Search for enhanced TeV gamma-ray emission from Giant Molecular Clouds using H.E.S.S.

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The paradigm of origin and propagation of cosmic rays (CRs) is based on direct observations of CRs in the vicinity of the solar system. However, in specific regions of the Galaxy, the level of CRs differs from the spectrum measured in the vicinity of Earth. Probing giant molecular clouds (GMCs) at high energies can reveal crucial information about the distribution of cosmic rays across our Galaxy. The high energy emission from GMCs can be used as a direct tracer of the cosmic-ray density and the matter density inside the clouds.

Such studies at GeV energies have been performed with Fermi-LAT, leading to detection of enhanced flux and spectral hardening from specific clouds. Observations of such clouds at TeV energies can confirm if the enhancement continues at high energies, leading to crucial information about the density and propagation of CRs. However, such analysis is complicated to perform with present generation Imaging Atmospheric Cherenkov Telescopes (IACTs). Along with a proper rejection of the hadronic background, it is essential to separate between the emission from the cloud and the larger-scale diffuse emission. This needs a careful choice of exclusion regions, which is difficult due to the limited field of view of these instruments.

In this contribution, we show that using a 3D field of view likelihood technique, as implemented e.g. in gammapy, allows us to distinguish between the emission from the direction of the cloud and the larger-scale diffuse emission, while simultaneously modeling the hadronic background and masking the contribution from the known known sources. Using H.E.S.S. data collected over 16 years on the region of cloud 877, we report significant detection of emission from the given line of sight. The detected excess correlates well with the contours from the 353 GHz dust opacity gas tracer. Enhanced GeV emission has already been reported from this cloud [1], and the TeV spectrum follows an extrapolation of the Fermi-LAT spectrum, confirming the cosmic-ray energy density enhancement over the locally measured one.

References

[1] F. Aharonian, G. Peron, R. Yang, S. Casanova and R. Zanin, *Probing the sea of galactic cosmic rays with fermi-lat*, *Phys. Rev. D* **101** (2020) 083018.