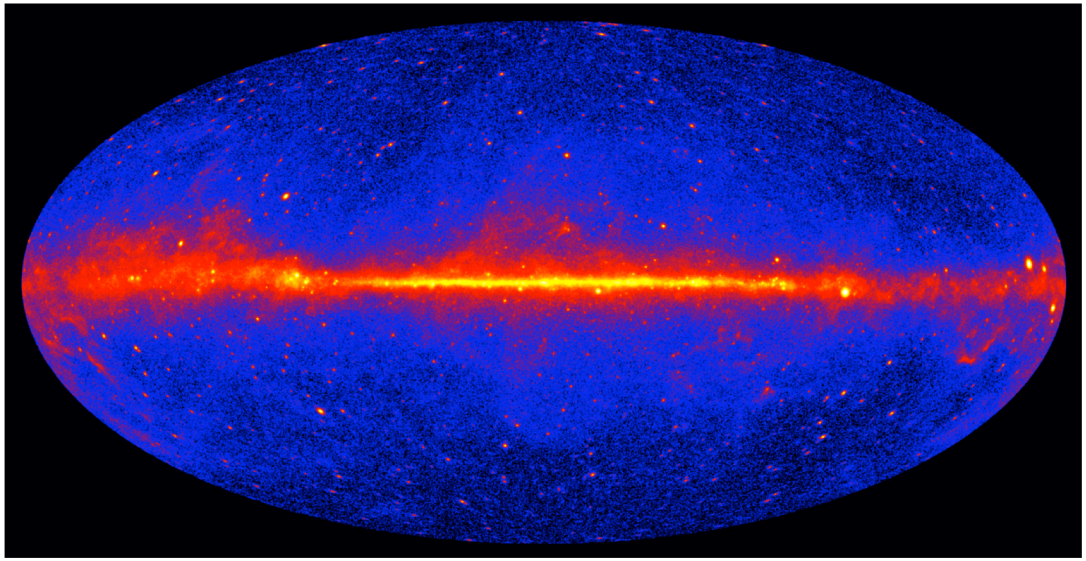
UNIVERSITAT DE BARCELONA

ICCUB Institut de Ciències del Cosmos

EXCELENCIA MARÍA DE MAEZTU

High-energy astrophysics



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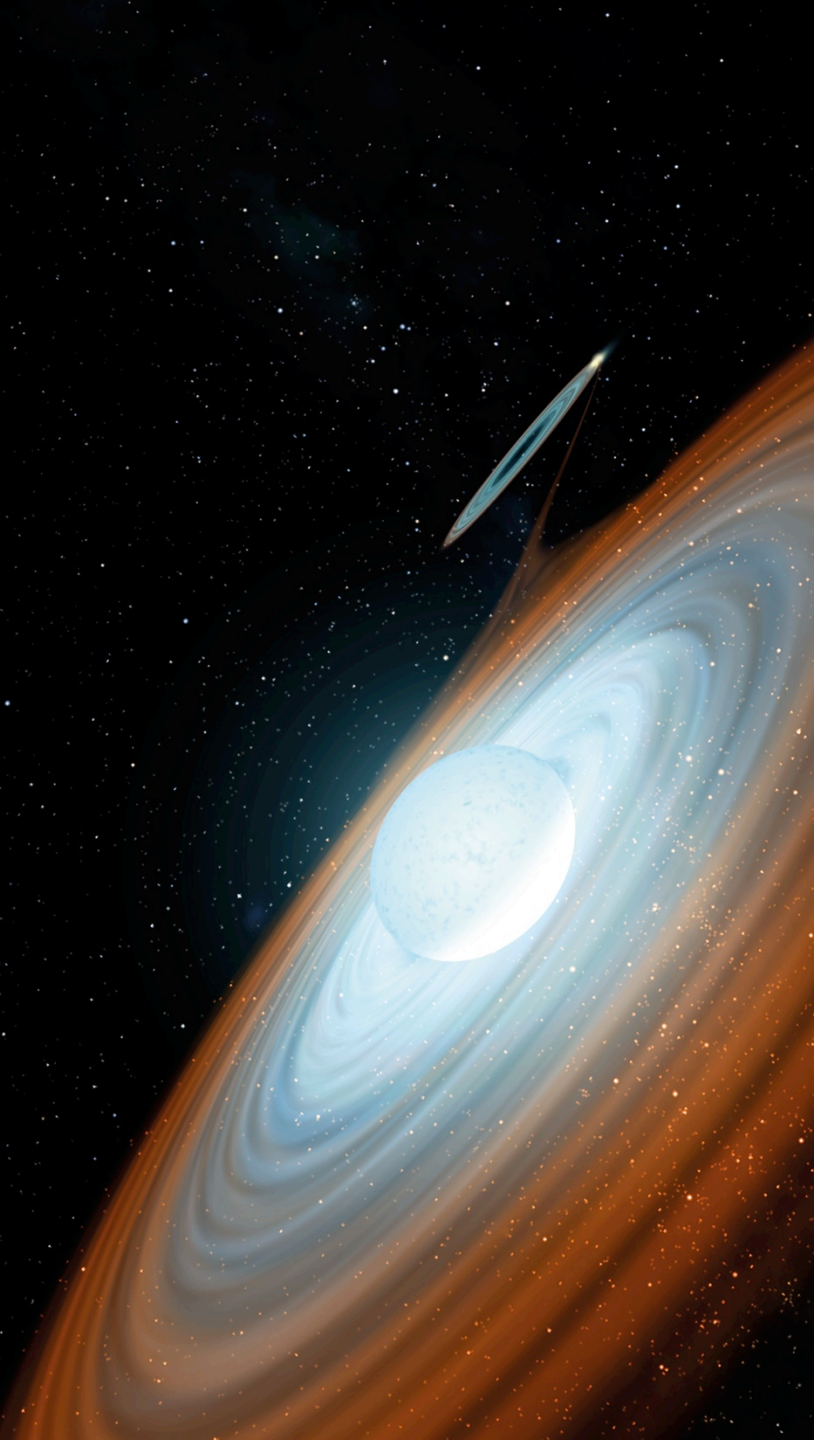
(http://icc.ub.edu/research/research_areas/high_energy)

Master in Astrophysics, Particle Physics, and Cosmology
Academic year 2019-2020



Objectives:

To train, from the observational and theoretical point of view, a group of future researchers in HE astrophysics.

To understand the:

- physical mechanisms capable of **accelerating particles** to high energies and the **radiative processes**.

- **phenomenology** of various kinds of HE astrophysical sources such as supermassive BH in galactic nuclei, XRB stars, pulsars, SNR.

- most recent **observational results** and their impact in the models available.

Program: 30 h: 24 h lectures, 1 h exam, 5 h presentations,

1. Particle acceleration and radiation mechanisms in HE astrophysics

JMP, 12 sessions
25 Sep – 15 Oct

1.1. Particle acceleration mechanisms
1.2. Diffusion
1.3. Energy losses
1.3. Radiative processes
- 1.3.1. Thermal emission
- 1.3.2. Synchrotron radiation
- 1.3.3. IC scattering
- 1.3.4. Bremsstrahlung
- 1.3.5. Hadronic processes
- 1.3.6. Particle annihilation

2. Relativistic outflows at high energies

VBR, 4 sessions
16 – 22 Oct

2.1. Outflows: jets and winds (general physical description)
2.2. Flow dynamics (production, propagation, content, termination)
2.3. Emission in relativistic outflows: electron-positron pairs
2.4. " : protons and nuclei
2.5. Radiation reprocessing: absorption (ϒ-rays, radio and X-rays)
2.6. " : electromagnetic cascades (source ϒ-ray transparency and consequences at lower energies)

3. Accretion and ejection in relativistic sources — VBR, 1 session, 23 Oct; MR, 3 sessions, 24-29 Oct

3.1 Powerful accretion onto compact objects
3.2. Observational tools (analysis and fundamental diagrams)
3.3. X-ray binary accretion modes
3.4. Disks and jets
3.5. Black holes at all scales: from X-ray binaries to AGN

4. HE gamma-ray sources in the Universe — MR, 4 sessions 30 Oct – 5 Nov

4.1. HE ϒ-ray detectors and satellites
4.2. Imaging atmospheric Cherenkov telescopes.
4.3. Galactic HE ϒ-ray sources (pulsars, PWN, SNR, X-ray and ϒ-ray binaries, etc.)
4.4. Extragalactic HE ϒ-ray sources (AGNs, GRBs, EBL, etc.)
4.5. Fundamental physics at HE ϒ-rays (dark matter, Lorentz invariance, etc.)

Bibliography

AHARONIAN, F. A. Very high energy cosmic gamma radiation: a crucial window on the extreme universe. Singapore : World Scientific Publishing, cop. 2004.

CHARLES, PHILLIP A. ; SEWARD, FREDERICK D. Exploring the X-ray universe. Cambridge : Cambridge University Press, 1995.

LONGAIR, MALCOLM S. High energy astrophysics. Third ed. Cambridge : Cambridge University Press, 2010.

PACHOLCZYK, A. G. Radioastrofísica : procesos no térmicos en fuentes galácticas y extragalácticas . Barcelona : Reverté, DL 1979.

ROMERO, G.E.; PAREDES, J.M. Introducción a la astrofísica relativista. Textos docents 365. Publicacions i edicions Universitat de Barcelona

Room V12M	**Monday, Tuesday, Wednesday and Thursday**
17:40-18:40	High Energy Astrophysics (25/09/2019 - 05/11/2019) (J.M. Paredes, V. Bosch, M. Ribó)

Work required to the students:

Class attendance and active participation
Exam preparation
Active preparation/discussion of the assigned work with the supervisor
Oral presentation of the work

Evaluation

Participation 25%
Exam 25%
Written work 25%
Oral presentation 25%

Proposed works and supervisors

Marc Ribó
M1. Supernovae at GeV-TeV
M2. Pulsars or PWN at GeV-TeV
M3. X-ray binaries (options: NSs vs. BHs, GeV emission, etc.)
M4. Gamma-ray binaries at GeV-TeV
M5. Blazars at GeV-TeV (options: EBL, neutrinos)
M6. EM emission from NS-NS mergers

Valentí Bosch-Ramon
V1. High-Energy Emission from Jet/Medium Interactions in Active Galactic Nuclei
V2. High-Energy Emission from Microquasar Jets
V3. Gamma-rays from Young Stellar Objects
V4. Disk-Jet connections in Black Hole X-ray Binaries

Another topic of your interest, either observational or theoretical