Dust Lifetime Re-evaluation in the Light of a New Dust Model

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Two major populations of dust grains are formed in the circumstellar outflows from carbon-rich and oxygen-rich stars: carbonaceous and silicate grains. During their journey through the interstellar medium (ISM) these undergo different sorts of processing. For example the hard radiation field in photodissociation regions (PDRs) or in and around H_{II} regions can lead to photo-induced destruction[5,8]. Furthermore, interstellar shock waves lead to destruction due to sputtering and grain-grain collisions[1,2,3,7].

The fact that the dust formation timescale is much longer than the destruction timescale in the ISM has been a problem for a long time. However, carbonaceous dust appears to be rapidly recycled in the ISM and, in contrast to silicates, there are viable mechanisms for its re-formation in the ISM[4].

From a theoretical point of view, the fraction of dust that is eroded and injected into the gas phase in a shock wave depends on the initial size distribution of the assumed dust model[2,3]. In this study we use the new dust model by Jones et al. (2013)[6]. This dust model uses experimental based properties for both carbonaceous and silicate grains and introduces 3D small aromatic-aliphatic nanoparticles in the place of PAHs. With the use of a shock code (an adapted version of the code used by Jones et al. 1994, 1996[2,3]), we model the dust destruction in shocks and the evolution of the size distribution. The introduction of an almost mono-modal size distribution and a carbonaceous mantle on the surface of silicate grains leads to lower silicate destruction in shocks. This then leads to longer silicate lifetimes, which could explain the discrepancy between the dust formation and destruction timescales.

References

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