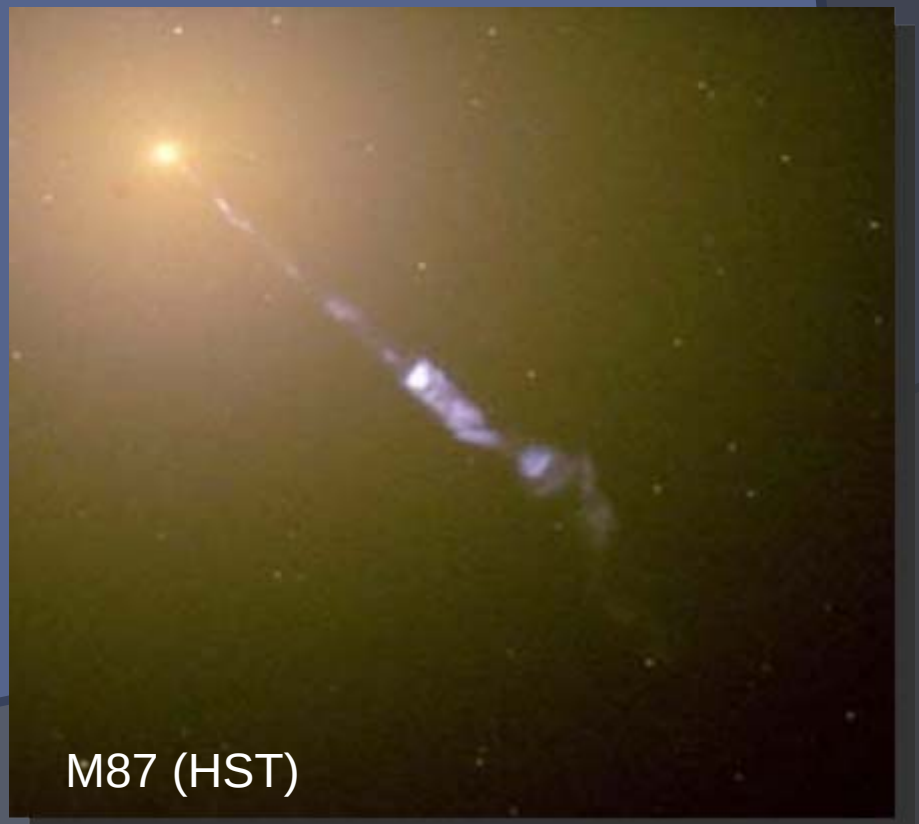
103 sources (42 Extragalactics + 61 Galactics) in July 2010

Blazars, FSRQs, FR-I, Starburst galaxies SNRs, PWNe, Pulsar, Binaries, un-IDs

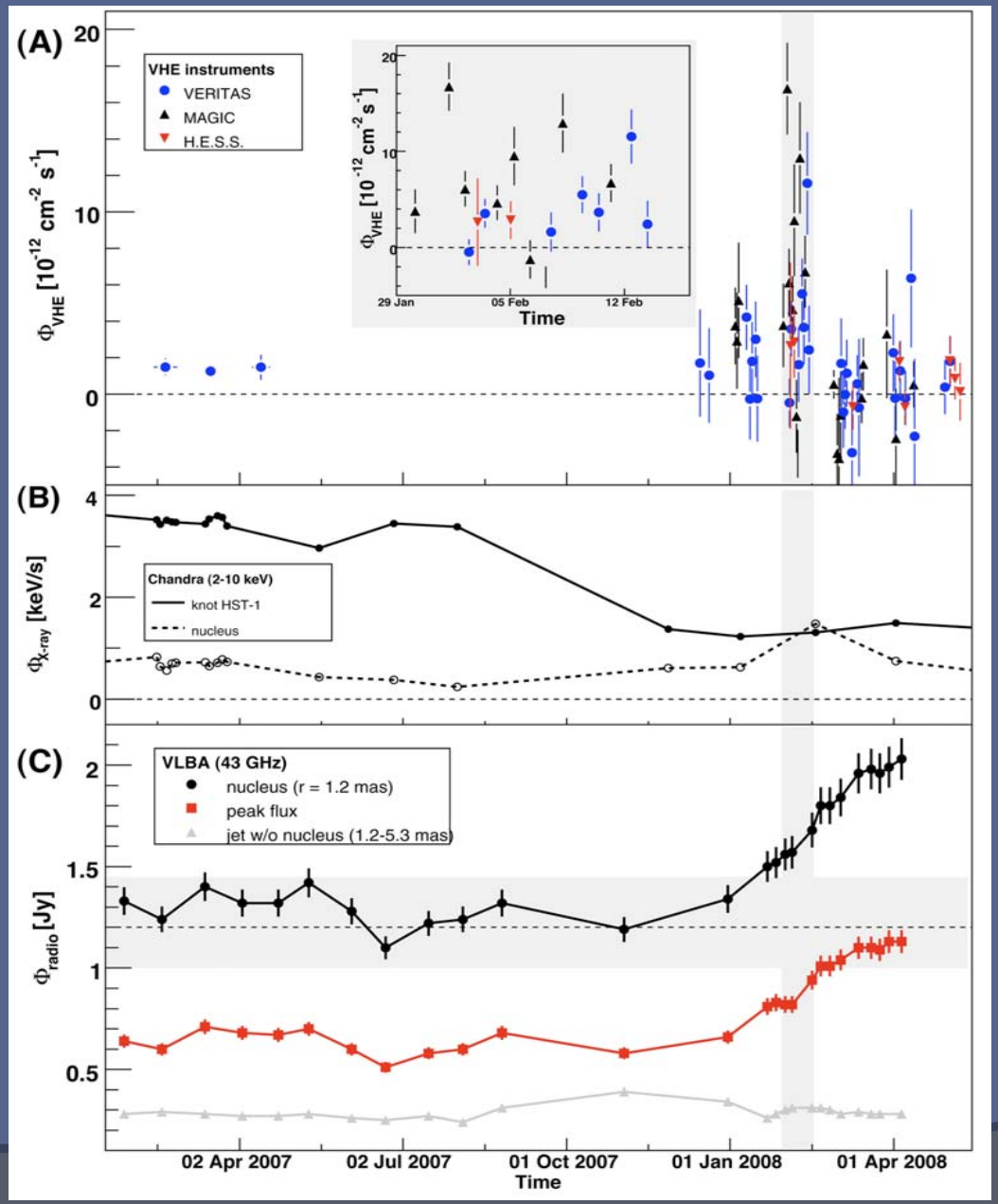
Cosmic Ray accelerator
Active Galactic Nuclei

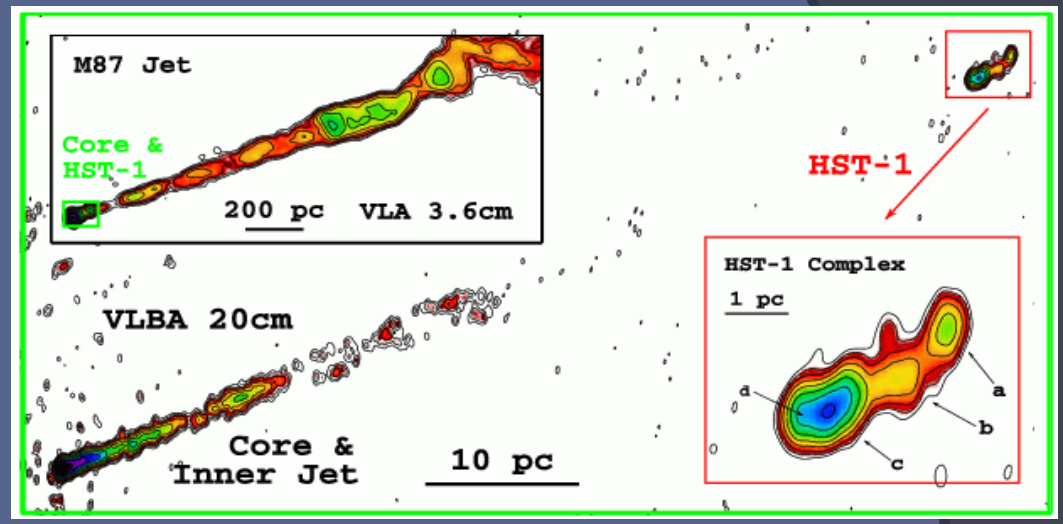
FRI, FRII **Blazars**



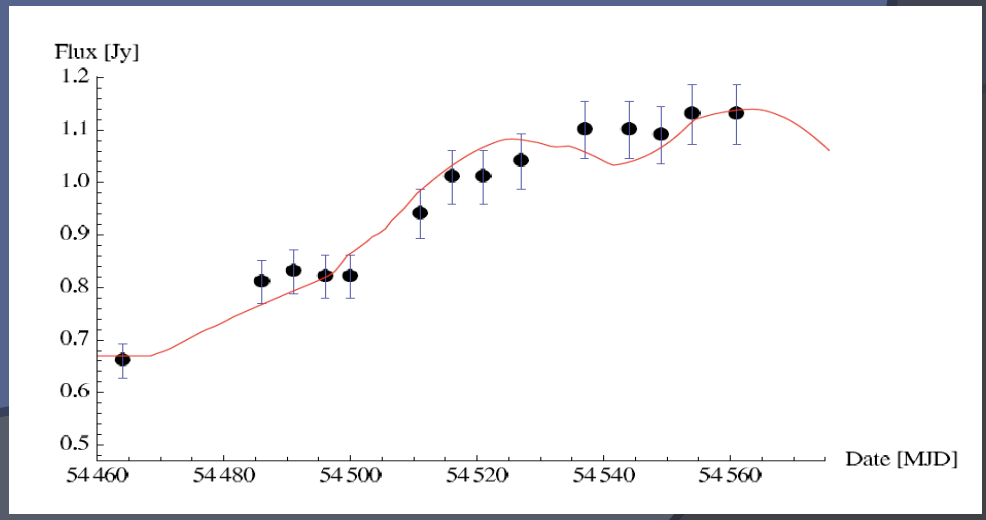

M87 (HST)

M87 flare in 2008: MAGIC, VERITAS, HESS, VLBA

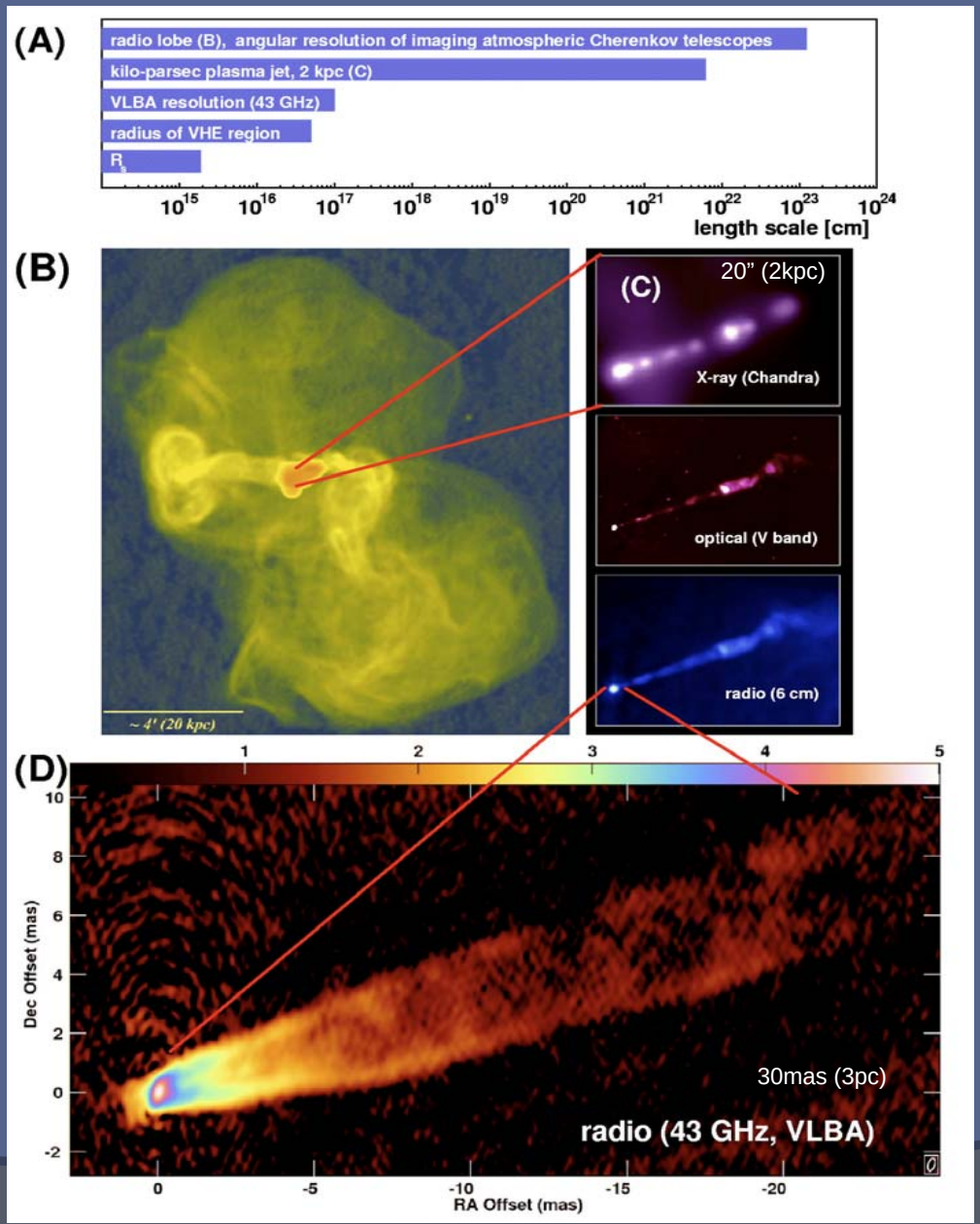


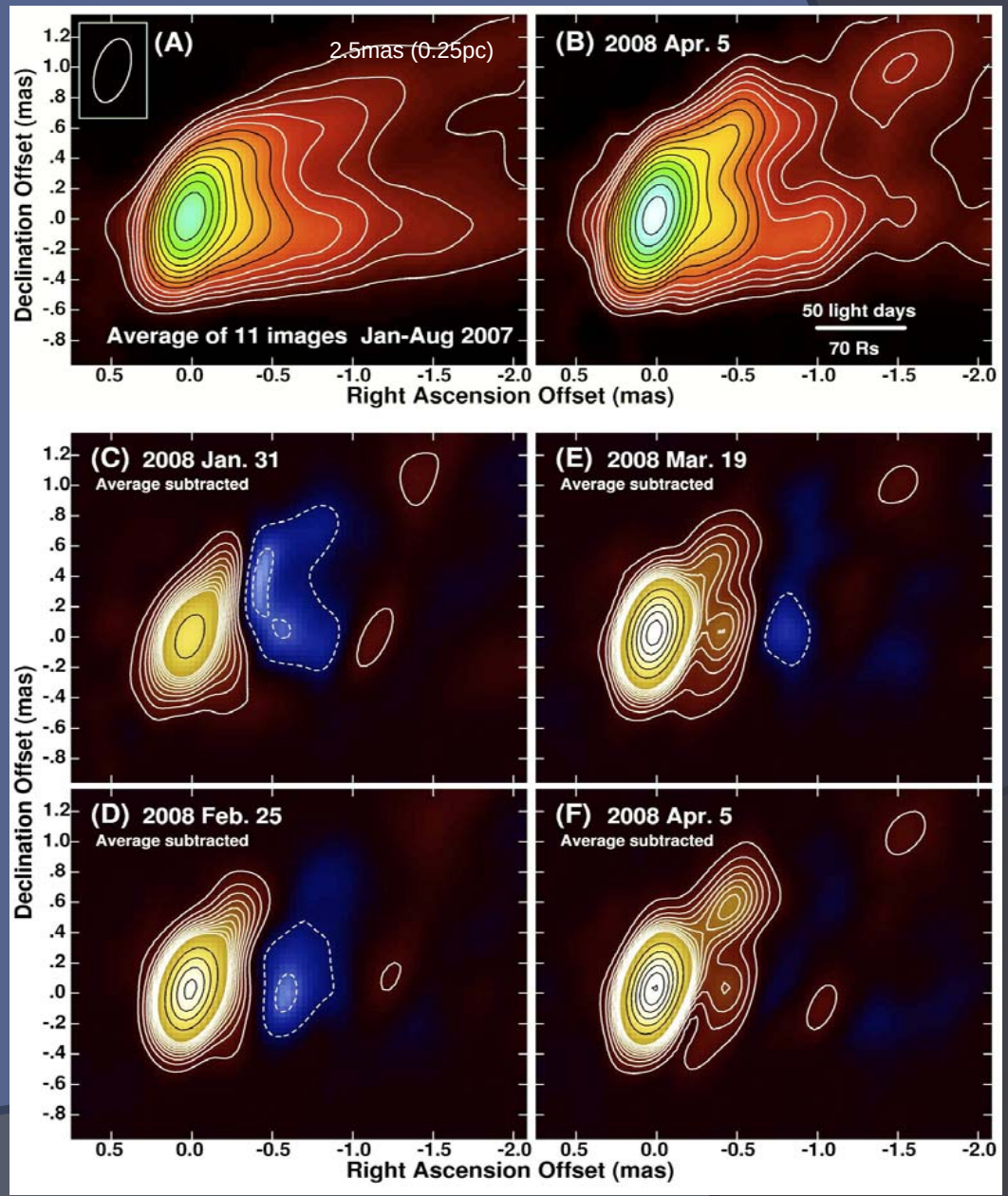


Model of 43GHz Radio flux
using the measured VHE gamma flux

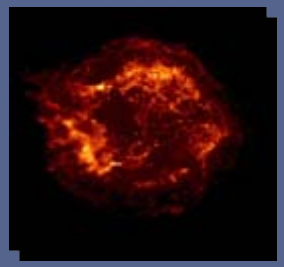


M87 flare in 2008:
MAGIC, VERITA, HESS, and VLBA

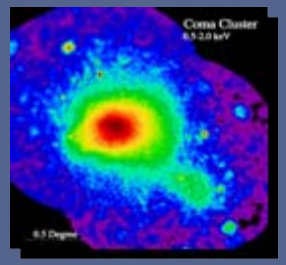




Specification and Physics



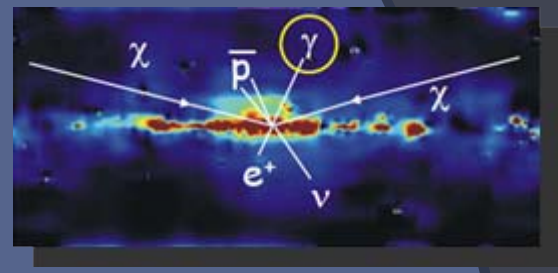
SNRs



New sources

Sensitivity x10 (10^{-14}erg cm^{-2}s^{-1})

Energy Res. x2 (10% @ 1TeV)

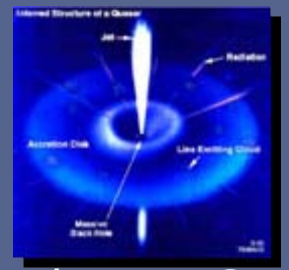


DM

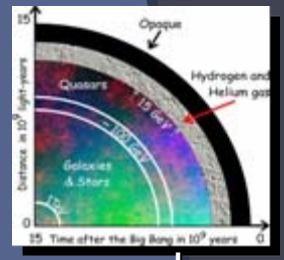
Morphology

Angular Res. x3 (2 arcmin @1TeV)

Low Threshold E x2 (20GeV)

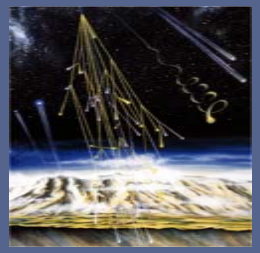


Distant AGNs



cosmology

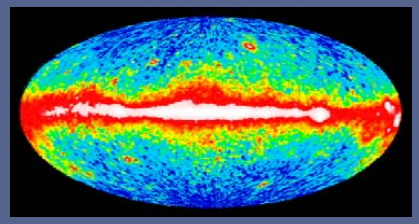
Origin of CR



Large Accept. x30 (3x 10^6m^2 >1TeV)

Fast rotation 20 sec/180°

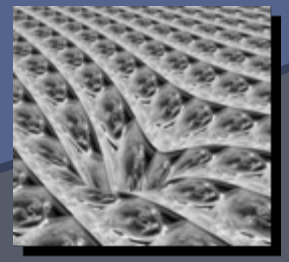
GRBs



TeV - All sky map
Galactic diffuse

Better S/N x3 >99.9%

High Time Res. x10 (~1sec)

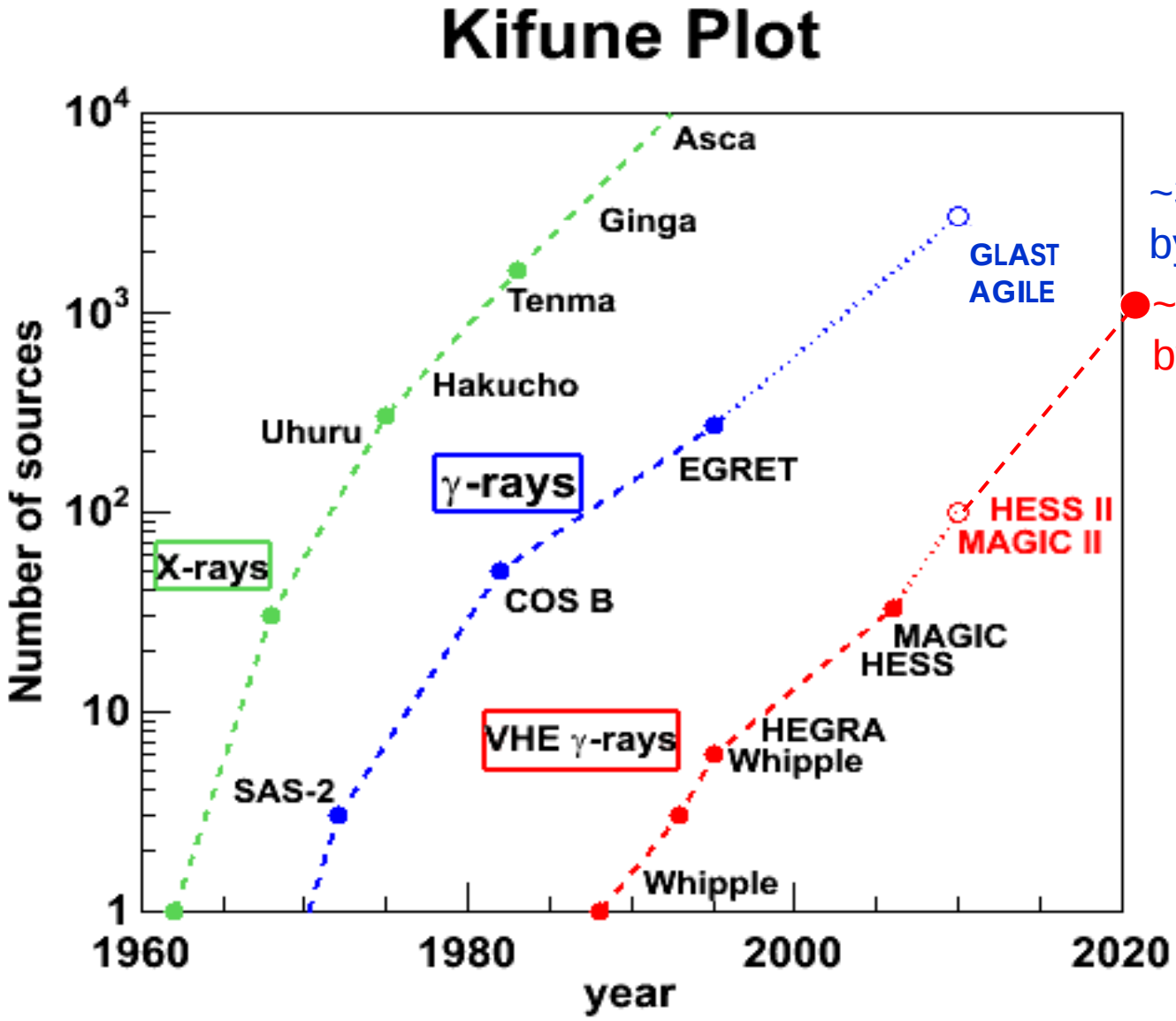


Space and Time

All Sky Observatory

Flexible modes Scan / Monitor

Number of Sources
(expectation from log S - log N)

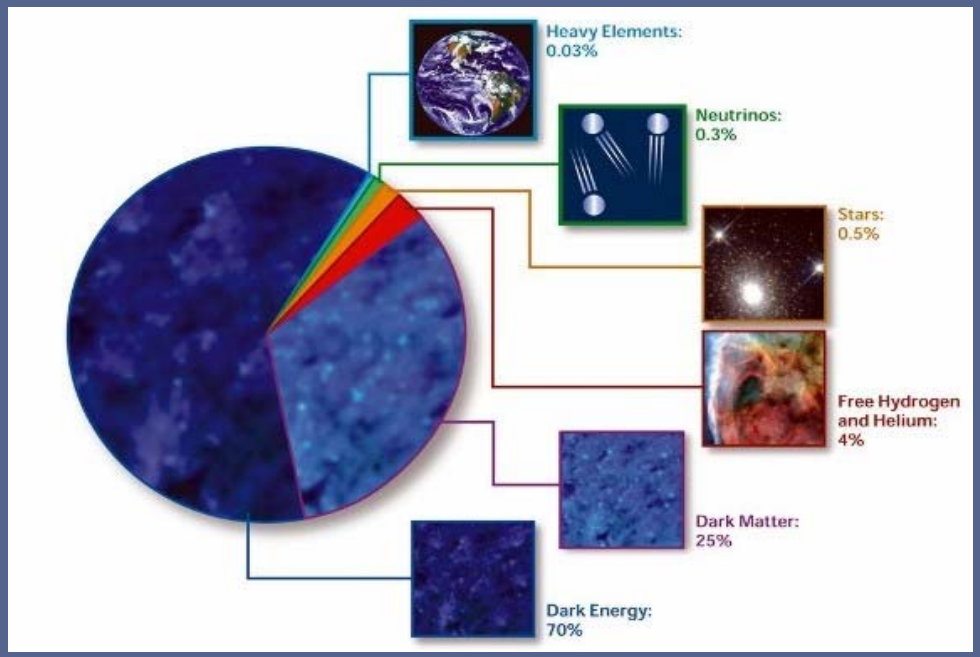


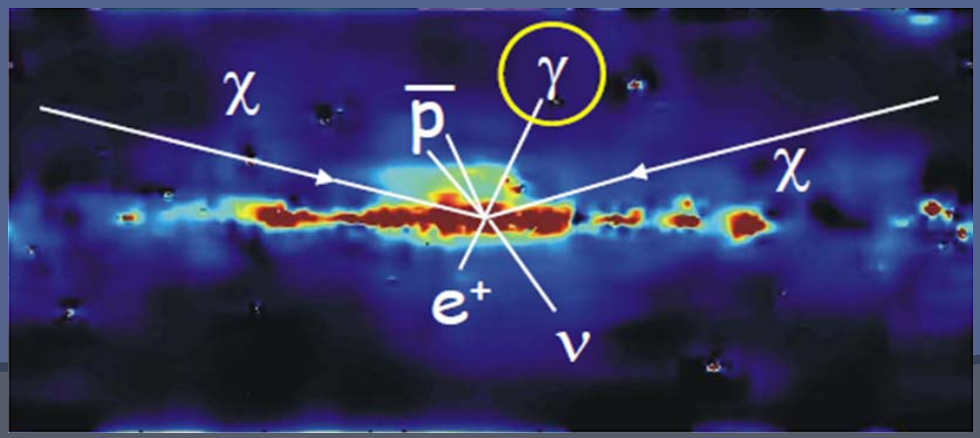
~3000 sources
by GLAST, AGILE

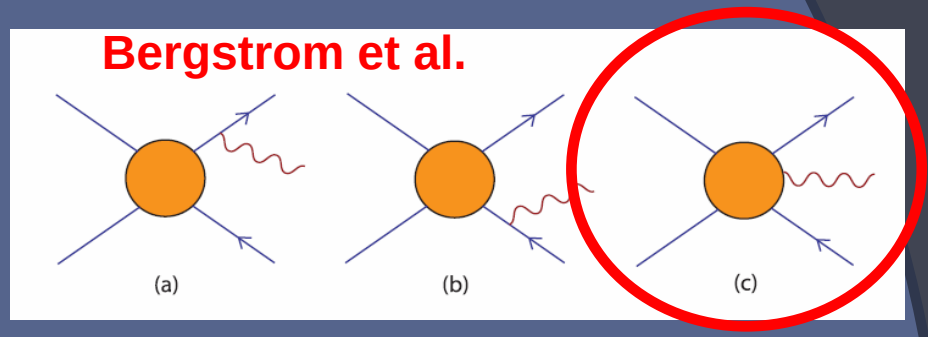
~1000 sources
by CTA

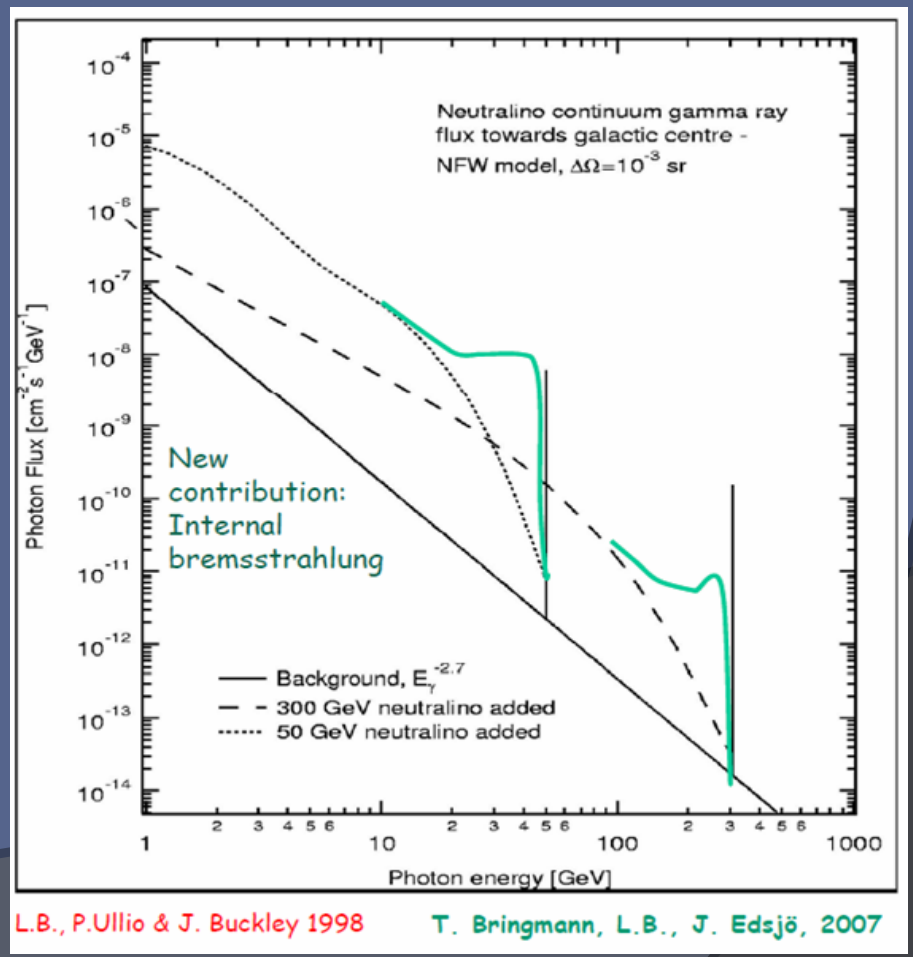
Gamma ray emission process from DM Annihilation

Dark Matter Annihilations







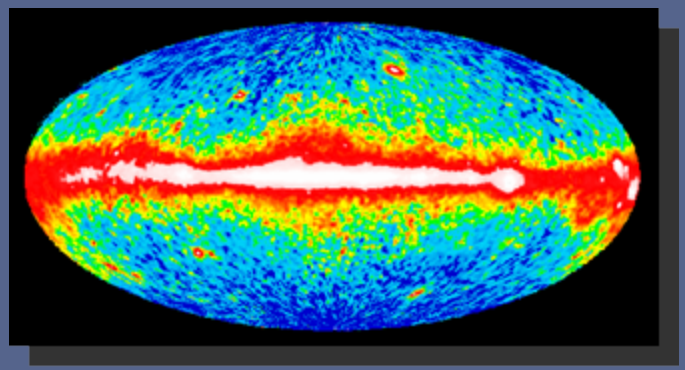


Summary Physics of CTA

- VHE gamma ray astronomy is now blooming!!
  - H.E.S.S., MAGIC and VERITAS are producing a lot of physics results. ➔ 2-3hrs long review
  - Still we have many open questions about High Energy Universe.
  - We need the next generation instrument ➔ CTA
- CTA will achieve excellent sensitivity, higher resolutions and cover wider energy range
  - More than 1000 sources will be discovered
  - All high energy sources in our galaxies can be observed (~400)
    - Origin of galactic cosmic rays
  - Observation will reach to the very deep universe (Early Universe when it was several times smaller)
    - ➔ Evolution of Active galactic nuclei and Super massive Black Holes.
    - ➔ History of Universe: Structure formation, Star formation
  - We can answer many questions not only in Astronomy but also in the fundamental physics and cosmology
    - Search for DM
    - Test the special relativity using long flying high energy photons


CTA

Possible New Classes of Sources

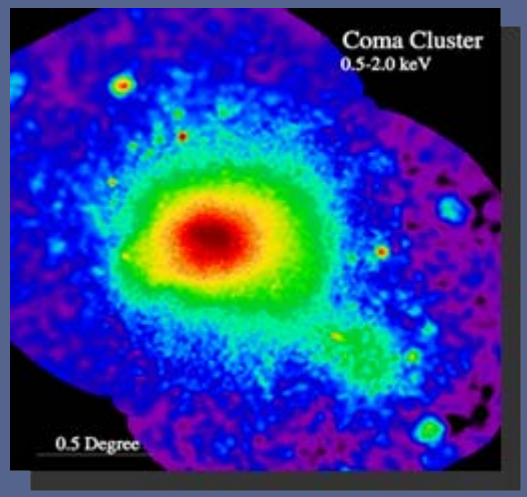


Galactic Diffuse
All skymap

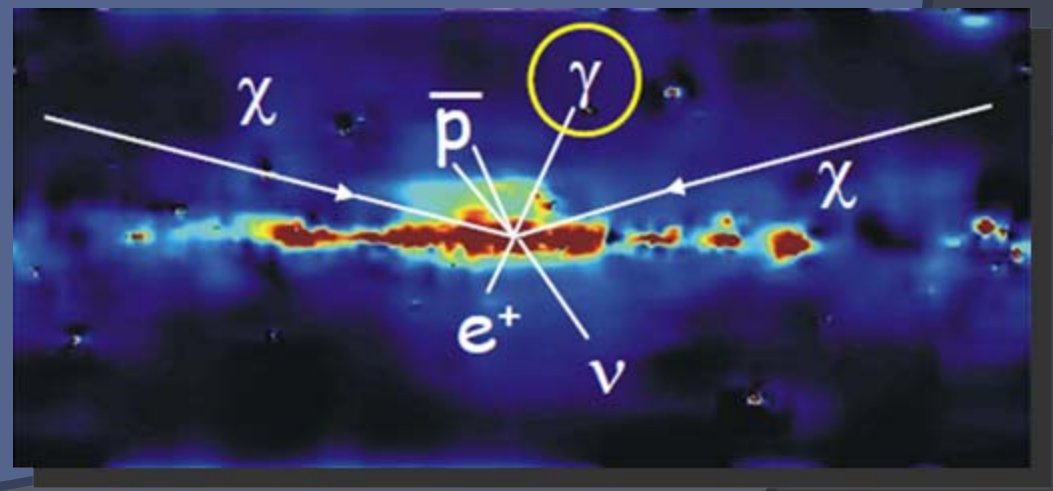
GRBs

UHECR Sources

Starburst galaxies
Galaxy mergers

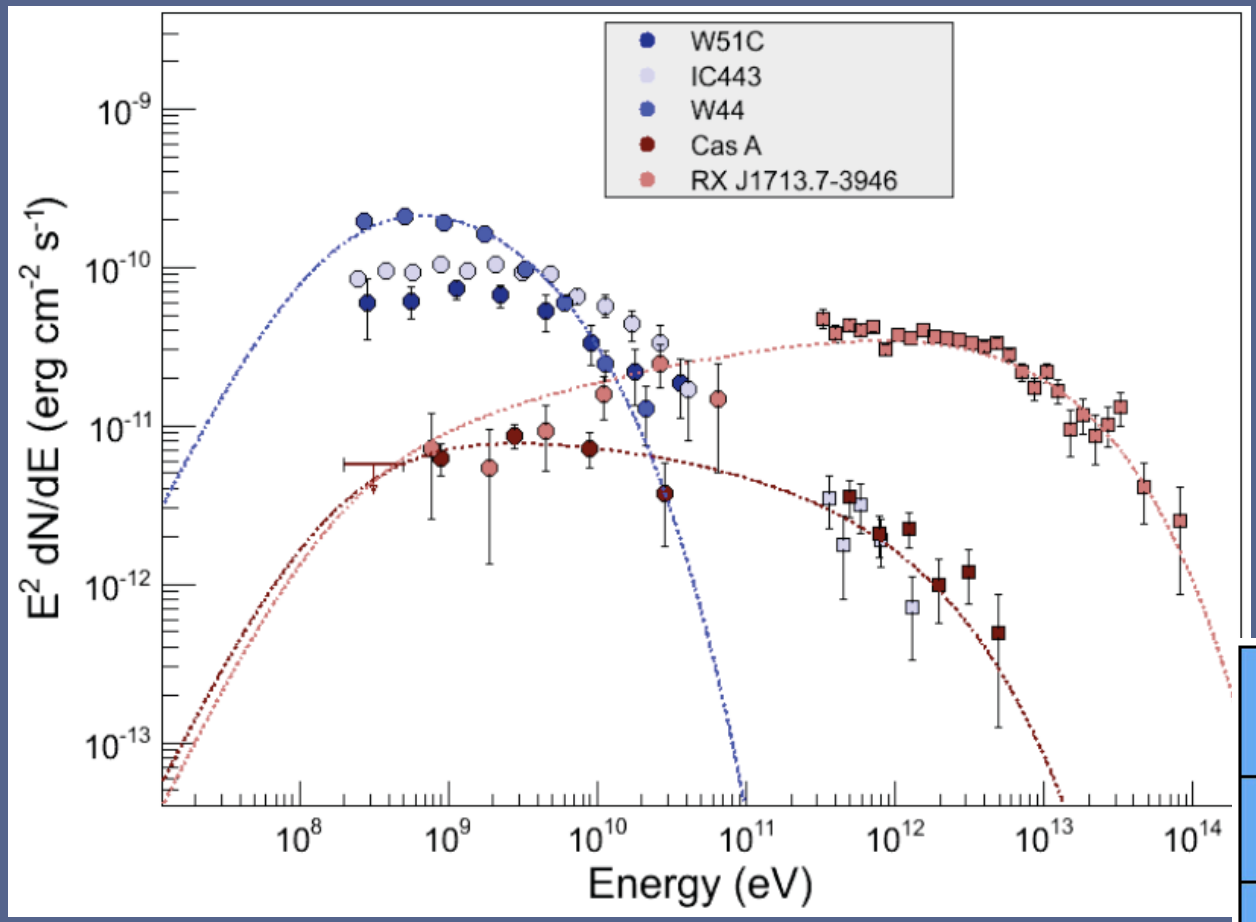


Clusters of galaxies



Dark Matter Annihilation

More SNRs: Evolution of SNR



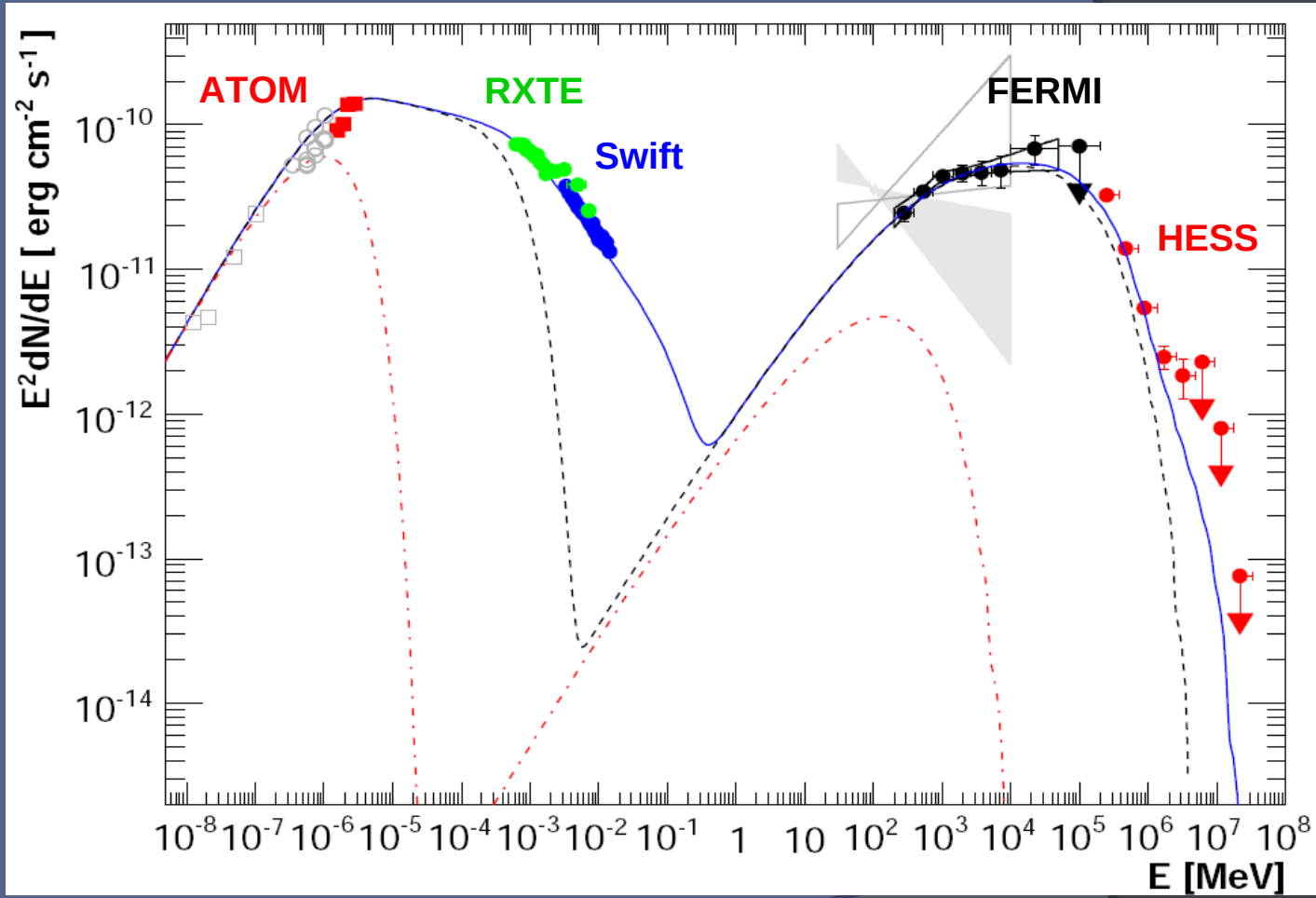
We can study SNRs in different evolutionary stages

	Cas A	RX J1713.7 -3946	IC443	W44	W51C
Age (kyears)	0.3	2	10	20	30
$n_{average}$ (cm-3)	10	0.1	10	100	10
$CR_{fraction}$	2%	50%	25%	5%	10%

Courtesy of S.Funk

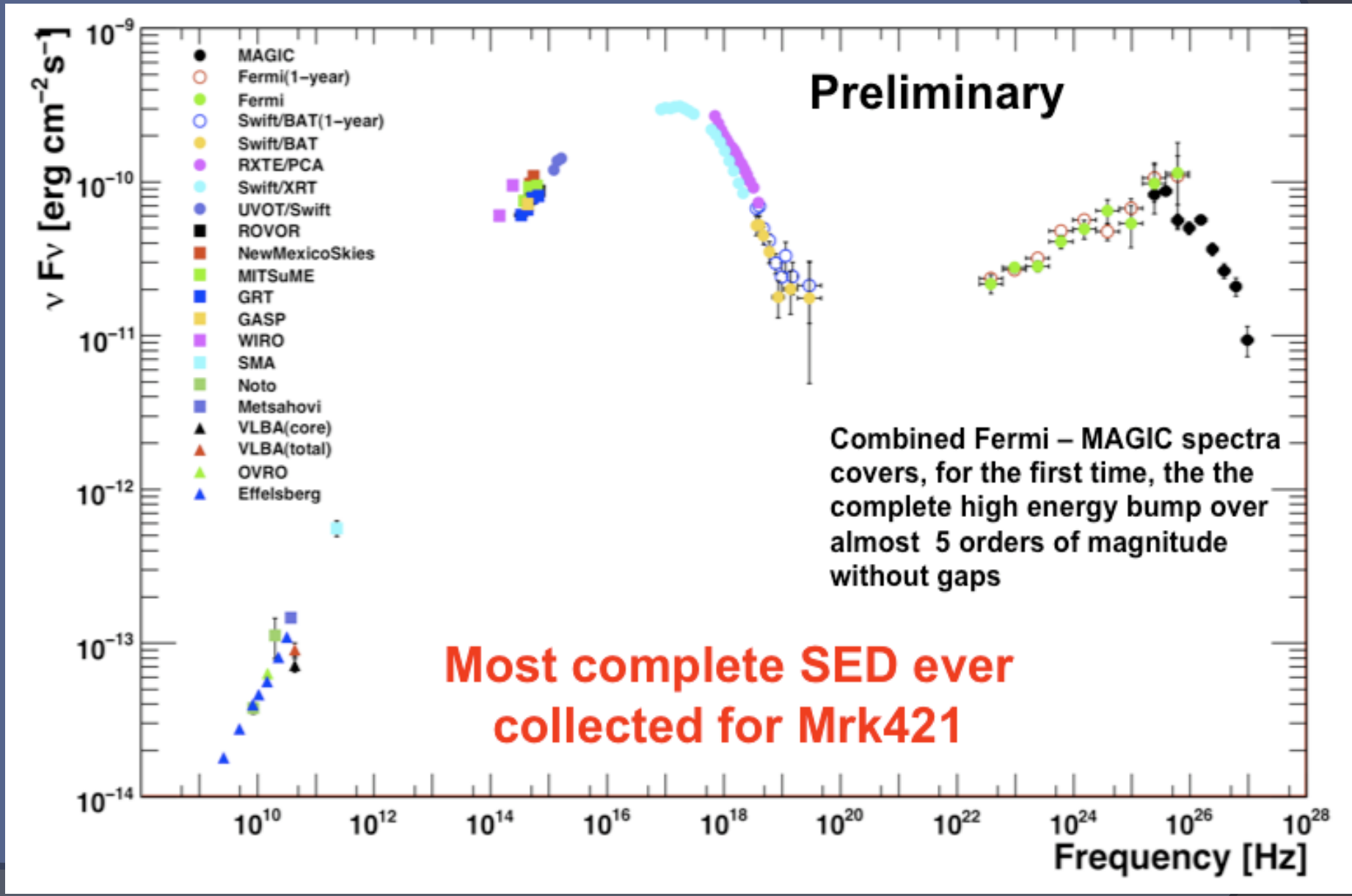
PKS 2155–304
Spectral Energy Distribution

- Time-averaged SED is well described by a single zone SSC model:

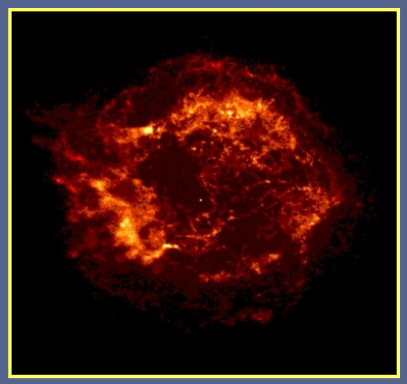


Highest energy electrons (γ_e>2×10^5) produce the X-ray emission, but contribute relatively little above 0.2 TeV

Mrk421 MWL SED



Physics objectives



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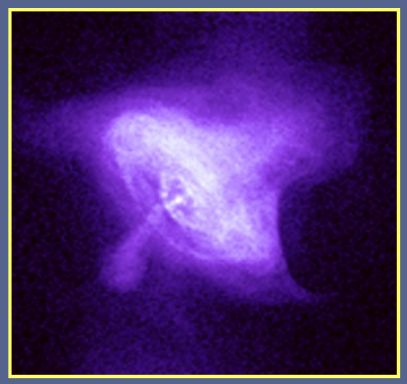

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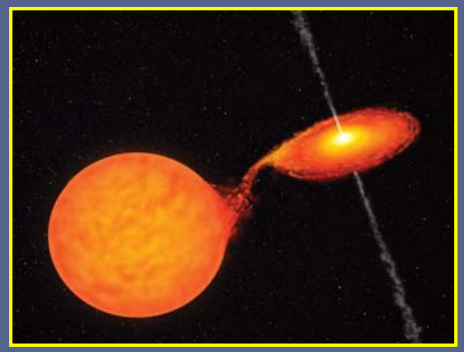

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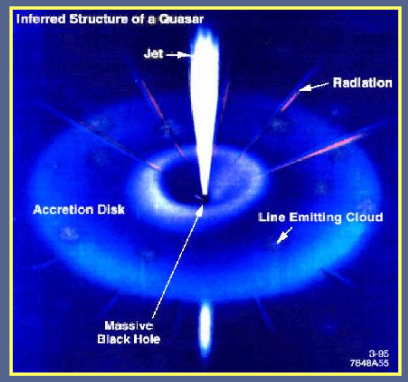

AGNs

GRBs

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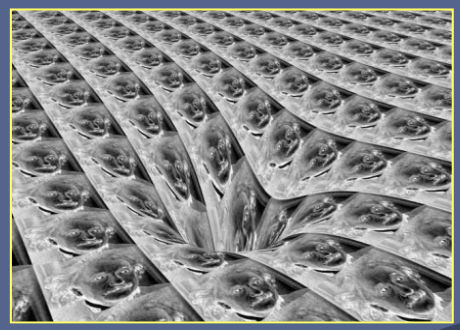
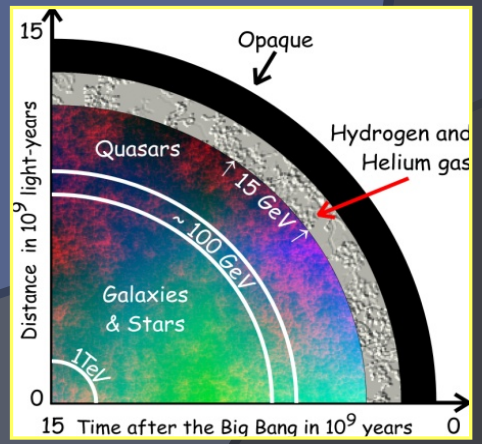
Dark matter

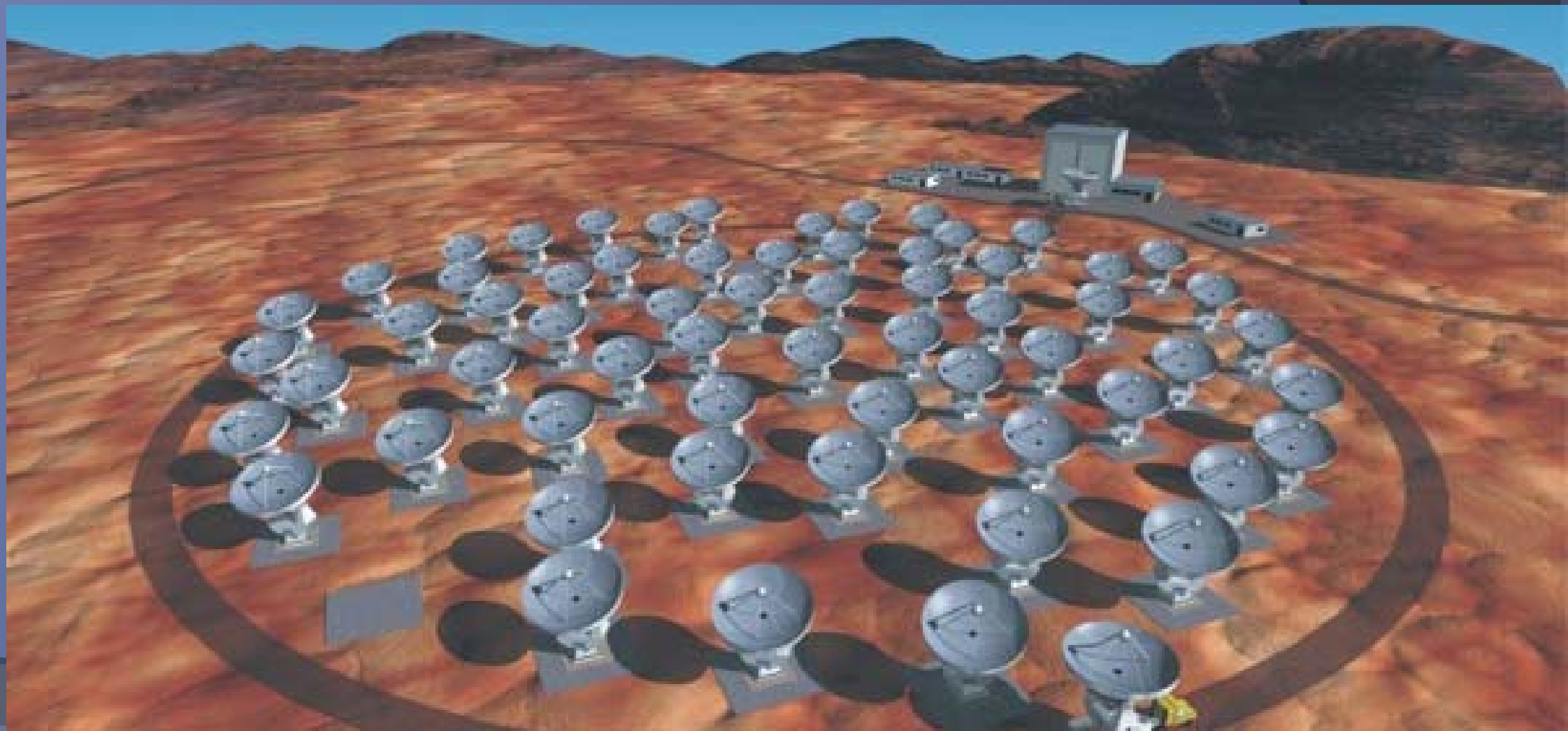


Space-time & relativity

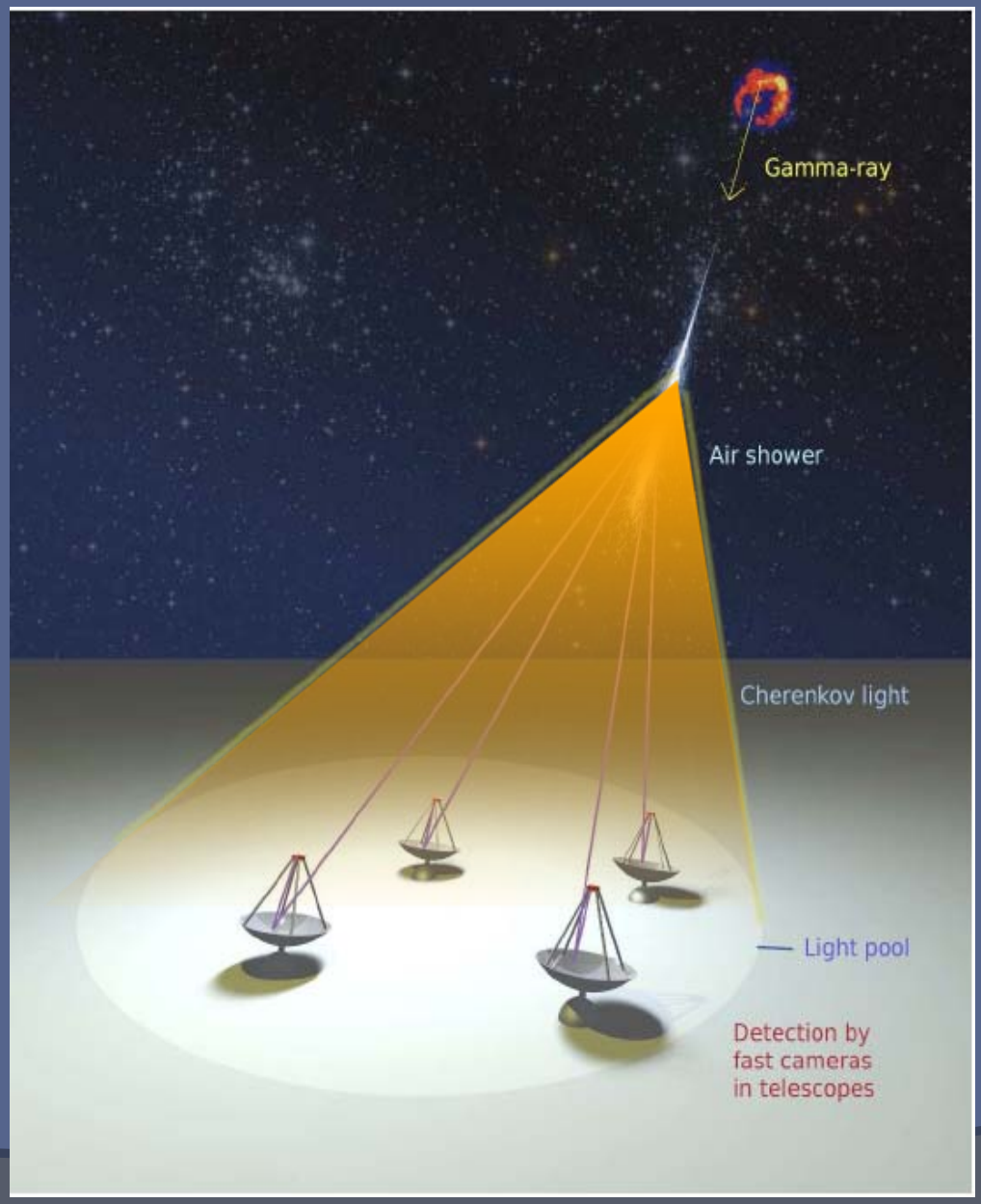


Cosmology

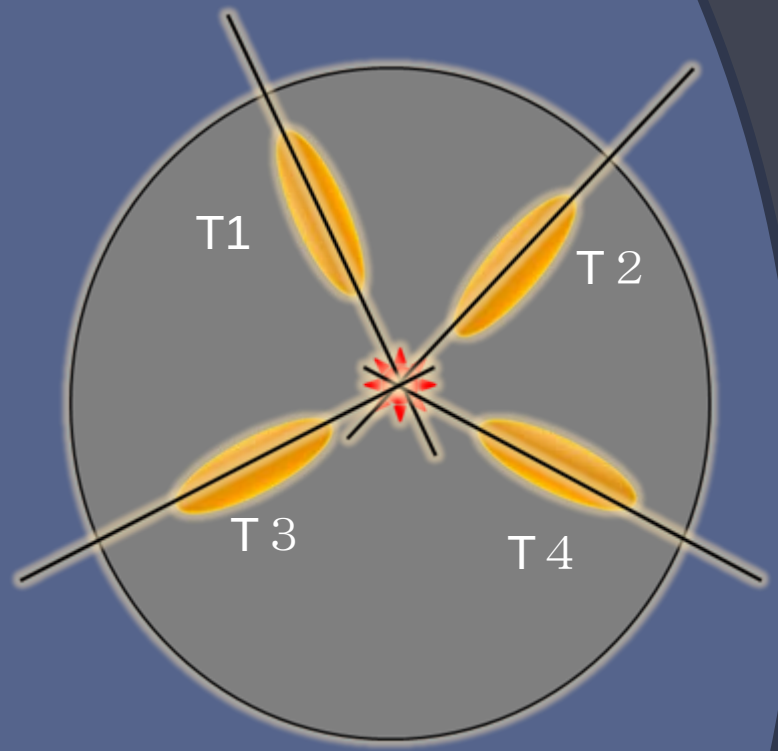
Telescopes



Imaging Air Cherenkov Telescope



Cherenkov Light Images on cameras
50photons/m^2 ~1000 p.e./Tel at 1TeV



CTA-Typical parameters

Energy range	20GeV ~ 100TeV
CR rejection power	~99.9% (Multiplicity 6 Tels)
Angular resolution	~0.03 degrees at 1TeV
Energy resolution	~10% at 1TeV
Detection area	> 3 x $10^6 m^2$
Sensitivity	1m Crab Flux (10^{-14} erg/cm^2s) at 1TeV

Aiming sensitivity