

**Título/Title:**

All-sky ray tracing tools to study dark-matter annihilations and cross-correlations with CMB and weak-lensing mass maps

**Orientador/Supervisor:**

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**Descrição/Description:**

Present observations indicate that a simple inflationary homogeneous and isotropic model with collisionless dark matter and a cosmological constant as the source of dark energy (the LCDM model) provides a consistent description of the main global properties of the Universe on large scales. However, the LCDM model faces persistent challenges on small scales. One of these challenges is related with the nature of dark matter, which may have a collisional nature that can give rise to interactions with relativistic species (photons and neutrinos) at early times (interactive dark matter models) affecting the internal structure of dark matter haloes and sub-haloes at late times. On the other hand, the annihilation or decay of dark matter particles open the possibility of indirectly detecting dark matter particles via the identification of their annihilation or decay products as gamma-rays, antimatter and neutrinos, over the expected backgrounds, that may be revealed by existing (e.g. Fermi) and/or proposed (e.g. e-ASTROGAM) gamma ray space telescopes. The study of the correlation of these signals with large-scale weak lensing signal and the angular distribution of galaxies that will be made by the Euclid satellite mission, will allow further studies into the nature of dark matter and possibly improve cosmological parameter constrains.

This project is devoted to the construction of a ray-tracing tool that will allow to generate all-sky maps of gamma-ray and neutrino emission due to the annihilation of dark matter particles and weak lensing mass maps from N-Body simulations of large scale structure. The ray-tracing tool will build upon the all-sky version of the XSZMAP (non-public) code that uses a ray tracing method to map Cosmic Microwave Background secondary anisotropies (the SZ effect). After implementation and testing, the new all-sky map making tool will be used to characterize the pixel distributions and compute the angular power spectrum of cosmic ray fluxes due to dark matter annihilations. These maps will also be used to study correlations between dark matter annihilations, weak lensing mass and SZ effect for the same sky realization of the N-body simulations.

This proposed work is part of the topics being addressed by the IA cosmology group in the context of the Euclid mission.

**Requisitos/Requirements:**

Previous knowledge of programming in any language (preferably python, IDL or R) is required. Preference will be given to candidates with previous experience in N-body simulations large-scale structure and simulation data analysis.