Dust grain size distribution across the disc of spiral galaxies

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Abstract

The physical properties of the dust are directly linked to those of the ISM where it is located. The dust is not only heated by the ISRF but it is also affected by other mechanisms that lead to a change in the physical properties and/or to the destruction of a particular dust grain type. These mechanisms dominate the evolution of the dust content as well as the grain size distribution in galaxies. Following Hirashita (2015) the main mechanisms are: (i) dust supply from stellar ejecta (AGB stars and SN), (ii) dust destruction via sputtering in SN shocks in the ISM, (iii) grain growth via accretion of metals in the gas phase, (iv) grain growth via coagulation, and (v) grain disruption/fragmentation (shattering) in SN shocks. All these processes act differently on large and small grains: (i) SNe and AGB stars are predicted to supply mainly large grains (Nozawa et al. 2007; Ventura et al. 2012), (ii) dust destruction by sputtering affect both large and small grains, (iii) grain growth via accretion is favoured when the number of small grains is large, as small grains have a larger surface-to-volume ratio (Hirashita 2012), (iv) grain growth via coagulation occurs in the dense ISM and move the grain size distribution towards larger grain sizes (Ormel et al. 2009), and (v) fragmentation associated to shattering creates a large number of small grains (Jones et al. 1996). Due to all these processes, the dust grain size distribution in a galaxy evolves with time. Therefore, the relative abundance of the dust grain types gives us very useful information to study the mechanisms that affect the dust evolution, which in turn is directly linked to the evolution of galaxies.

In this talk I present a detailed study of the relative contribution of the different dust grain sizes in a set of spiral galaxies: M33, NGC628 and M101. We have fitted the dust spectral energy distribution in a pixel-by-pixel basis across the disc of M33 (Relaño et al. 2018) and M101 and NGC 628 (Vilchez et al. 2019). We have used the classical Desert et al. (1990) dust model, which consists of three dust grain types: polycyclic aromatic hydrocarbons (PAHs), very small grains (VSGs) of carbonaceous material, and big grains (BGs) of astronomical silicates. We have applied a Bayesian statistical method to fit the individual SEDs and derived the best output values from the study of the probability density function of each parameter. We have derived the relative amount of the different dust grains in the model, the total dust mass, and the strength of the interstellar radiation field (ISRF) heating the dust at each spatial location. The relative fraction of VSGs is shown for M33 in Fig. 1 (from Relano et al. 2018). Higher values of the relative fraction for VSGs (and lower corresponding values for the relative fraction of BGs) are located at the centre of the intense star-forming regions, consistent with the framework of the dust evolution models in Jones et al. (1994, 1996), suggesting dust grain destruction and/or fragmentation by interstellar shocks in the warm medium. We also find that the relative contribution for PAHs correlates well with the

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metallicity for the three galaxies of our sample. Furthermore, I will present the comparison of the relative contribution of small and large grains with recent hydrodynamical simulations (Hirashita et al. 2015, Hou et al. 2019) that, for the first time, include the evolution of the grain size distribution.

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