Contribution ID: **204** Contribution code: **GAL** Type: **Oral**

The dynamical impact of cosmic rays in Milky Way-like galaxies

Monday 2 September 2024 15:45 (15 minutes)

The Milky Way, with its distinctive observational features, is a unique laboratory to constrain physical parameters and test various theories of galaxy evolution ranging from star formation, to the formation of gaseous structures and galactic outflows, such as the Fermi and eRosita bubbles. A particularly important ingredient in the interstellar medium are cosmic rays (CRs), which reveal their impact via gamma rays.
We perform high-resolution magnetohydrodynamical simulations of the Milky Way, in which we follow individual massive stars and include self-consistent stellar feedback such as SNe and CRs, dynamically coupled to the MHD equations. We model the multi-phase interstellar medium using a non-equilibrium chemical network, allowing us to take into account the relevant cooling and heating processes and compare the simulations to observations.
We will present how thermal and CR feedback affect the structure of the galaxy and the gas dynamics. We show how the inclusion of CRs change the structure and thermal phase of outflows and fountains flows in different regions of the galaxy, from the Galactic Center to the solar circle and beyond. We further elaborate how Fermi and eRosita bubbles are periodically launched by supernovae from the galactic center, and how and when they are visible. Finally, we back up our simulations with accurate gamma ray maps both in the solar vicinity as well as for the global galaxy, which we compare to observations of the gamma-ray sky.

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Session Classification: Parallel 1