UNIVERSIDADE DE SÃO PAULO
Instituto de Física de São Carlos

Av. Trabalhador são-carlense, 400 / 13566-590
Caixa Postal 369 / 13560-970
São Carlos - SP, Brasil
Fone: +55 16 3373-9777

www.ifsc.usp.br
svposgrad@ifsc.usp.br

Short Course on: Theory and data analysis of Astroparticles

19 – 23/02/2024

Prof. Dr. Bruno Khelifi (CNRS/IN2P3, França)
Prof. Dr. Humberto Martinez-Huerta (UDEM, México)
Prof. Dr. Iarley Pereira Lobo (UFP, Brasil)

The main topics to be covered in this course are:

1. understand the basics of how particles travel in universe under standard and beyond the standard model physics;
2. learn about the fundamental aspects of special relativity and its extension in the propagation of astroparticles
3. learn about the computational methods used to simulted and analyse the data;
4. understand the difficulties and limitations of model-building;
5. learn how to build and run the Gammapy code.

Outline.

- Class 1: Bruno - Introduction to Gammapy (2h) During this presentation, Gammapy will be introduced. This open Python research software aims to analyse high-level data (under the GADF or OGIP formats) from gamma-ray instruments, like H.E.S.S/MAGIC/VERITAS/CTA (using the Imaging Atmospheric Cherenkov Technique) or HAWC/SWGO (using the Water Cherenkov Technique), as well Fermi-LAT. This software permits the production of the common very-high-energy astrophysical products (like flux maps, spectral energy distribution, time domain analysis). This talk will describe the library based on its version v1.2 (2024), its main features and data flow, the organisation of the Gammapy project.
- Class 2: Humberto - A brief introduction to symmetries and Lorentz violation.
- Class 3: Bruno - First hands-on session on Gammapy (2h). This first session aims to learn on your own laptop the basic uses of Gammapy, by using Jupyter Notebooks. We will work on the extraction of a spectrum from a point source, and on the realisation of a 3D analysis of an extended source.
- Class 4: Iarley - Vamos abordar o problema de introduzir uma escala de energia que governa desvios da descrição relativística do espaço-tempo (supostamente a escala de Planck), motivado por teorias que quantizam a gravidade. Os principais modelos que descrevem esses desvios, que quebram ou deformam a simetria de Lorentz (chamados de modelos LIV e modelos DSR) serão apresentados.
- Class 5: Bruno - Second hands-on session on Gammapy (2h). This lecture will focus on the simulations of data, which then permits to asset the performances of an instrument to a given source or to realise studies on reconstruction quality (assessment of systematics errors). We will primary experience the simulations of reduced binned dataset of a steady source and a time-variable object. The simulation of a full event list will be introduced at the end.

UNIVERSIDADE DE SÃO PAULO
Instituto de Física de São Carlos

Av. Trabalhador são-carlense, 400 / 13566-590
Caixa Postal 369 / 13560-970
São Carlos - SP, Brasil
Fone: +55 16 3373-9777

www.ifsc.usp.br
svposgrad@ifsc.usp.br

- Class 6: Bruno - Third hands-on session on Gammapy (2h). The last session will aim to quantify systematic errors using simulations. We will derive the errors on spectral parameters caused by a possible absolute energy scale bias or a possible background rate bias.
- Class 7: Humberto - A framework for LIV models and motivation.
- Class 8: Iarley - Vamos discutir os principais observáveis (com enfoque em observáveis astrofísicos) que podem levar à detecção de assinaturas de um espaço-tempo quântico e à distinção entre os modelos LIV e DSR.
- Class 9: Humberto - Astrophysical LIV tests - A review of some of the most prominent astrophysical search methods and exclusion limits.

Monday 19/02	Tuesday 20/02	Wednesday 21/02	Thursday 22/02	Friday 23/02
	10 - 12 h: Class 2 - Bruno	10 - 12 h: Class 4 Iarley	10 - 12 h: Class 6 Bruno	10 - 12 h: Class 8 Iarley
16 - 18h Class 1 Bruno	16 - 18h: Class 3 - Humberto	16 - 18 h: Class 5 Bruno	16 - 18 h: Class 7 Humberto	14 - 16 h: Class 9 Humberto

The course will be offered by our Post-Graduate Program as “SFI5897 Seminários de Pós-Graduação I” and registered students can get 2 credits for it.