Using H.E.S.S. for an Estimate of the Cosmic Ray Flux to Estimate the Scattering Cross Section of sub-GeV Dark Matter

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For many years now, the WIMP dark matter model have been the leading and most investigated proposal to explain DM particles, and this great interest led to the search for a WIMP signal signature in many experiments, using different techniques, such as indirect detection, particles accelerators and direct detection experiments. This last one, has heavily constrained the cross-section parameter space for this specific model, with prospects for next generation detectors to improve even more their sensitivities, and therefore, their constraints in this model.

With this in mind, the community have started to also look at other possibilities and models to explain dark matter. The one we propose here is the indirect detection of DM particles scattered by cosmic-rays in the galactic centre region and this can be done looking at the gamma-ray signature from this interaction, and trying to detect it in Imaging Atmospheric Telescope Arrays (IACTs), such as H.E.S.S. and CTA.

This method is interesting in a way that is allows us to probe much smaller masses that the usual WIMP searches, probing a part of the cross-section parameter space that is not available today for direct detection experiments, making this novel signature one of the only ways to evaluate DM particles in this mass range. However, this approach brings with it a few new challenges.

The galactic centre is a problematic region when we talk about matter for a few reasons. The dark matter density profile in this region is actually not entirely known, bringing lots of uncertainties with it. Also, this is a region with a lot of astrophysical background, making any data analysis and the search for a potential signal much harder. And finally, since this approach deals with cosmic-rays, it requires that we make and assumption of the cosmic-ray flux in the galactic centre, another source of uncertainties.

The cosmic-rays are interacting with the molecular gas within the galactic ridge causing the production of gamma-rays. These are detectable with gamma-ray experiments like H.E.S.S. By modeling this so called foreground emission one can reproduce the underlying cosmic ray spectrum. This can for instance by done with the opensource tool HERMES. By improving the model of the gamma-ray flux that we expect to scatter with the DM within the Galactic Centre region we hope to get a more accurate picture. For the analysis we are planing to use the almost 300 hours of H.E.S.S. observations within the gammapy framework.