High Energy Astrophysics [Multi-messenger group]

Michele Doro,
michele.doro@unipd.it
05/04/2018

Who we are

Giovanni Busetto
Prof. Ordinario

Alberto Franceschini
Prof. Ordinario

Alessandro de Angelis INFN dir. of
Prof. Ordinario

Mose' Mariotti
Prof. Associato

Denis Bastieri
Prof. Associato

Giampiero Naletto
Prof. Associato

Elisa Bernardini
Prof. Associato

Luca Zampieri
Researcher

Michele Doro
RTDB

Eugenio Bottacini
RTDB

Elisa Prandini
Ass. Senior

Riccardo Rando
Ricercatore conf.

Manuela Mallamaci
postdoc Premiale

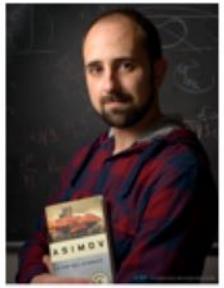
Ruben Lopez
postdoc INFN stranieri

Simona Paiano
Assegno Astro

Alba Fernandez
Assegno junior (Doro)

Alex Burtovoi
Postdoc

Michele Fiori
phd



Luca Foffano
PhD student

+ bi-weekly meeting of GAG group (once @Astro, once@Phys)

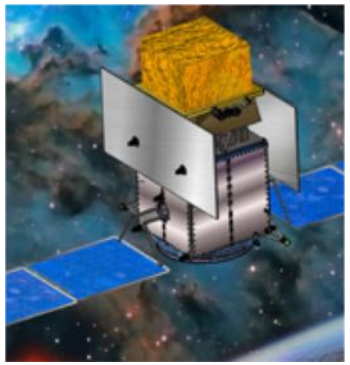
Contact any of us for a description of activities

(Dont' look at the numbers)

Multi-messenger

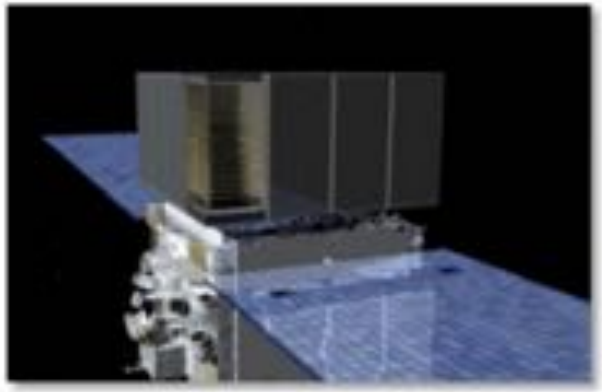
E-ASTROGAM

Compton
(in space)
10 MeV→



FERMI-LAT

Pair-production
(in space)
100 MeV—100 GeV



MAGIC/CTA

Cherenkov
(ground)
10 GeV—100 TeV

HAWC/LATTES

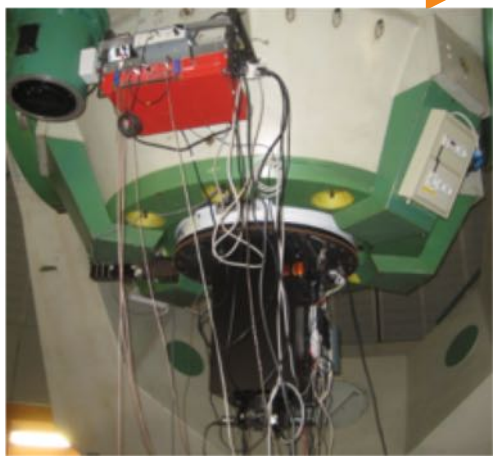
Shower front
(ground)
1 TeV—100TeV+

ICE-CUBE

Showers from
through-going
neutrinos

AQUEYE

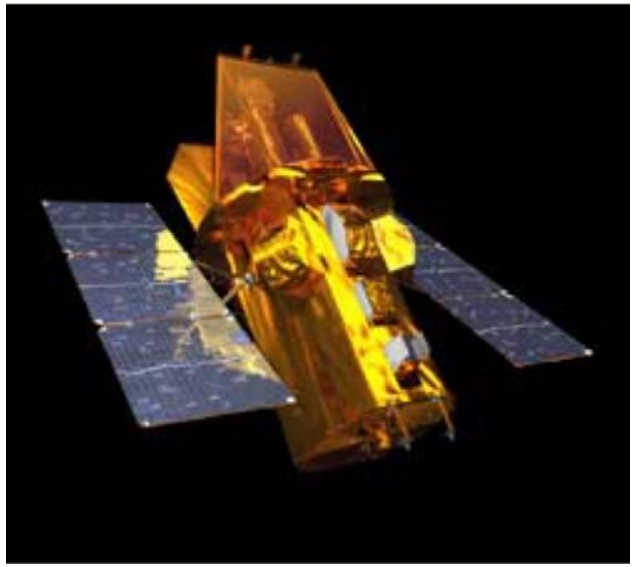
Intensity
interferometry



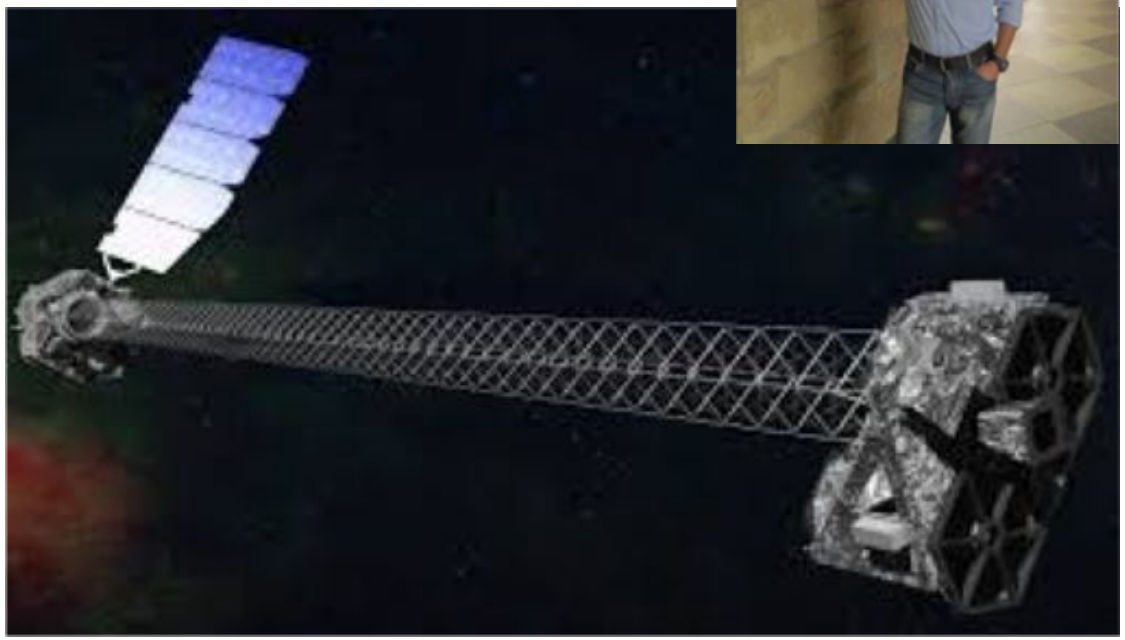
Multi-wavelength

http://www.thebotta.com

XMM: 0.1 - 12 keV



Swift: 15 - 150 keV



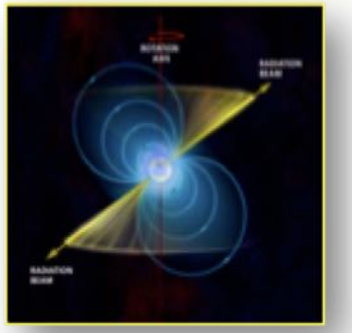
NuSTAR: 3 - 79 keV

INTEGRAL: 3 - 8 MeV

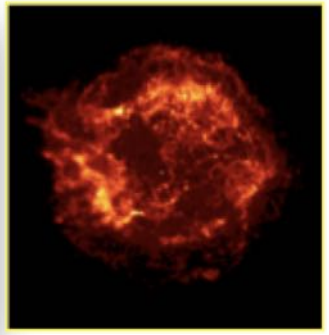
Chandra: 0.4 - 10 keV

What we do

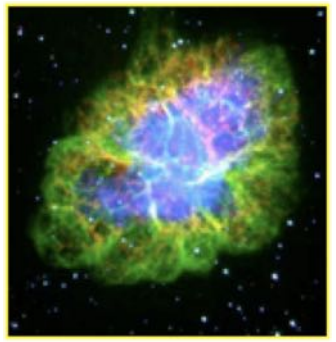
Galactic Science



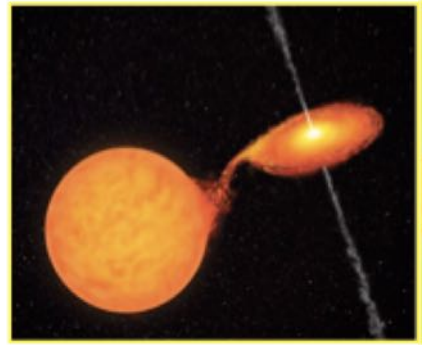
Pulsar



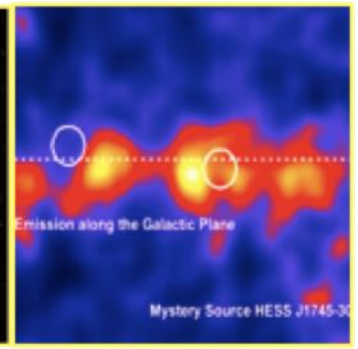
Supernova Remnants



Pulsar wind nebulae

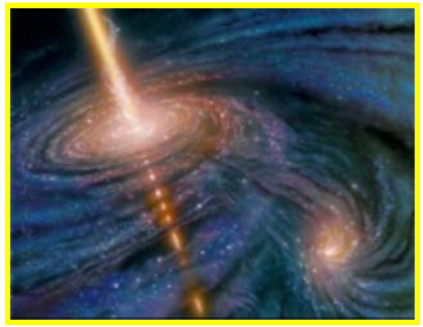


Micro-quasars

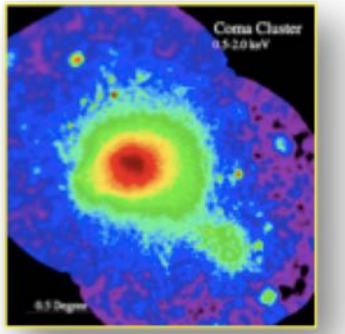


Galactic center

Extra-galactic Science



Active Galactic Nuclei



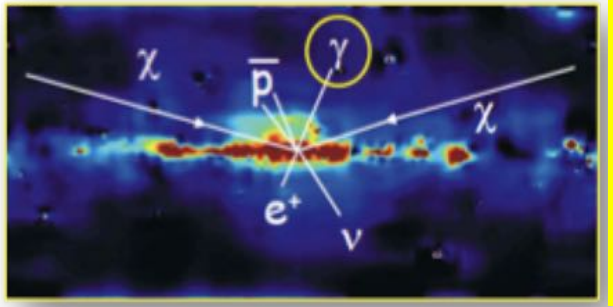
Galaxy Cluster

Starburst galaxies

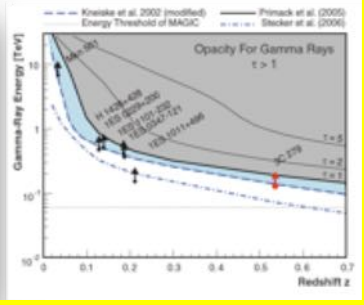
Merging Galaxies

Gamma-ray Bursts

Fundamental Physics



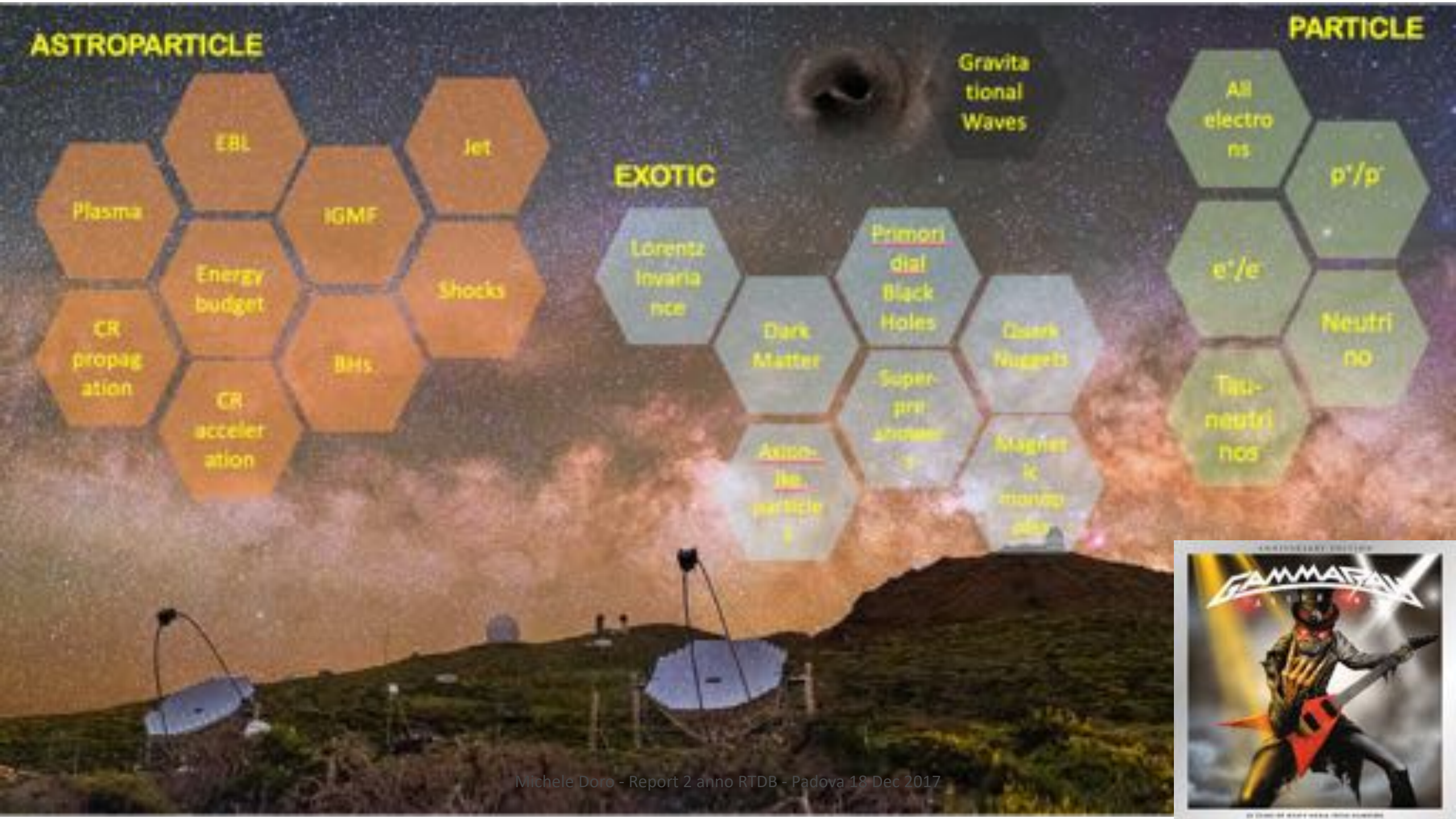
Dark Matter annihilation



Universe transparency

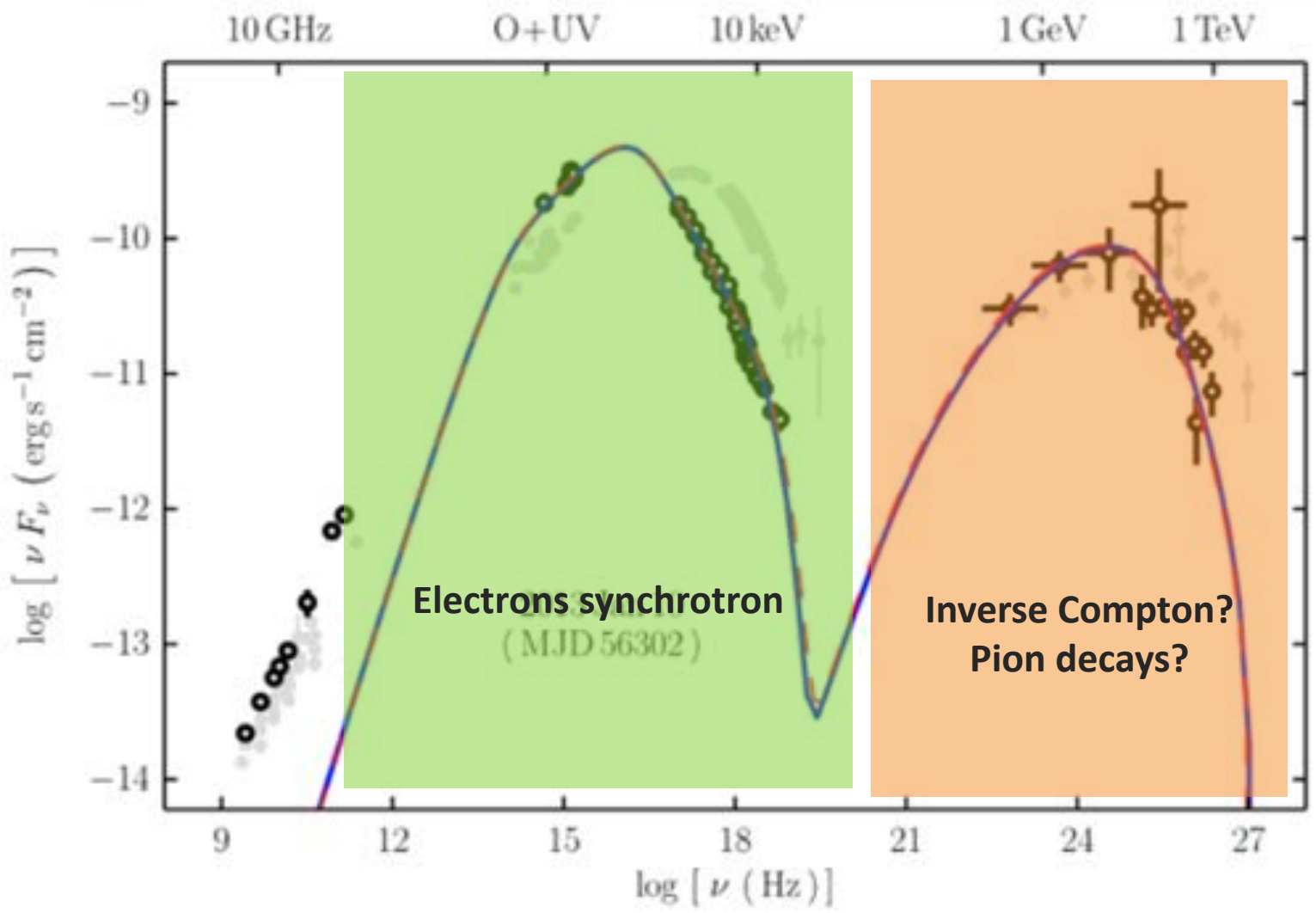
And even more exotic:

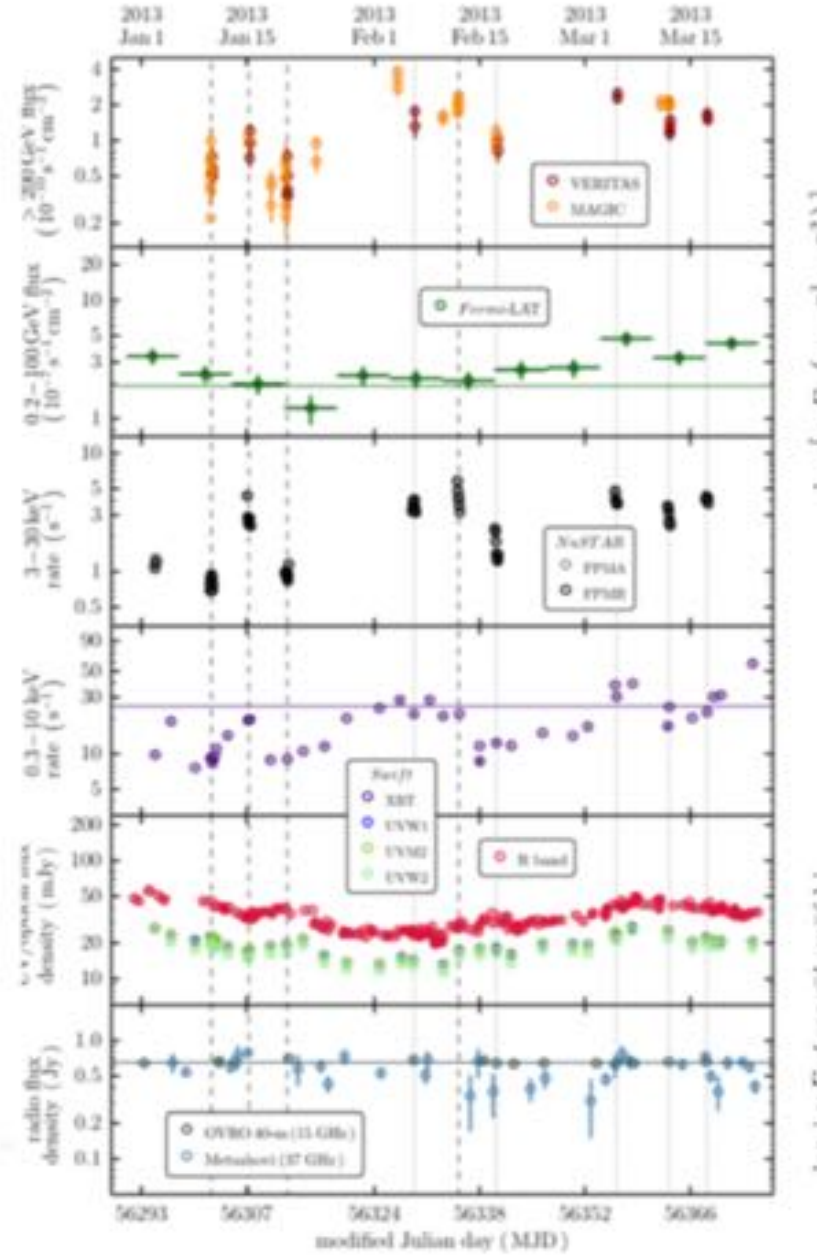
* Axion-like particles
* Tau-neutrino induced showers
* Magnetic monopoles
* ....


ASTROPARTICLE
EBL
Jet
Plasma
IGMF
Energy budget
Shocks
CR propag ation
BHs
CR acceler ation
Gravita tional Waves
EXOTIC
Lorentz invaria nce
Primordial Black Holes
Dark Matter
Super-pre
Axion-like particle s
PARTICLE
All electro ns
p+/p-
e+/e-
Neutri no
Tau-neutri nos

GAMMARAY

Check out the black hole vicinities



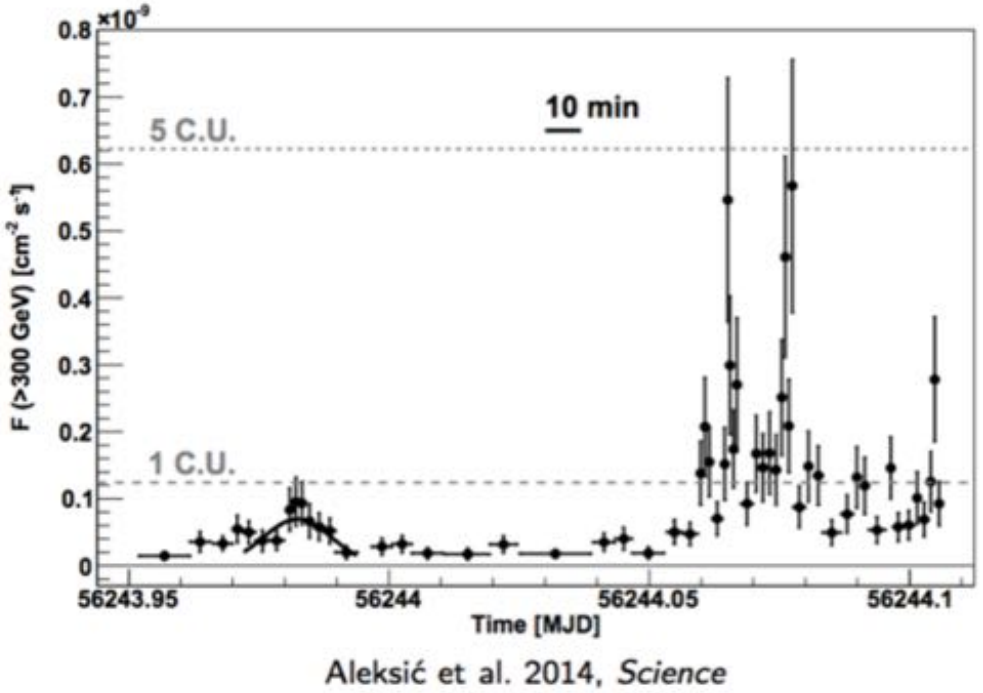


Astrophys.J. 819 (2016) 156

Plot from https://arxiv.org/abs/1611.02232

A thunderstorm in the BH of IC310

Aleksic et al., SCIENCE (2014)



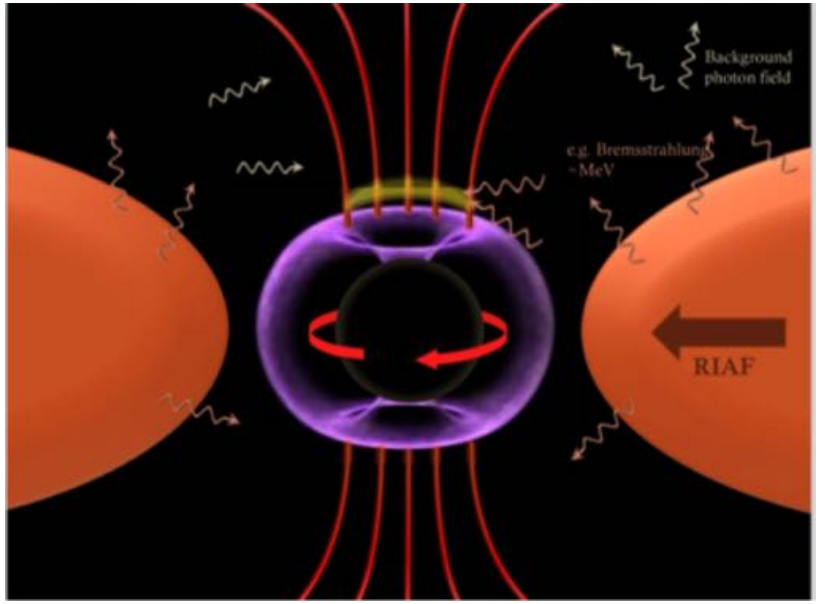
Aleksić et al. 2014, *Science*

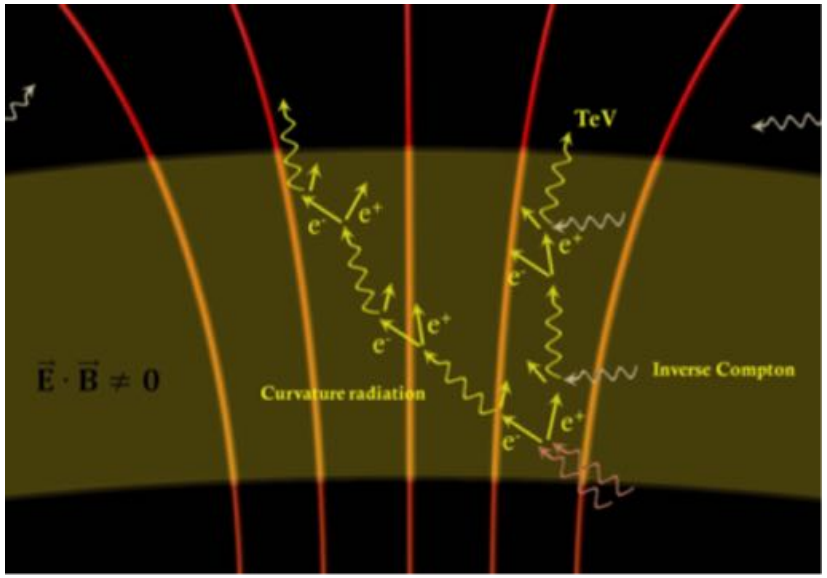
Explanation (pulsar-like):
particle acceleration by the electric field across a magnetospheric gap at the base of the radio jet. Electric fields can exist in vacuum gaps when the density of charge carriers is too low to warrant their shortcut.

In 2014, MAGIC saw an impressive flare of the radio-galaxy **IC310**

Flux-flare was 2x in 4.8 minutes!

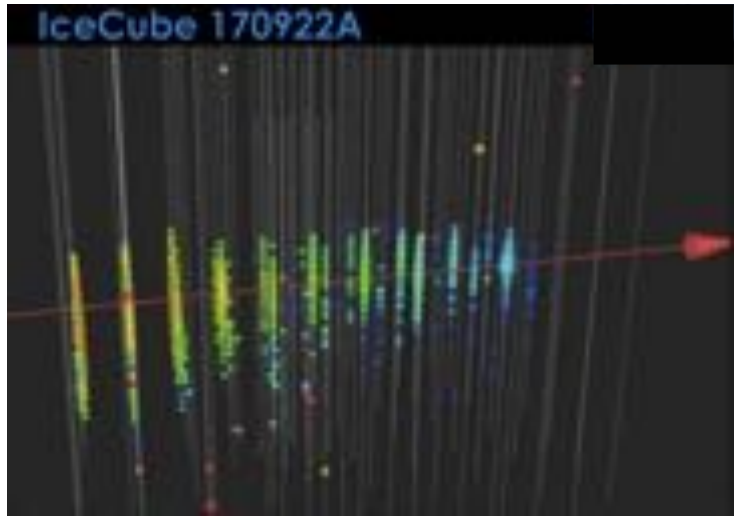
What mechanisms could provide such boost?
Emission region must have size smaller than the 20% of BH

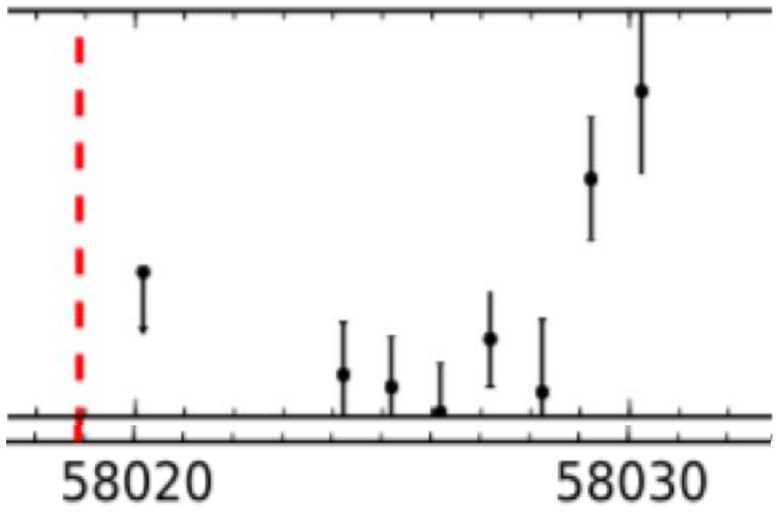


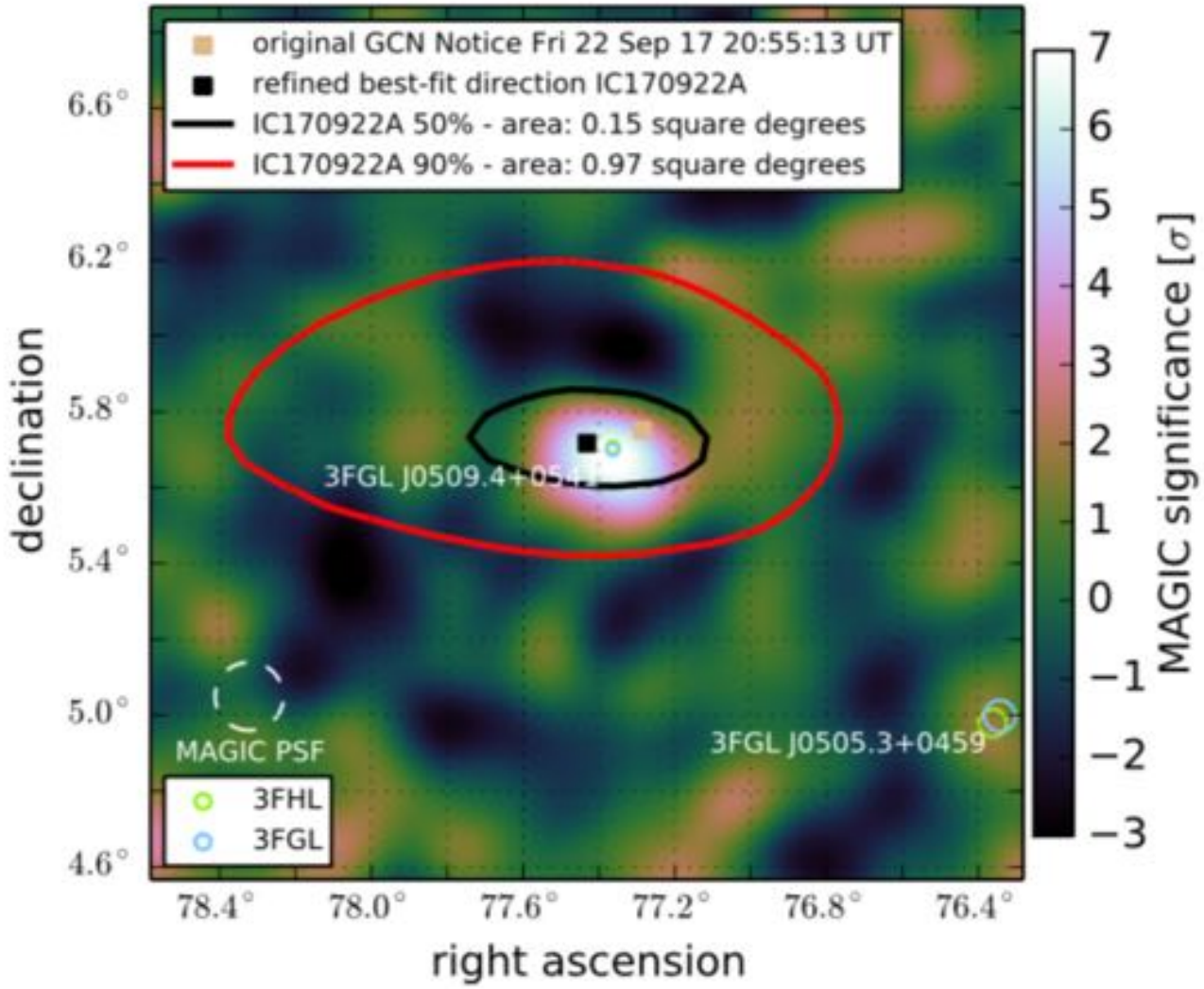


Neutrino and gamma rays in coincidence from TXS0506

EMBARGO

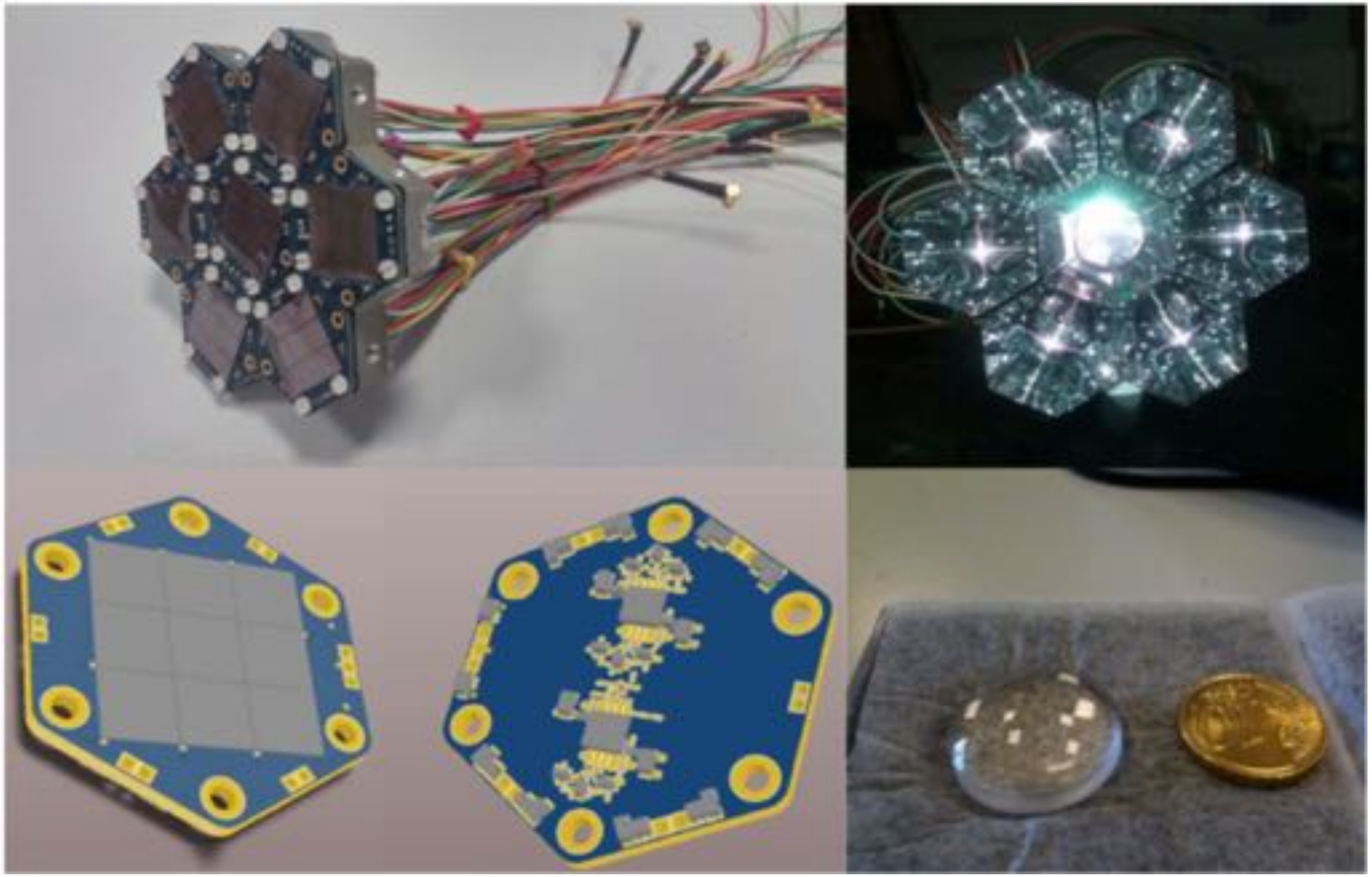


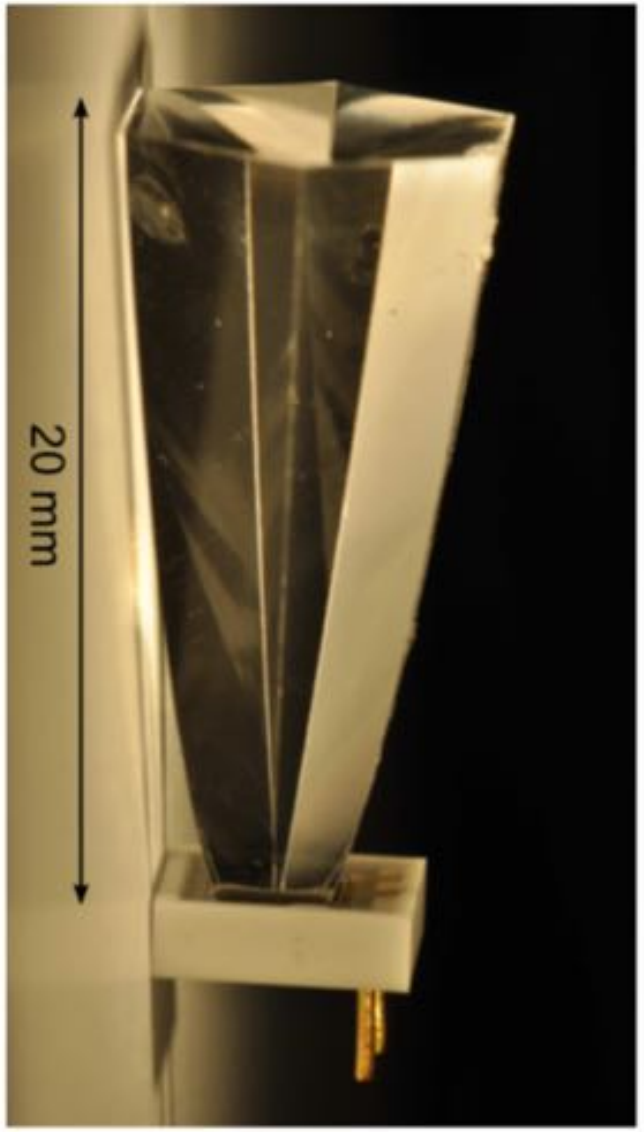




IceCube + Fermi + MAGIC. Submitted to Science

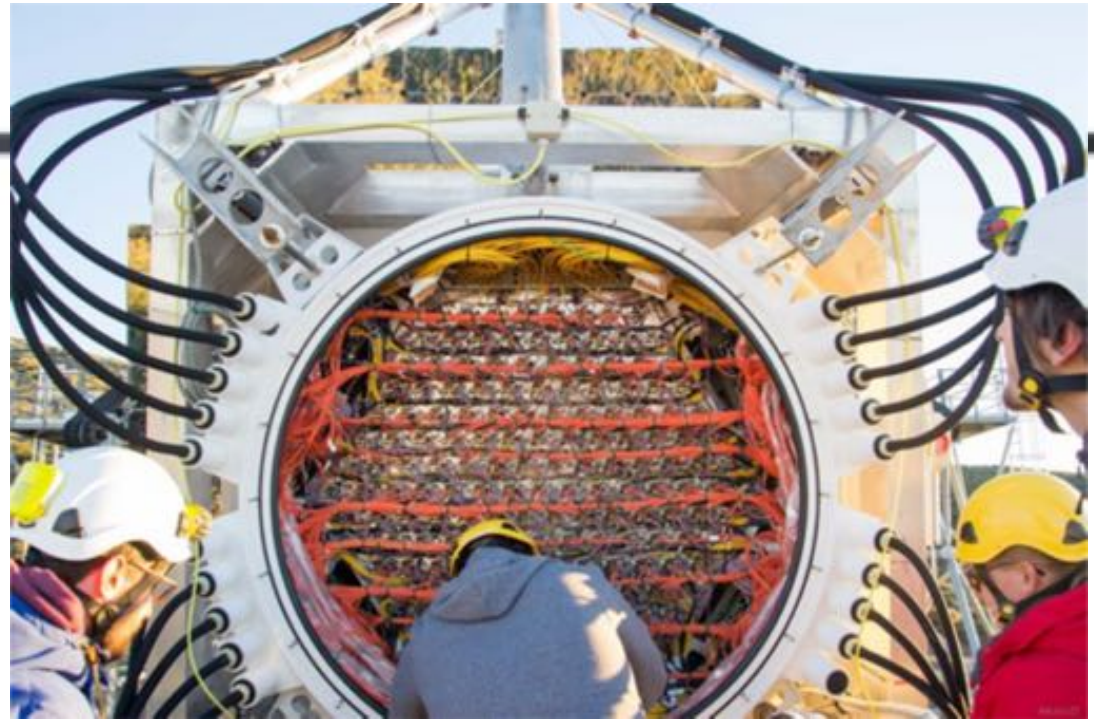
Technological activities

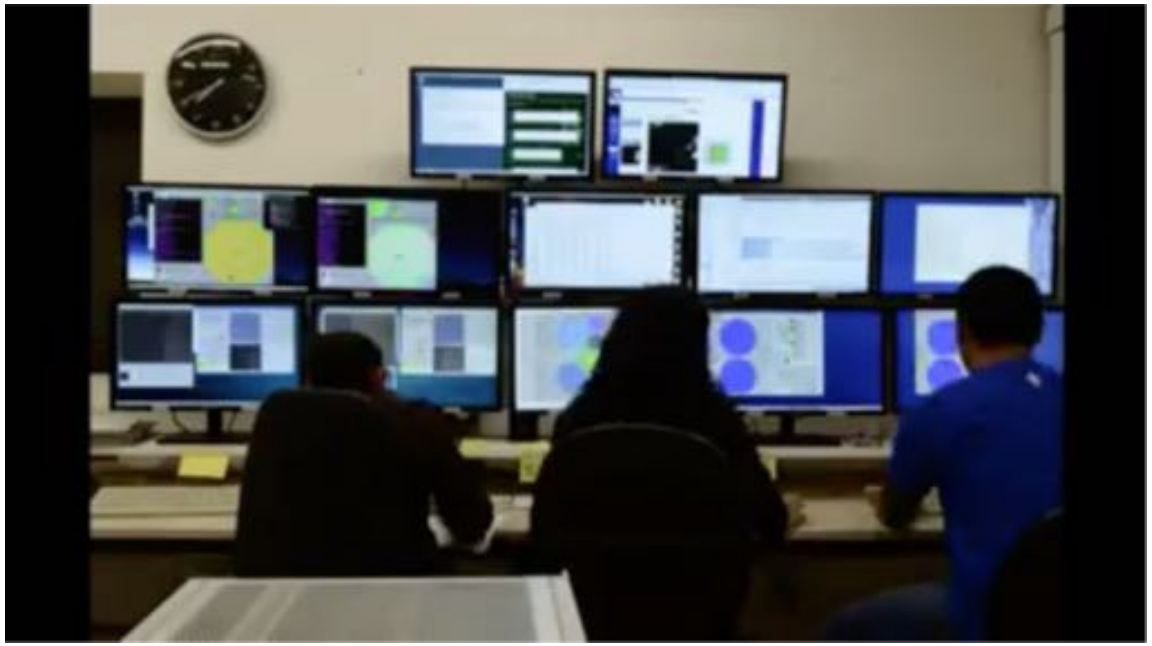




- SIPM photosensors and optical lightguides

Data taking shift

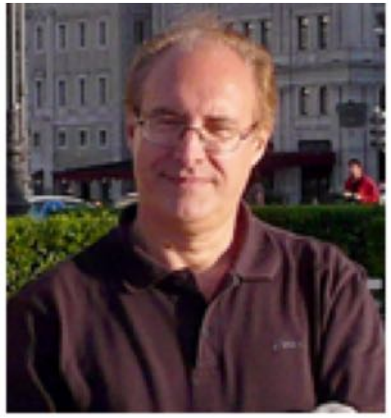




@MAGIC Telescopes

Teaching : High Energy Astrophysics

Alberto Franceschini



- LM Astronomy – II year – 1 semester
- Syllabus
  - Fundamentals of classical electrodynamics (4h)
  - Brehmsstralung radiation (4h)
  - Gas dynamics and plasma effects (4h)
  - Hot plasmas in galaxies and clusters of galaxies (4h)
  - Synchrotron radiation (3h)
  - Inverse compton emission. Comptonization effects (3h)
  - Cosmic rays and particle acceleration mechanisms (3h)
  - Active galactic nuclei . radio galaxies and quasars (3h)
  - High energy emission from active galactic nuclei and blazars (5h)
  - Accretion power in astrophysics (6h)
  - Propagation of radiation and particles through plasmas (4h)
  - Cherenkov astronomy (2h)
  - The cosmic photon-photon and photon-particle opacities (2h)
  - New frontiers. Neutrino astrophysics and gravitational radiation (2h)

Teaching (Physics Curr.)

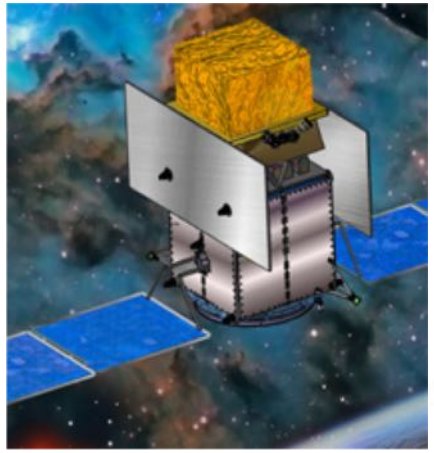
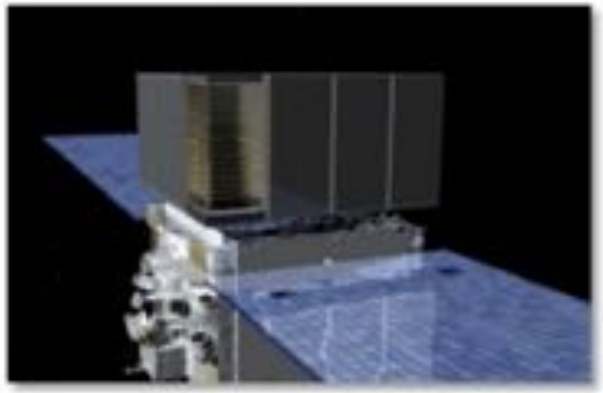
Alessandro de Angelis

- Multimessenger Astroparticle Physics
- Phd Physics Course
- Syllabus
  - 1. Understand the basic physical processes involving high-energy particles and originating the emission of high-energy messengers - in particular: photons from astrophysical accelerators in high-density regions and from Dark Matter.
  - 2. Know the methods and observing techniques to study high-energy emissions.
  - 3. Describe the sky as seen with high-energy detectors.
  - 4. Identify the kinds of astrophysical sources visible at high energies and relate them to relevant emission processes.
  - 5. Have insight into current research in gamma and multimessenger astroparticle physics.
  - 6. Read a scientific article related to gamma and multimessenger astroparticle physics.
  - 7. **Analyze the data from the Fermi LAT** gamma-ray satellite; extract a spectral energy distribution and a light curve for a generic source.

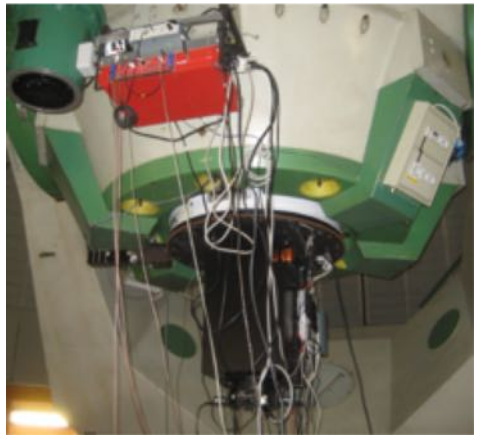
Elisa Bernardini

- Multimessenger Astrophysics
- LM Physics – II year – 1 semester
- Syllabus
  - To be activated.

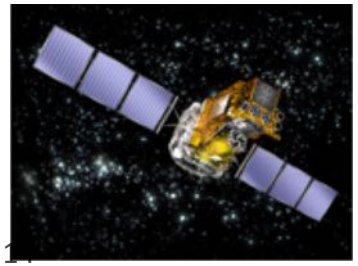
Theses

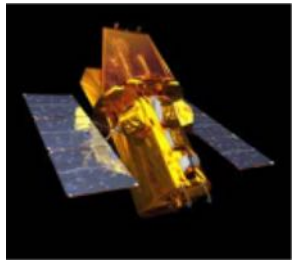
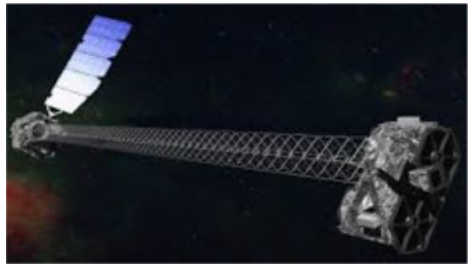







- Analisi dati (scienza)
- Prospettive future (scienza)
- Tecnologiche



Theses Proposal

Updated theses link: https://www.dropbox.com/s/jfihvlao2pmeopl/Theses%20proposals.pdf?dl=0

- These are only examples.
- Better contact one of us for further projects/discussions

1/ TESI LAUREA TRIENNALE

Creazione catalogo dati MAGIC (Doro, Prandini)

2/ TESI DI LAUREA MAGISTRALE

2.1/ MAGIC

Analisi dati telescopio MAGIC (Doro+)

Fisica Astroparticellare con il telescopio alte-energie MAGIC (Doro+)

Studio effetti della trasparenza dell'atmosfera terrestre sui dati del telescopio MAGIC (Doro)

2.2/ Multi-wavelength

Alla scoperta di nuovi buchi neri supermassicci (Bottacini)

Using gamma rays to estimate the distance of active galactic nuclei (Prandini, in 2019)

A population study of powerful active galaxies (Prandini, in 2019)

Evaluating the effects of a low diffusion coefficient in the galactic disk (Lopez Coto)

2.3/ Intensity interferometry

High Time Resolution Astronomy with the A/Iqueye instruments at the Asiago Observatory (Naletto)

Intensity Interferometry at Magic (Naletto)

2.4/ E-Astrogam

Esplorazione dell'Universo nella regione di energia attorno al MeV (De Angelis)

2.5/ Storica

Galilei for the common reader (De Angelis)

http://www.icyaa.it

International Conference of Young Astrophysicists and Astronomers 2018

Brilliant PhD students are invited to present their research activity in a highlight talk.
Students having their master degree thesis in an advanced stage have the opportunity to give a short talk.
The conference is supported by the University of Padua (Italy).

Venue: University of Padua (Italy) at the Department of Physics and Astronomy
When: Friday June 8th, 2018
No Registration Fee

Which ENERGY

Plot from https://arxiv.org/abs/1611.02232