

Interstellar molecular clouds as weakly-ionised, dusty plasmas

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Dust is almost everywhere in interstellar space, forming in the expanding envelopes of mass-losing stars and in the warm gas cooling behind supernova shock waves, making up about 1% by mass of the interstellar medium. Dust grains play a key role in regulating the temperature of interstellar gas, heating it via photoejection of energetic electrons, absorbing heat in collisions with gas particles and reradiating energy by thermal emission. Grains also catalyse chemistry in cold interstellar clouds, their surfaces providing reaction sites and accumulating solid mantles of polar molecules. Grains are charged via photoejection of electrons by intense stellar radiation fields, and through sticking of electrons and ions from the gas phase; as a result charged dust grains play important dynamical roles in interstellar clouds.

I shall give an overview of the conditions in astrophysical dusty plasmas in different environments, before focussing on the dynamical role played by charged grains in cold, weakly-ionised, strongly magnetised, interstellar molecular clouds. I shall outline the basic theory of MHD in weakly ionised gases, briefly review the ionisation and recombination processes that determine the abundance of charged species and the charge distribution on grains, and then discuss applications to the structure of shock waves, star formation and astrophysical discs. Grains determine the thickness and internal dynamics of shock fronts, significantly modify the dynamics of gravitational collapse during star formation and control magnetic diffusion and turbulence in protoplanetary discs.