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INTERSTELLAR DUST AS A DYNAMIC ENVIRONMENT

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Abstract. In spite of representing only a small fraction of the Interstellar Medium (ISM) in terms of mass, getting up to approximately 1% of ISM observed in the Milky Way, dust is a primary actor in Astrophysics. In addition to its effects of extinction in the optical/UV frequency range and to its thermal emission at IR and sub-mm wavelengths, interstellar dust collects most of the refractory elements available in the diffuse medium. Moreover, the chemical processes that occur in dust grains are crucial for the formation and evolution of complex molecular compounds. As a consequence, understanding dust is fundamental for both astro-chemistry and the physics of interaction between different phases of the ISM. Observations of silicate and carbonaceous features show that their polarisation is different. This appears to imply that dust grains reside in distinct, segregated populations, that they have complex structures, or that these effects are combined together. However, this interpretation is so far qualitative, since it does not take fully into account the detailed effects of complex structures, as particles are typically modelled under the assumption of spherical symmetry. A more accurate, and quantitative interpretation of the properties of interstellar dust thus needs to take into account realistic particle structures. Unfortunately, a full solution of the radiation scattering problem, with different materials and relaxing spherical symmetry, is extremely complicated, requiring intensive numerical calculations. In this contribution, we present the Transition Matrix (TM) approach to investigate the properties of interstellar dust particles of realistic shapes and structures. The strategy adopted by the TM method is to subdivide particles with arbitrarily complicated shapes in a collection of spherical components and then to expand the radiation fields in spherical vector harmonics. Taking advantage of the linearity of the solution of the field equations, the scattering problem of an arbitrary particle can be solved by imposing continuity conditions between the incident and the scattered field across the surface of the particle layers. The result is a linear operator, characteristic of the particle, that connects arbitrary incident fields to their corresponding scattered fields, providing a tool to obtain analytical estimates of differential and integrated quantities. We show how the implementation of this method on state of the art parallel computers leads to the ability to model radiation-particle interactions on model systems much closer to real ones, illustrating the dynamic implications of the process on the types of particles exposed to different environments.