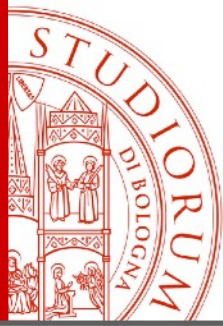


Astroparticle Physics – 87966

Prof. Franco Vazza



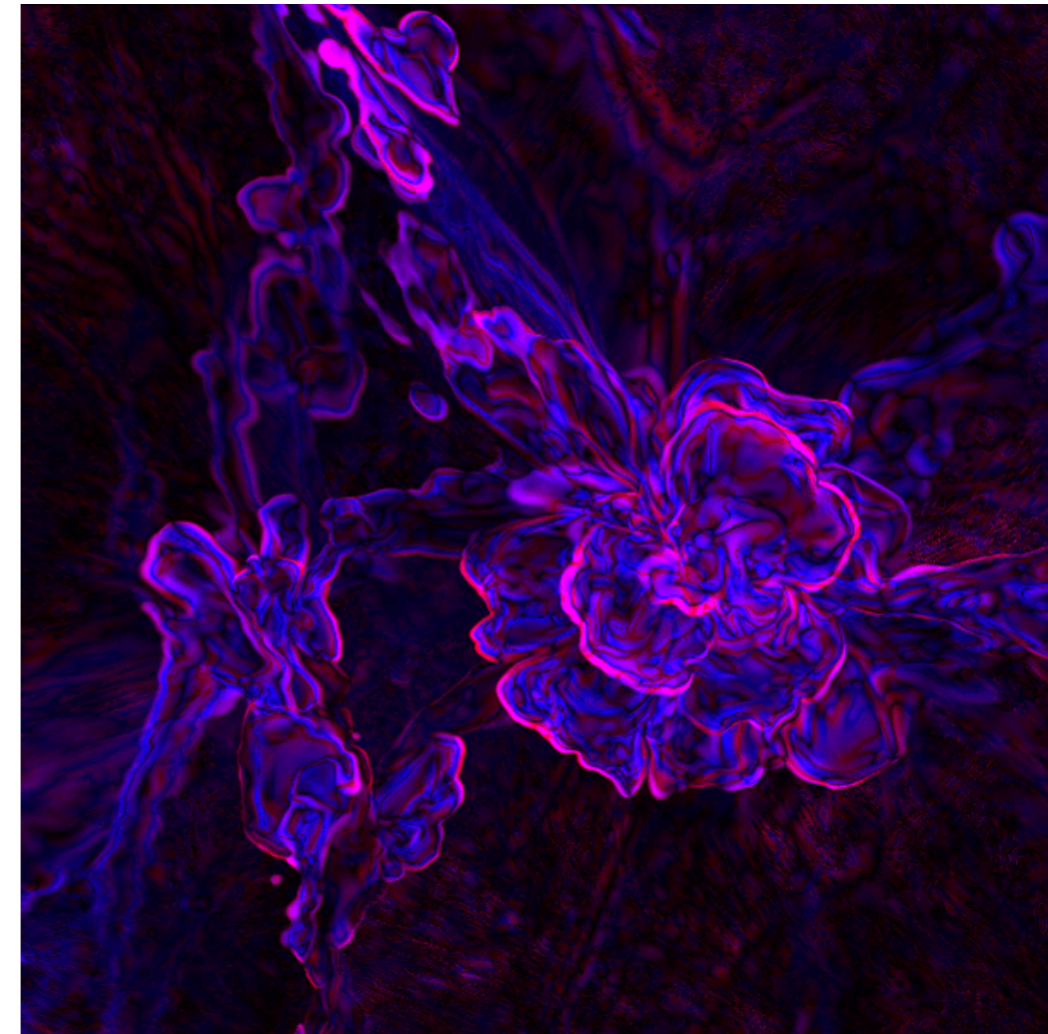
- WHAT DOES ASTROPHYSICS TEACH US ABOUT **PARTICLES**?
- WHAT DO PARTICLES TEACH US ABOUT **ASTROPHYSICS**?

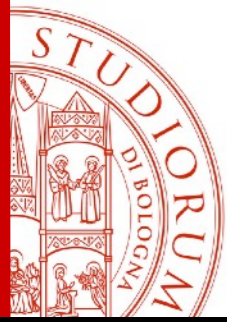


Some info about me

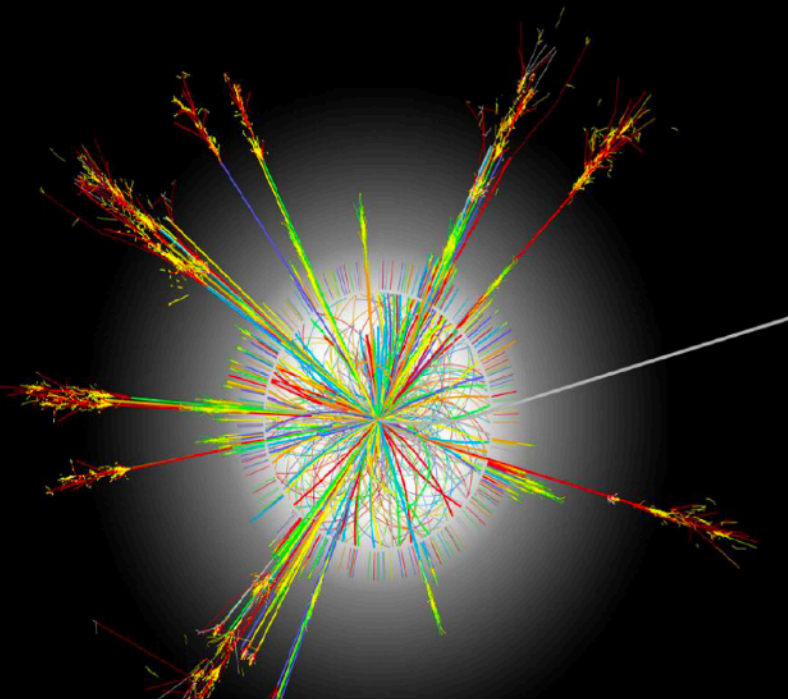
- Numerical Astrophysicist
- Prof. Associato at Dipartimento di Fisica ed Astronomia since 2020
- I study the origin of **extragalactic magnetic fields** and **cosmic ray acceleration** in cosmic structures.
- I produce large numerical simulations and use them to interpret real (mostly radio) observations
- I will teach "Astroparticles" for the 4rd year

➔ <https://cosmosimfrazza.eu>

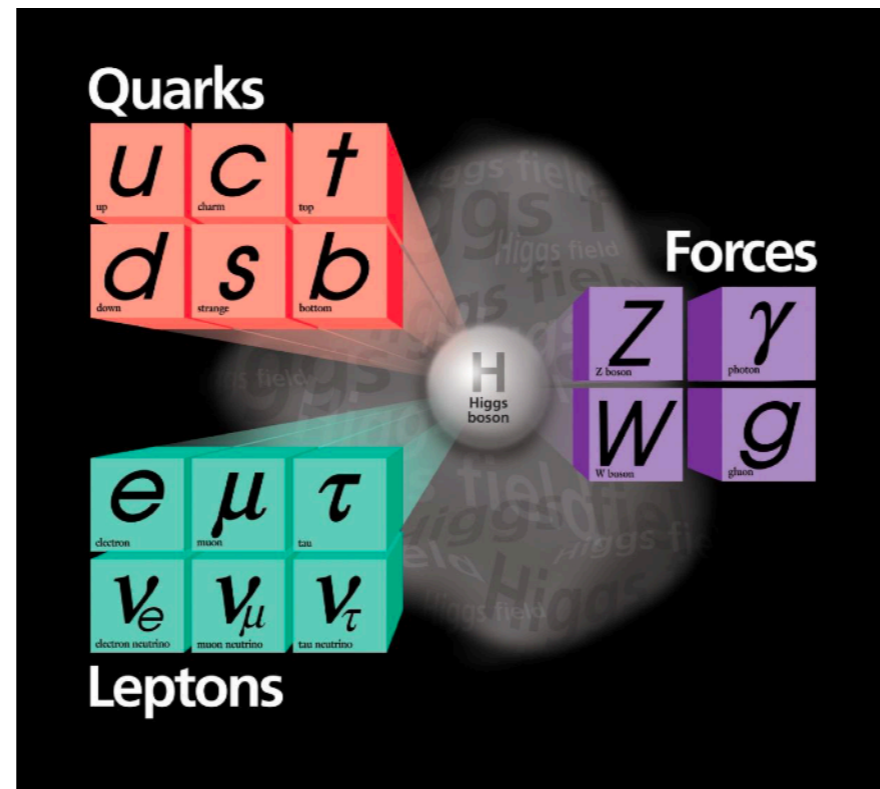
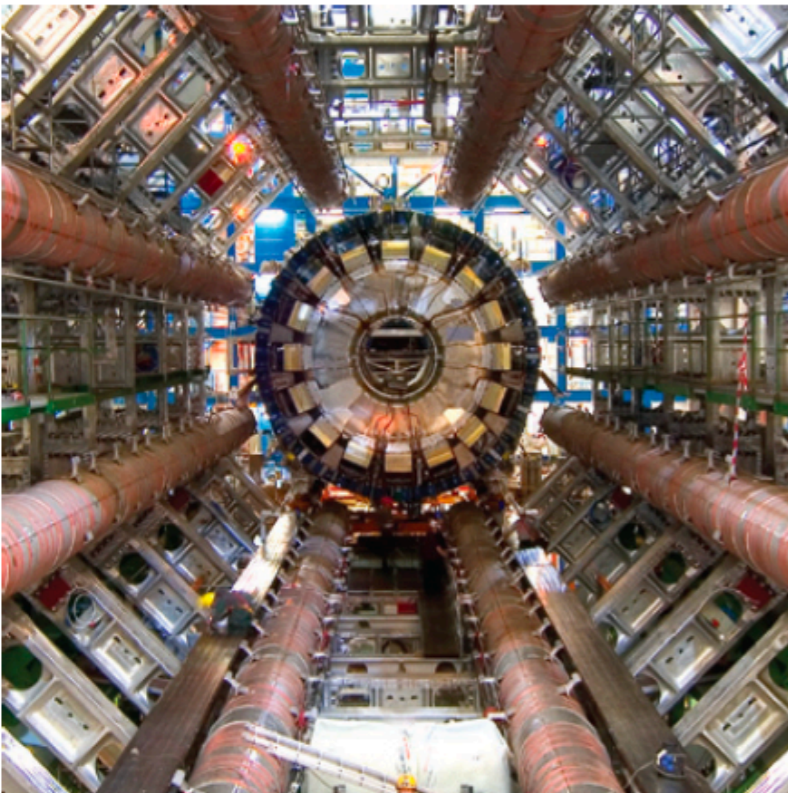


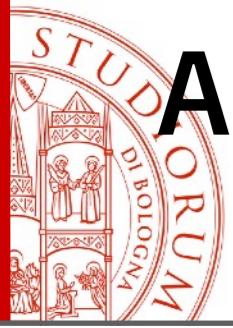


Overview of the Standard Model of Particle Physics

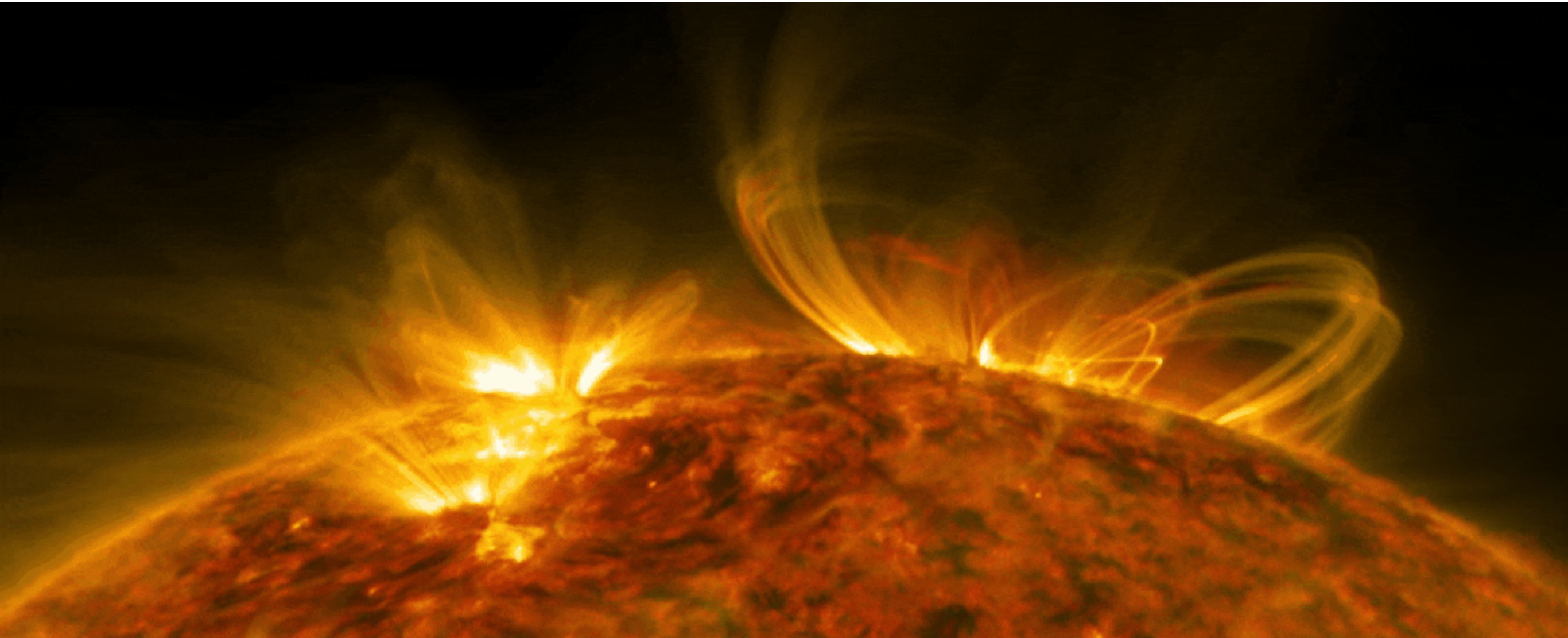


- FUNDAMENTAL PARTICLES
- FUNDAMENTAL FORCES
- SYMMETRIES AND RULES
- OPEN PROBLEMS





Acceleration of low energy cosmic rays by solar flares



- **RECONNECTION, ELECTRIC FIELD ACCELERATION**

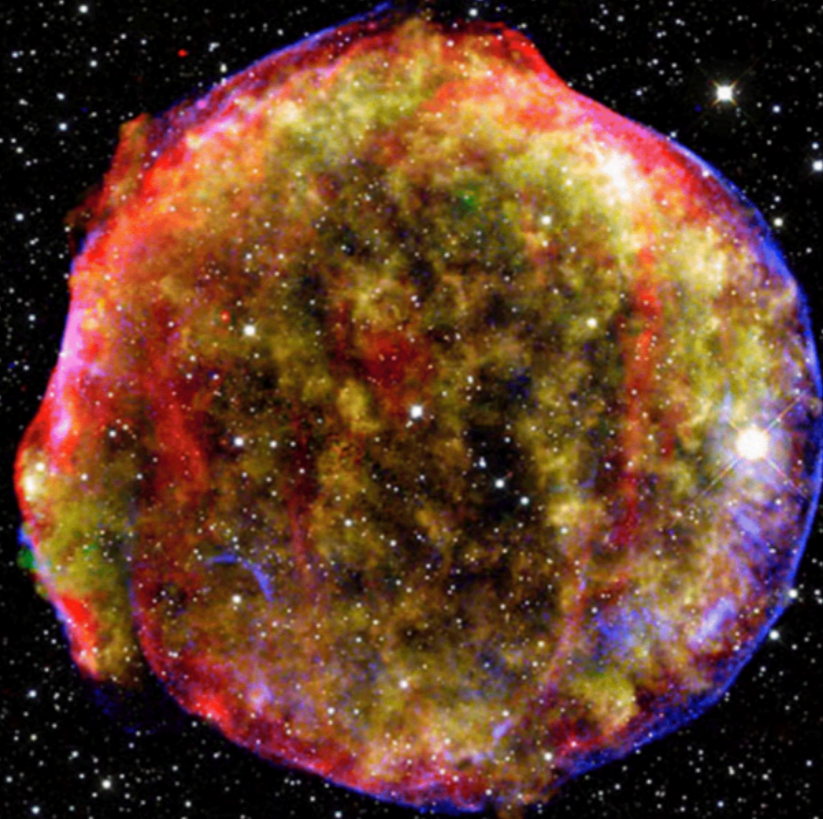


Acceleration of cosmic rays by Supernova Remnants

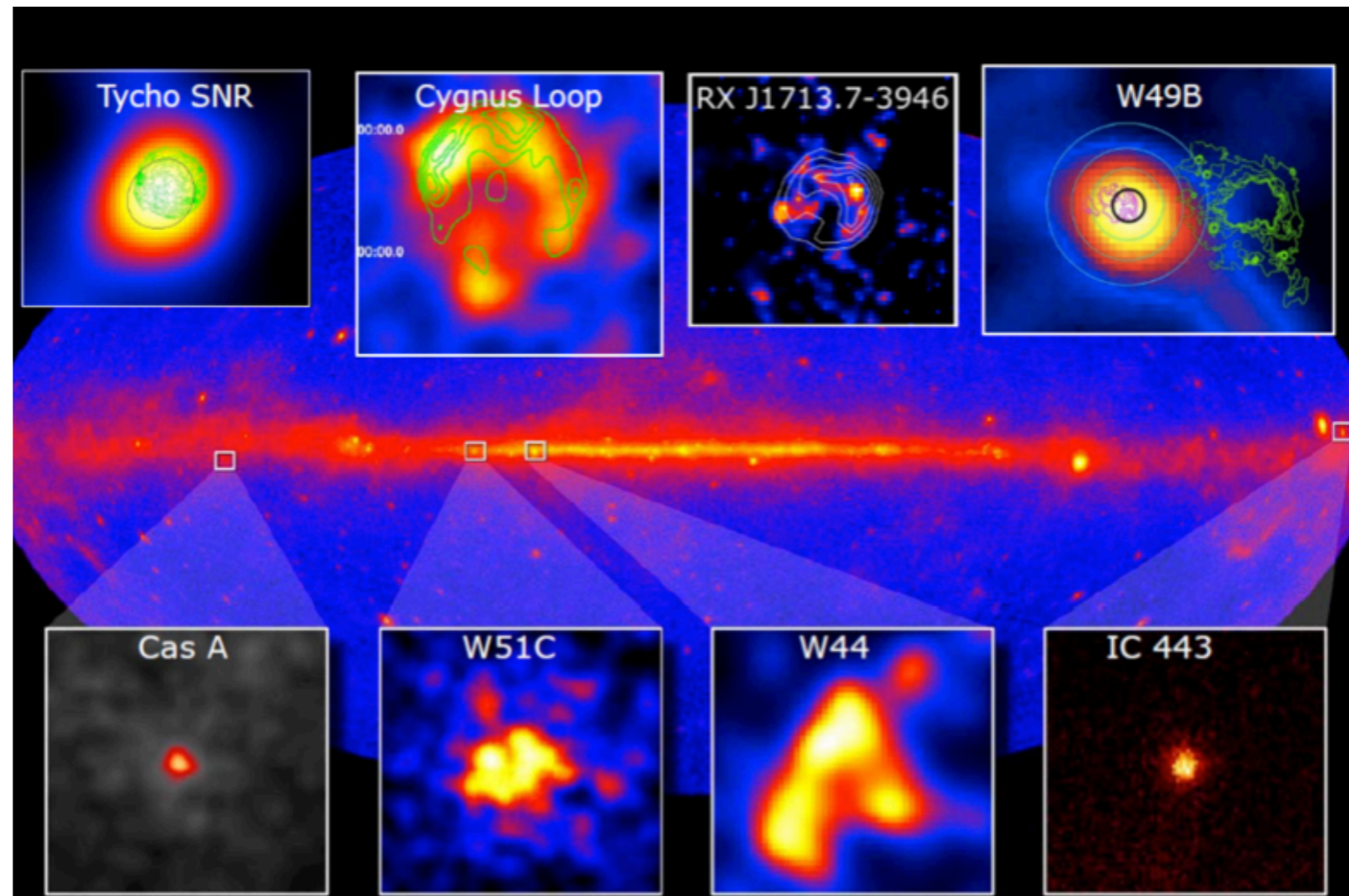
age: ~440 yr
distance: 1.7-5 kpc
size: 8' ~5-12 pc

Tycho's SNR
SN 1572
thermonuclear

- FERMIL ACCELERATION
- MODIFIED SHOCKS
- HADRONIC MECHANISM AND Γ -RAY EMISSION IN THE ISM



multi-wavelength composite:
X-rays (Chandra 1-2 keV and 4-6 keV)
optical (Calar Alto)
infrared (Spitzer)





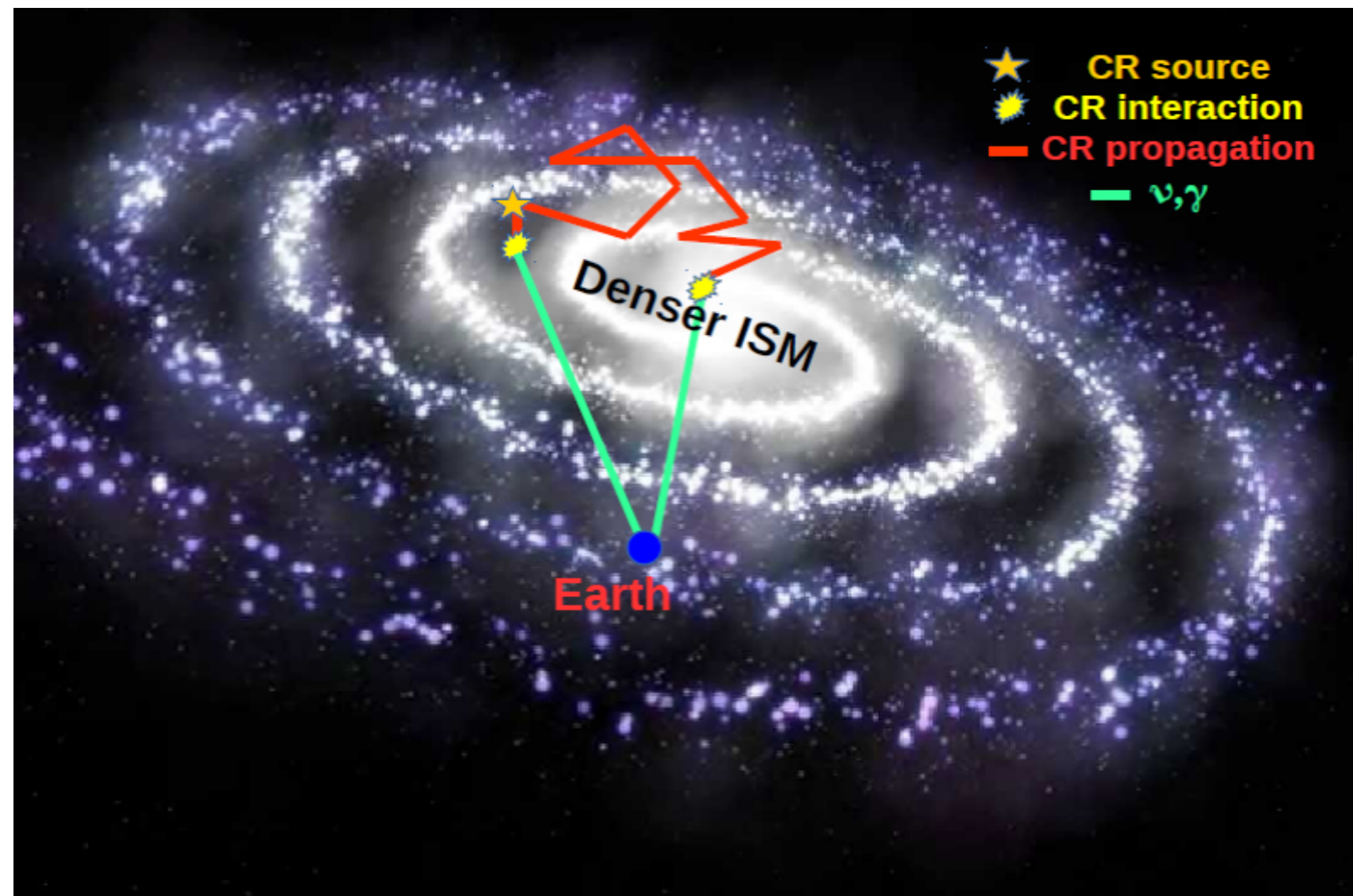
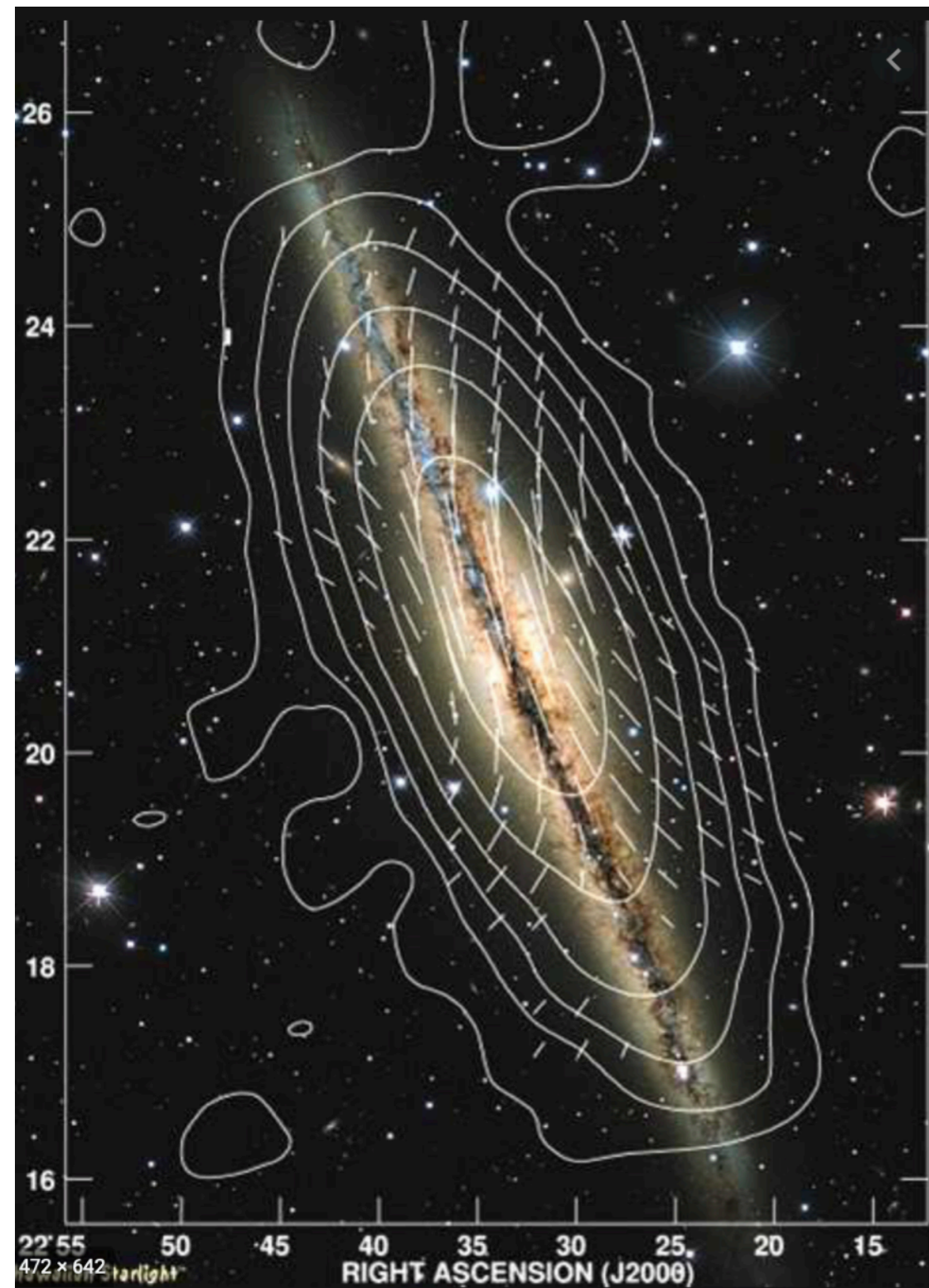
Acceleration of cosmic rays by Cluster Mergers



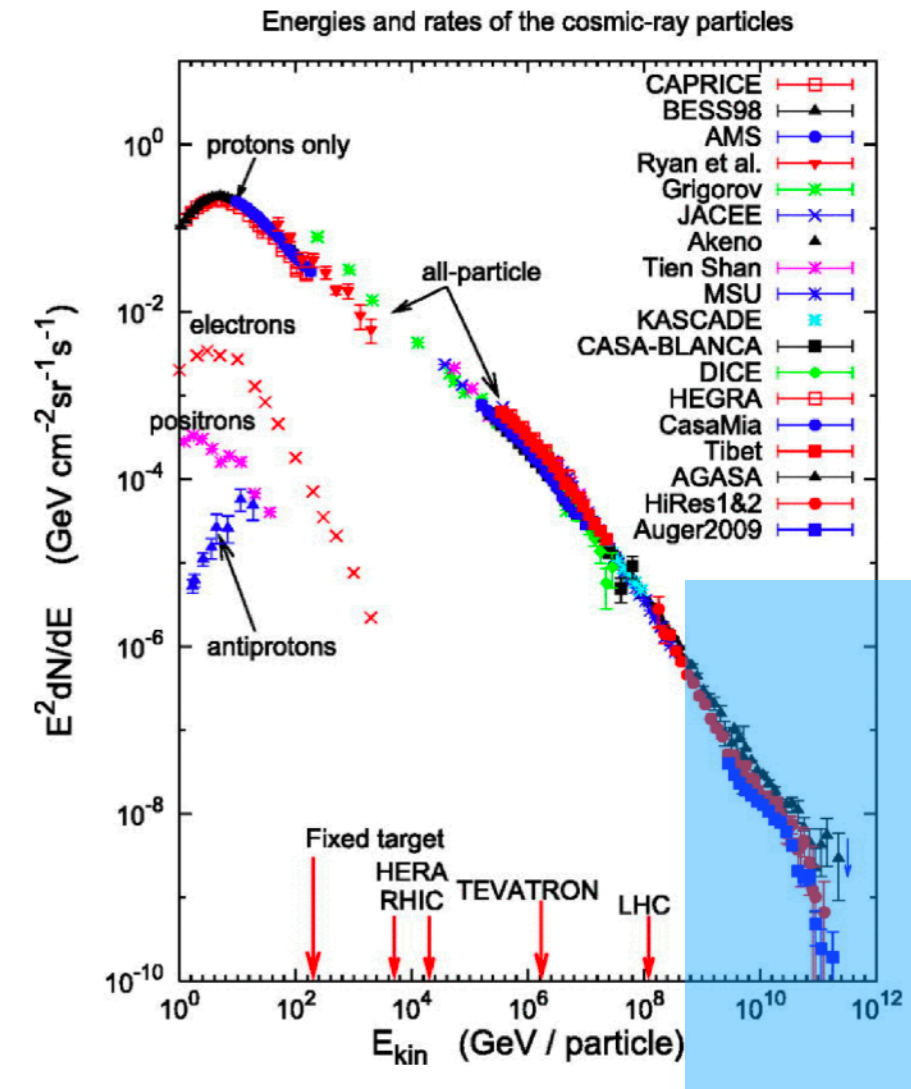
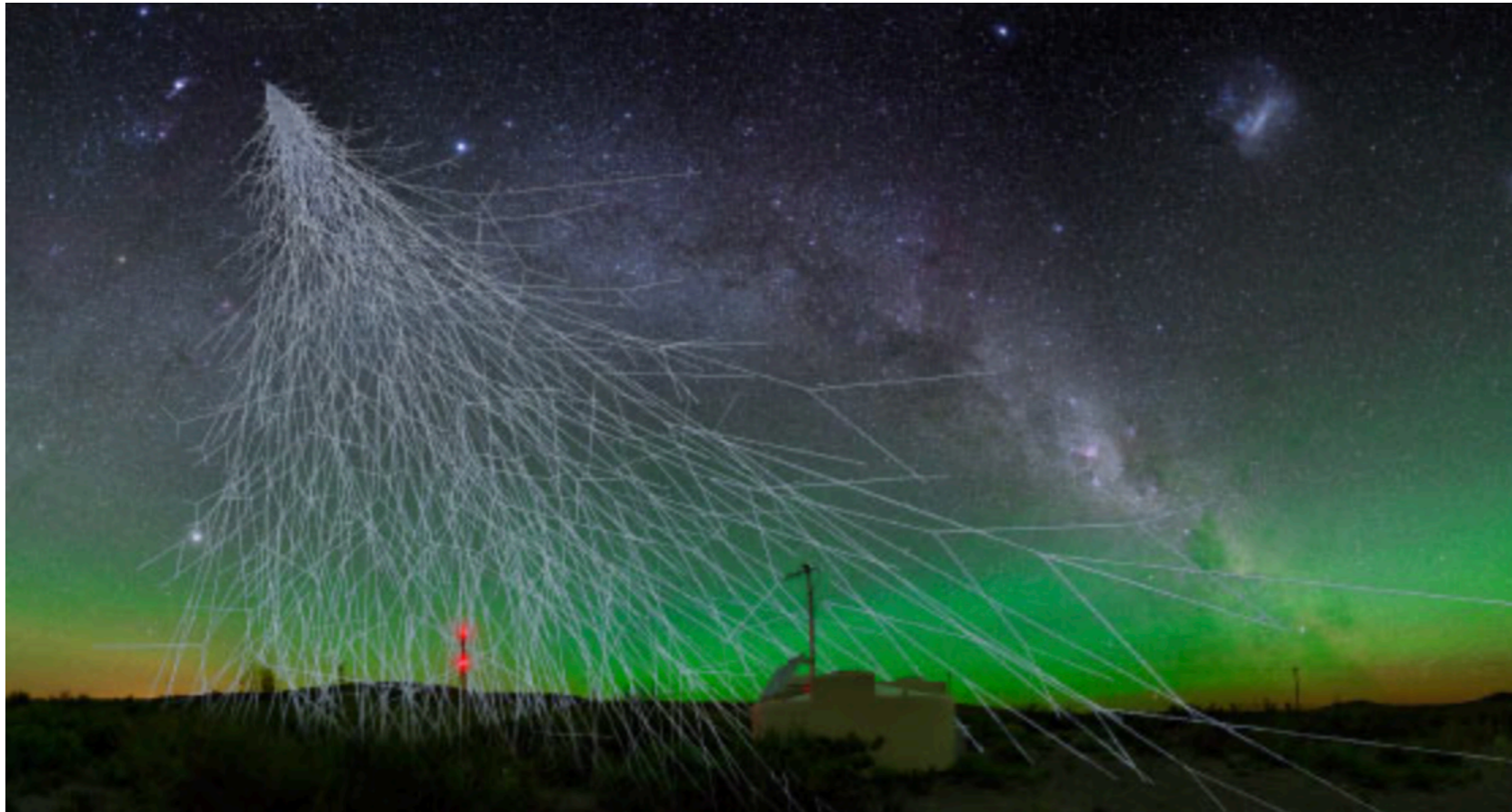
- FERMİ ACCELERATION BY SHOCKS AND TURBULENCE
- RADIO EMISSION

Galactic Cosmic Rays

- SOURCES AND PROPAGATION OF COSMIC RAYS IN GALAXIES
- DIFFUSIVE VS TURBULENT PROPAGATION



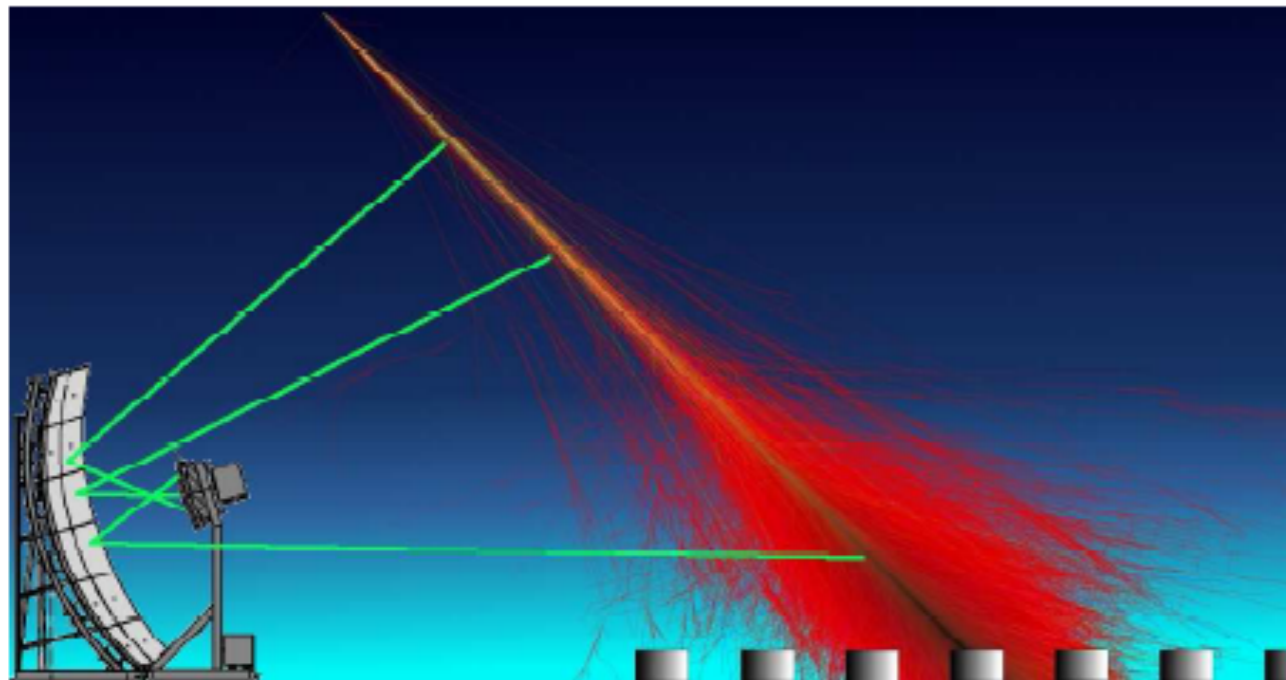
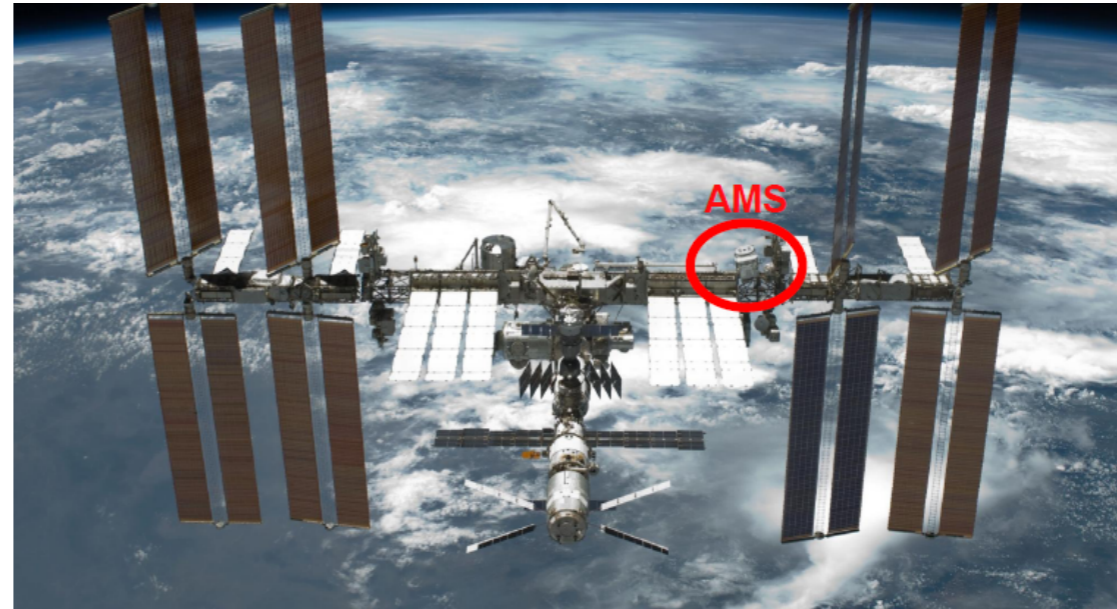
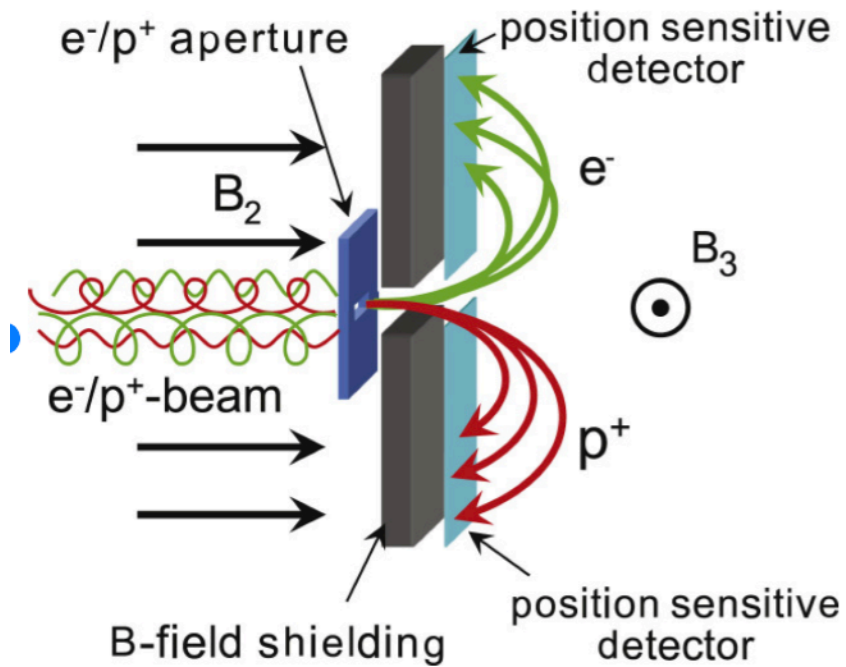
Ultra-high-energy Cosmic Rays



- PHYSICS & MYSTERIES OF THE HIGHEST ENERGY PARTICLES IN THE UNIVERSE
- SOURCES, PROPAGATION AND ENERGY LOSSES

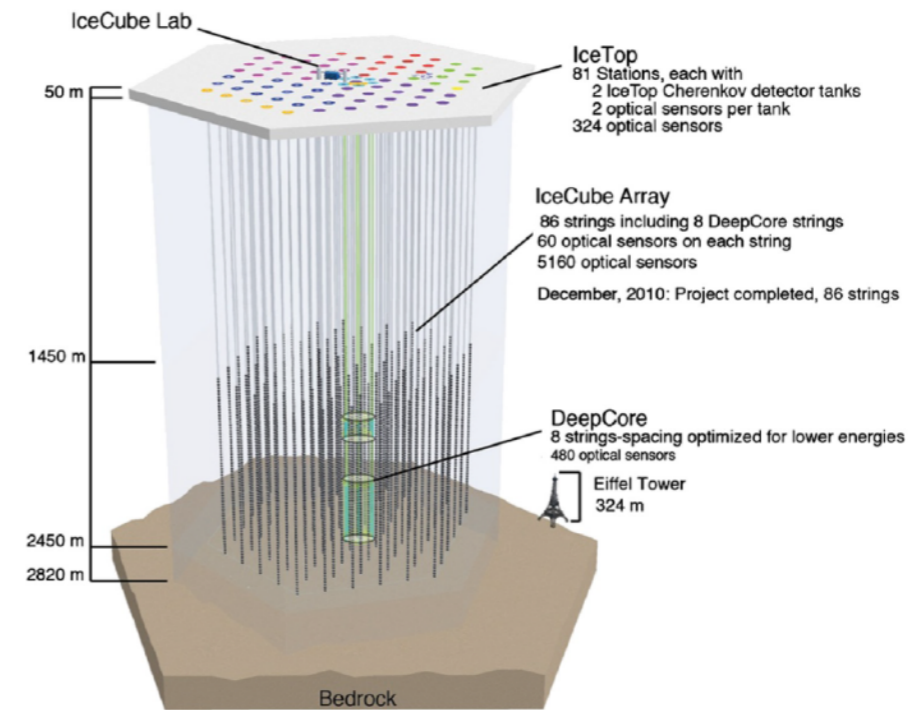
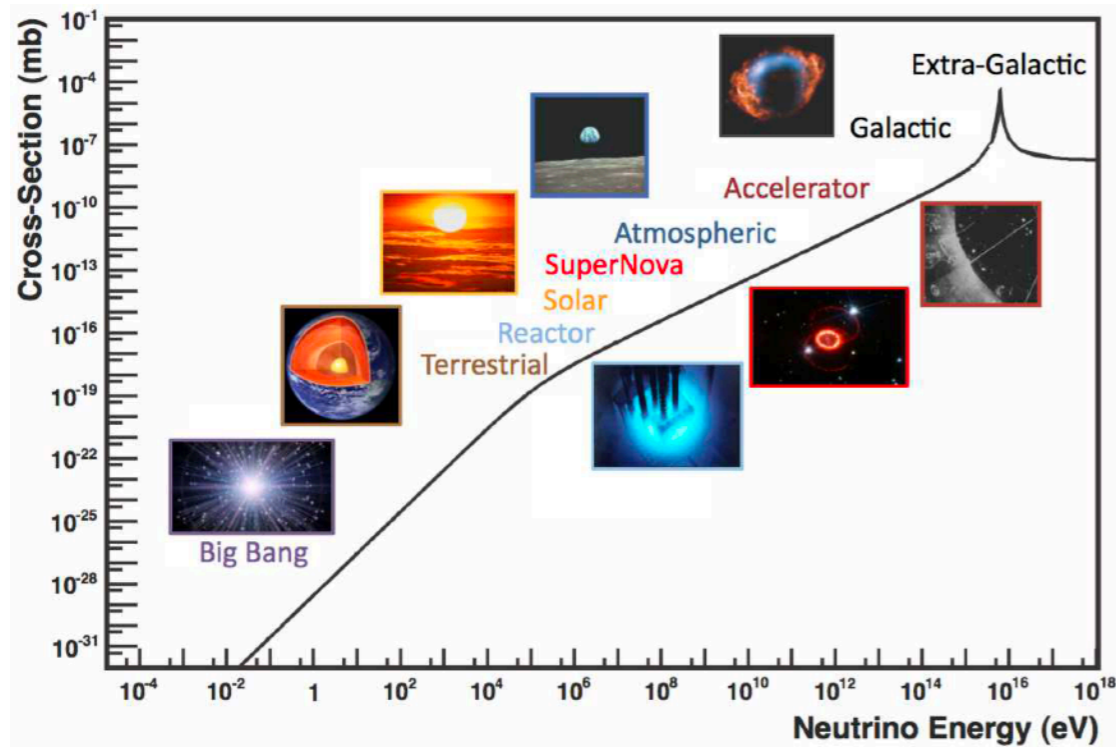


Direct & Indirect Detection of Cosmic Rays

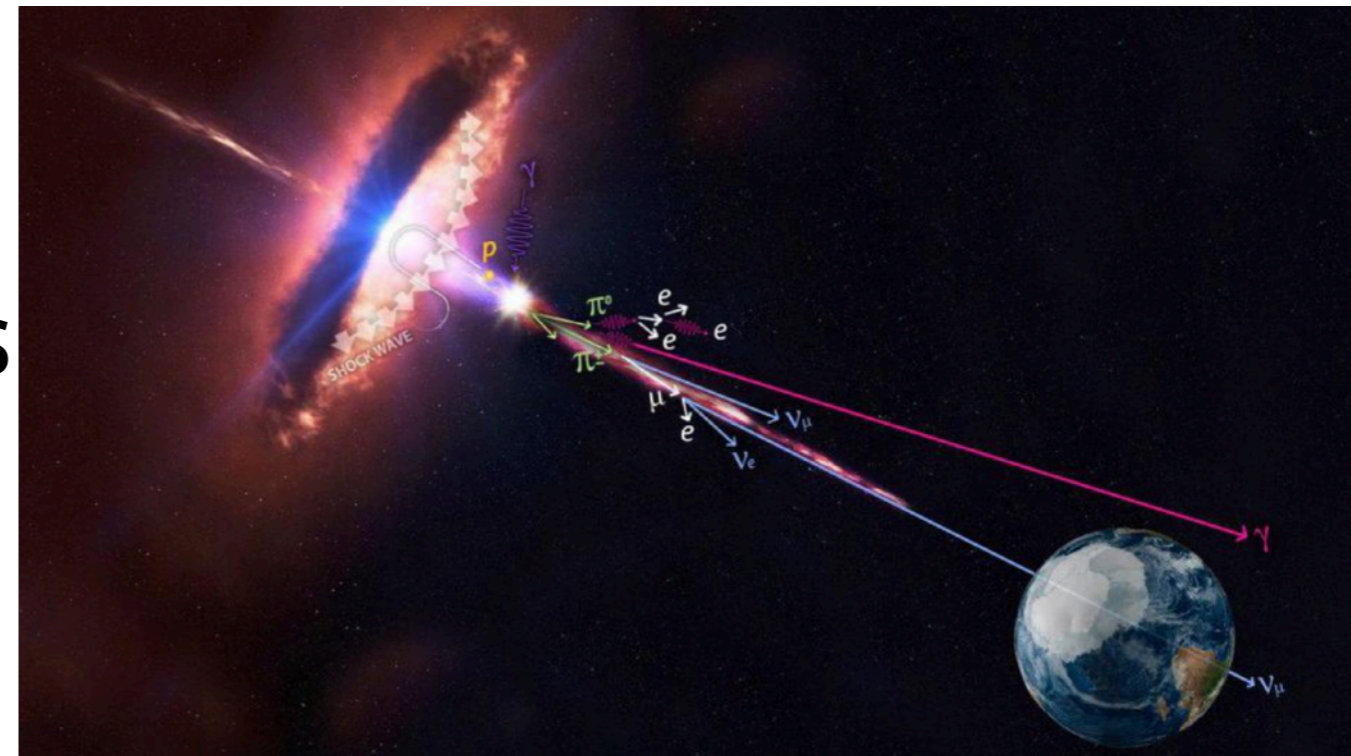


- METHODS & INSTRUMENTS TO DETECT COSMIC RAYS ABOVE AND BELOW THE ATMOSPHERE
- FUTURE INSTRUMENTS (CTA)

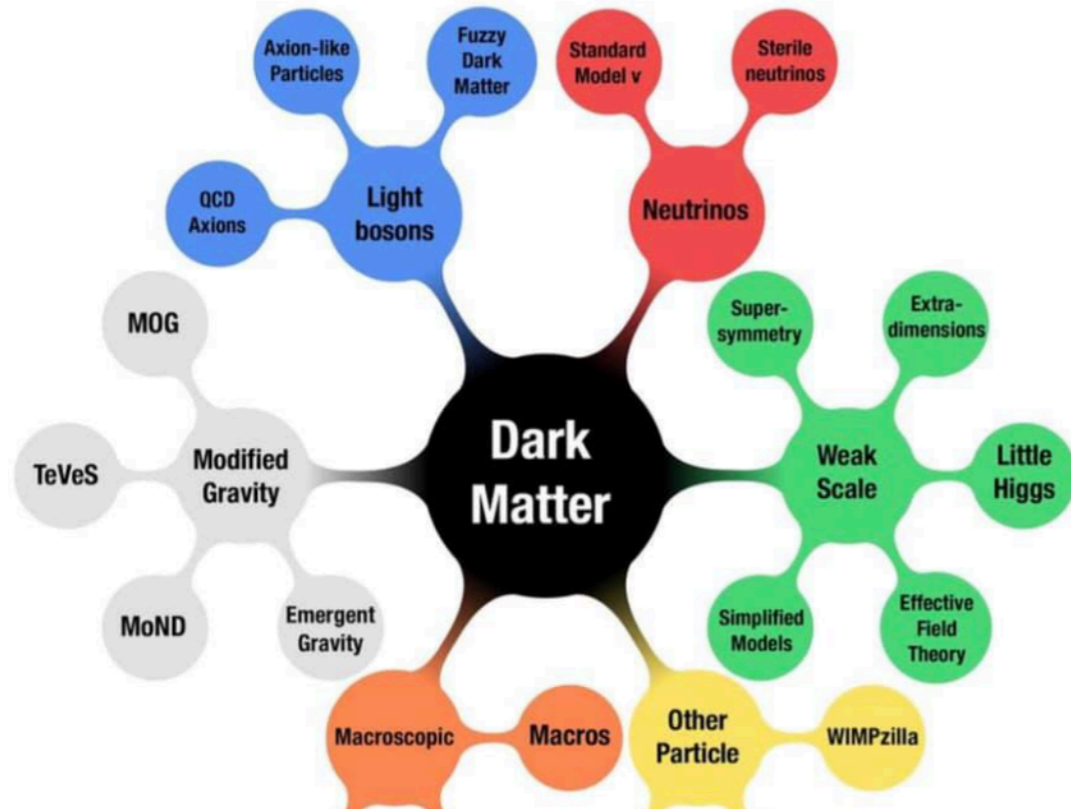
Neutrinos



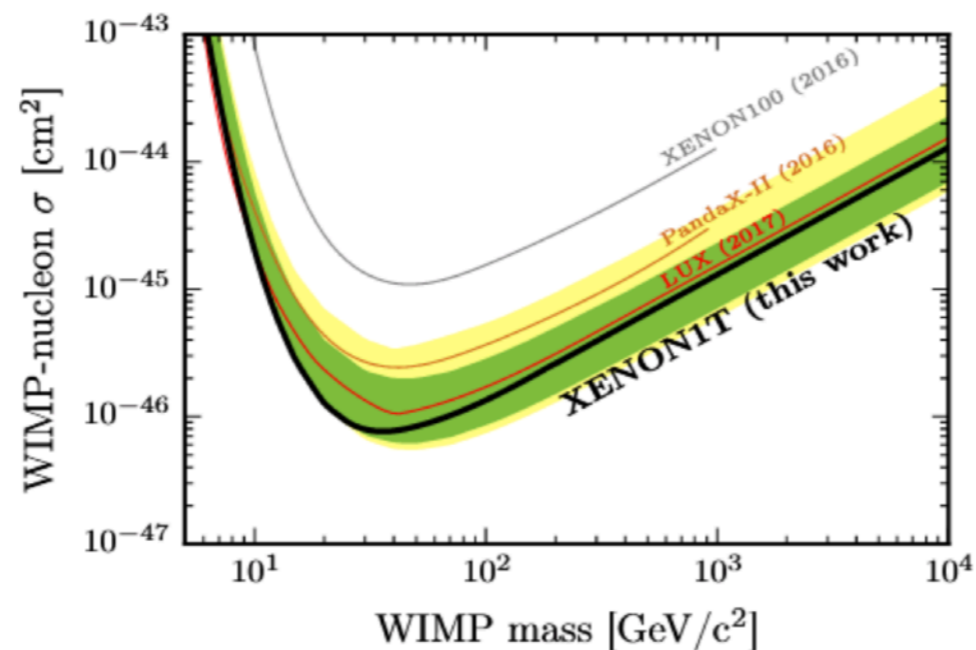
- SOURCES OF GALACTIC AND EXTRA GALACTIC NEUTRINOS
- NEUTRINOS AND BLAZARS
- NEUTRINO OSCILLATIONS

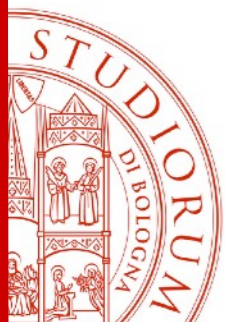


Dark Matter



- POSSIBLE CANDIDATES DARK MATTER PARTICLES
- DETECTION TECHNIQUES AND EXISTING BOUNDS





some numbers

IN 2022-23

- 7 STUDENTS GAVE THE EXAM
- AVERAGE MARK 27.7 (3 WITH ≥ 30)
- 2 MASTER THESIS

Testo delle domande	% Giudizi positivi*		
	Insegna-mento	Media CdS	Media Area VRA
01 Le conoscenze preliminari possedute sono risultate sufficienti per la comprensione degli argomenti previsti nel programma d'esame?	100,0	85,3	81,7
02 Il carico di studio dell'insegnamento è proporzionato ai crediti assegnati?	100,0	79,9	84,0
03 Il materiale didattico (indicato e disponibile) è adeguato per lo studio della materia?	100,0	83,9	84,3
04 Le modalità d'esame sono state definite in modo chiaro?	100,0	90,6	90,9
05 Gli orari di svolgimento di lezioni, esercitazioni e altre eventuali attività didattiche sono rispettati?	62,5	97,3	97,1
06 Il docente stimola / motiva l'interesse verso la disciplina?	87,5	89,6	82,7
07 Il docente espone gli argomenti in modo chiaro?	100,0	87,0	83,1
09 L'insegnamento è stato svolto in maniera coerente con quanto dichiarato sul sito Web del corso di studio?	100,0	98,2	97,6
10 Il docente è reperibile per chiarimenti e spiegazioni?	100,0	99,0	96,6
11 Sei interessato/a agli argomenti trattati nell'insegnamento?	100,0	88,3	82,3
12 Sei complessivamente soddisfatto/a di come è stato svolto questo insegnamento?	75,0	82,1	80,4

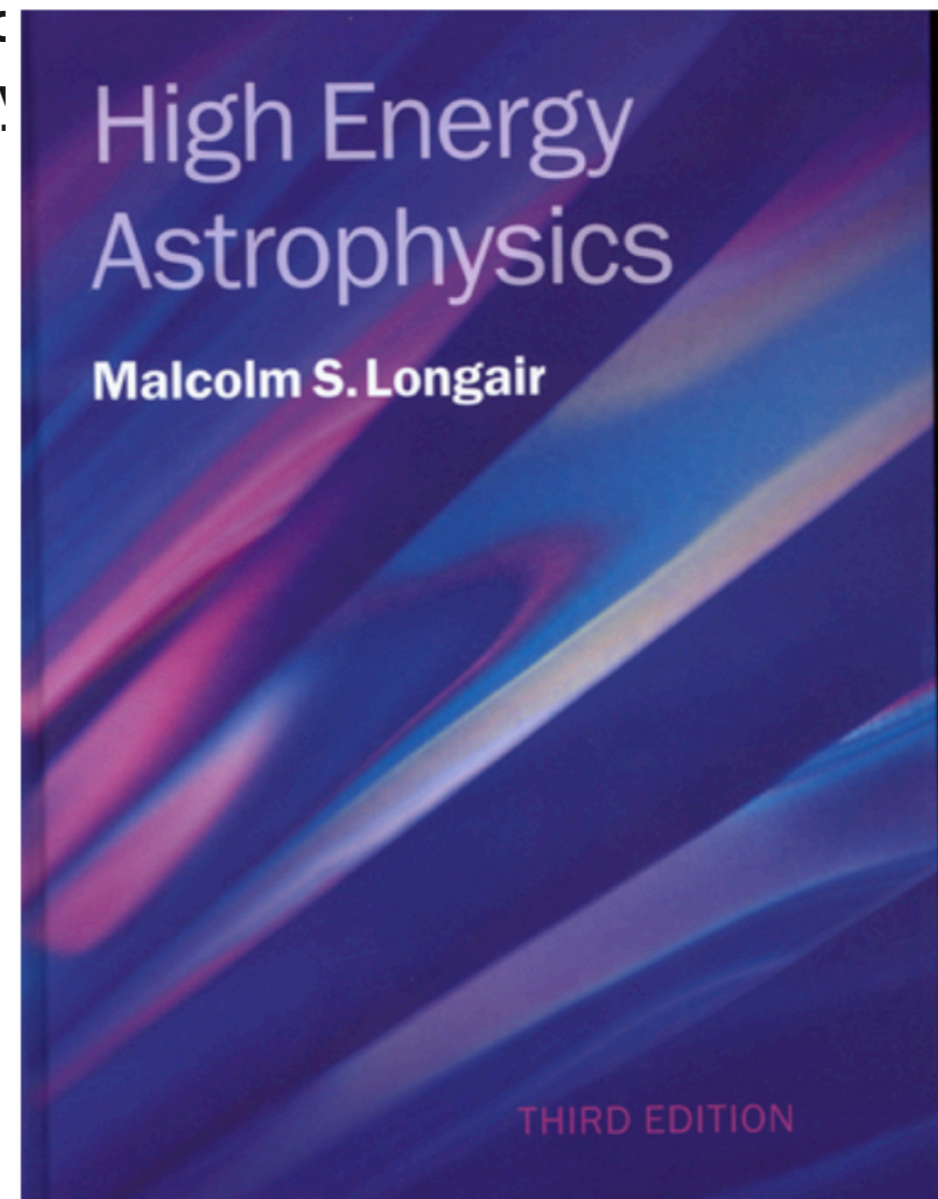


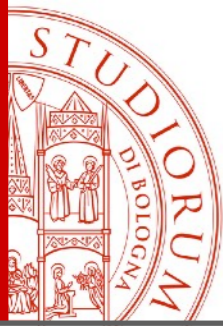
Books

“High Energy Astrophysics”

Prof. Malcom Longair

**Emeritus Jacksonian Professor of Natural Philo
Director of Development, Cavendish Laboratory
Emeritus Professorial Fellow of Clare Hall**





Books

“Probes of Multimessenger Astrophysics”

Prof. Maurizio Spurio
Dipartimento di Fisica e Astronomia

You can download from Insegnamenti Online from the course of Astroparticle Physics by M. Spurio (kindly made available by the author also for this course)

