Dynamical and thermal impact of cosmic rays on the formation of molecular clouds

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We explore the impact of Galactic cosmic rays (CRs) from supernova remnants on the dynamical structure of the ISM with a focus on the heating and ionisation balance of the gas and the formation of molecular stuctures. We perform three-dimensional simulations of stratified boxes covering a section of 0.5x0.5x10 kpc^3 of the Galactic disk. The CRs are implemented as 10 different relativistic fluids with energies ranging from 0.01 GeV to 1000 GeV. They are dynamically coupled to the gas in a MHD-CR advection-diffusion approximation. Ansiotropic diffusion of CRs with respect to the direction of the magnetic field is included as well as energy dependent diffusion coefficients for the 10 different CR energy bins. With this approach we are able to not only follow the global effect of CRs in the ISM but also the spectral evolution and the diffusion properties as well as the impact of individual CR energy ranges. The molecule formation is computed with a chemical network following the formation and distruction of H+, HI and H2. Shielding effects of the gas are computed using the TreeCol algorithm.

We find that CRs have a significant impact on the local energetic balance of the ISM, both dynamically with kinetic momentum input via the CR pressure gradient as well as thermally via CR heating. We show how CRs influence the formation of dense structures in the ISM and with it the formation of star forming environments.