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Dark Matter Gamma-ray searches in Galaxy Clusters: status and prospects

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Galaxy clusters are the largest gravitationally bound structures in the Universe, being completely dark matter (DM) dominated objects. For DM decay, local galaxy clusters yield the highest expected fluxes respect to other prime targets. For the DM annihilation scenario, clusters can provide fluxes comparable to the ones from dwarf spheroidal galaxies, as long as the DM interactions expected in their substructures are taken into account. In this talk, I will present the analysis of 12 years of Fermi-LAT data in the direction of 49 clusters. We modelled the expected substructure population in these objects, providing benchmark models to precisely quantify the uncertainty on their contribution to the annihilation flux. From the combined search, we found a signal of 2.5-3.0 sigma significance, potentially associated either with DM or hadronic induced emission produced in the intracluster region by cosmic rays colliding with gas and photon fields. Finally, looking into the future, I will also discuss the prospects of the coming Cherenkov Telescope Array Observatory (CTAO), to detect diffuse gamma-ray emission from the Perseus galaxy cluster. With its improvement in sensitivity of more than one order of magnitude with respect current IACTs, we derive the tightest constraints for DM decay scenarios in the TeV range reaching values of $\tau_{DM} \sim 10^{27}$ s, using a template fitting approach.

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