Contribution ID: **7** Type: **Poster**

Sub-GeV Dark Matter and Proton Interaction in the Active Galactic Nucleus NGC 1068.

Friday, 14 June 2024 15:30 (1h 40m)

Observations of high-energy neutrinos from the active galactic nucleus NGC 1068 suggest the acceleration of cosmic rays in the vicinity of the central supermassive black hole (corona) 1. These high-energy cosmic-rays can collide either with gas or with photon fields, producing charged and neutral pions. The decay of neutral pions leads to a gamma-ray flux, which in other sources has been used to test proton-dark-matter interactions 2 (DM-cooling). However, in NGC 1068 gamma-rays are strongly attenuated and not directly visible. The decay of charged pions produces instead neutrinos, presumably explaining the signal observed by IceCube.

I test the presence of proton-dark-matter interactions using this neutrino signal. Such interactions can distort the proton energy distribution, and in turn modify the neutrino signal observed by IceCube. In practical terms, I determine the expected proton spectrum, both in the standard scenario and in the case with proton-dark-matter interactions, by solving the transport equation (Fokker-plank equation, a second order PDE), using a leaky box model with parameters informed by the observations. I treat the proton-DM interaction as a cooling in the transport equation. The proton-DM interaction is derived by assuming a gauge theory with a heavy mediator(gauge boson) for the proton-DM interaction. I treat the proton-dark-matter cross section as a parameter free to vary. By comparing the resulting spectra (from solving the transport equation) with the IceCube observations, we can extract limits on how large the proton-dark-matter cross section can be to remain in agreement with the measurements. While this scenario has been analyzed in previous work 3, I go beyond the simplifying assumptions made there, such as neglecting the inelastic component of the proton-dark-matter scattering, and I will consider variability in the results based on the uncertainty in the astrophysical parameters and acceleration mechanisms within the corona.
interaction.

As for now I have solved the transport equation and so gotten the proton spectrum with and without elastic DM-cooling. Soon I will include inelastic scattering and derive the neutrino spectrum. This is what I can present off the project. Though I know what to do for the rest of the project, it is yet to be done.
The DM-proton interaction was derived by assuming Dirac fermion DM particles interacting with protons via a scalar mediator with a mass much larger than the transfer momentum $q^2 = 2mT$.
Recently a new paper came out using a DM candidate with mass $m_{DM} < m_A/2$ in the sub-GeV range, which can either be a complex scalar Φ or a Dirac fermion ψ, that couples to the dark
photon A. I may use this model instead to derive the DM-p interaction. As for that I may also present this model at the symposium

Field of study

Astrophysics

Supervisor

Mauricio Bustamante

Primary author: KNAGE, Andreas (University of Copenhagen)

Session Classification: Poster session: Enjoy the posters!