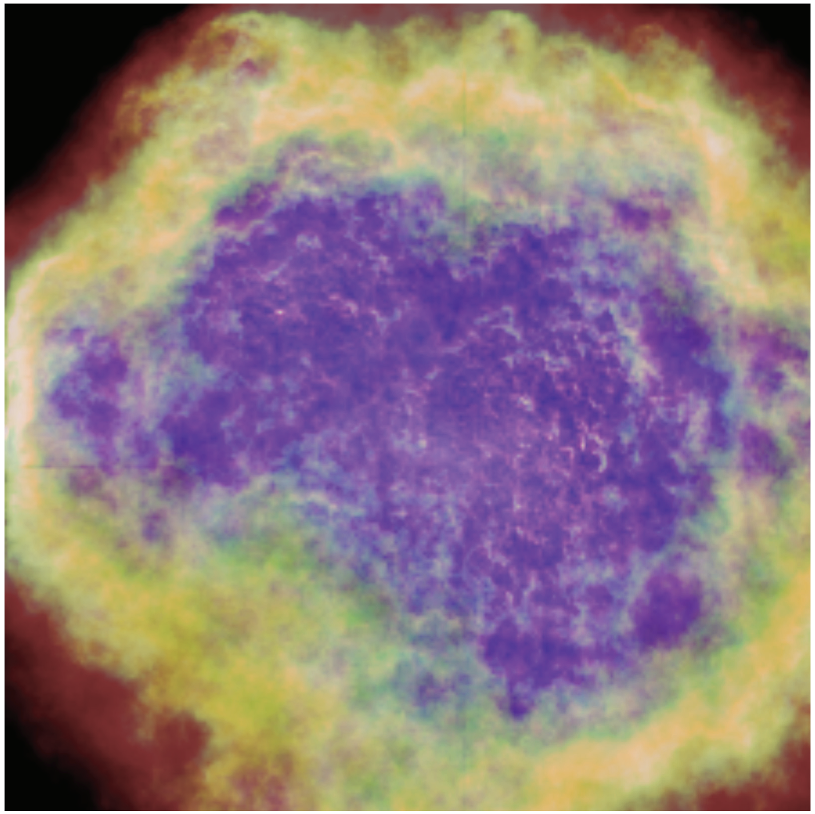
UNIVERSITÄT DUISBURG ESSEN | PHYSIK E=

Physikalisches Kolloquium

Mittwoch, 09.04.2025
13:00 Uhr
MC 122 und Zoom

https://uni-due.zoom-x.de/j/64228670246?pwd=RjVQeFNIUkRKRkpiNVpKYXhJaFNLdz09 (gilt für alle Vorträge)

Cosmic rays and the molecular universe



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In the local universe, star and planet formation occur ubiquitously in cold, dense molecular gas, with gas temperatures dropping to 10 - 30 Kelvin, and densities exceeding 100 particles/cc. Due to the cold temperatures, the gas-phase molecular chemistry is driven by ion-neutral reactions. In the dense gas, shielded from ultraviolet radiation, energetic, charged particles, dubbed cosmic rays, are the dominant source of ionization. Cosmic-ray ionizations drive a diverse gas-phase chemistry and their interactions with icy dust grans stimulate complex organic and prebiotic chemistry in their ice. The cosmic-ray ionization rate, a statistical quantization of the average number of ionizations per second, is thus a fundamental parameter in astrochemical models.

Despite their importance, cosmic rays are often treated simply, with models assuming a constant rate, although energy losses via interactions produce strong gradients. New observations also show that particles are accelerated within clouds during star formation. I will present an overview of cosmic-ray-driven astrochemistry from the point of view of theory and modeling. I will highlight key results on identifying potential particle acceleration sources in star-forming regions, and their role in gas-phase chemistry. I will show three-dimensional chemical models of molecular clouds that include cosmic-ray attenuation, enabling unique studies in cosmic-ray astrochemistry. I will also introduce a new large, public database of electron-impact ionization cross-sections for molecules of astrochemical interest. Finally, I will showcase future plans for my Emmy Noether group to investigate the role of cosmic rays on the gas- and ice-phase chemistry of star-forming gas from the atomic to astrophysical scales.