Evolution of dust in the ISM

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Dust particles are found nearly everywhere in space. In different environments the dust is observed to have different properties. These observations imply that the dust properties change with their environment changes. Dust evolution starts in the ISM in regions where the density of matter increases. The understanding of this first stage of dust evolution is critical in order to study subsequent evolutionary processes, for example in protoplanetary disks, where planets are formed.

Dust in the ISM consists of amorphous carbon and amorphous silicate with a size distribution from nanoparticles to about µm-sized grains. The new dust model developed by Jones et al. 2013 considers particles that consist of small (<20 nm) aromatic-rich amorphous carbon grains and larger (>20 nm) core-mantle grains, where the core consists of aliphatic-rich amorphous carbon or amorphous silicate with an aromatic-rich amorphous carbon mantle. This dust model explains very well the observed data on dust in the diffuse ISM. Comparing these observations to those of dust in denser regions in the ISM, it is known that the dust temperature decreases while the spectral index increases. These variations are assumed to arise from dust evolution on entering denser regions of the ISM.

We find that the observed variations in dense regions of the ISM can be explained by the coagulation of grains into aggregates. These aggregates consist of the single dust grains as they are assumed in the diffuse ISM by Jones et al. 2013. Our model calculations show that the temperatures of these aggregates are lower than those of the single grains and we also find an increase in the spectral index. Additionally, and as is observed we find an increase in the emissivity, which, as our model calculations show, depends strongly on the contact area between the single grains connected into an aggregate. Detailed radiative transfer model calculations show these tendencies for Av<10, while for even denser regions additional processes occur, such as the accretion of ice mantles or further growth due to coagulation.