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Radial distribution of stars, gas and dust in SINGS galaxies II. DERIVED DUST PROPERTIES

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Abstract

We present a detailed analysis of the radial distribution of dust properties in the SINGS sample, performed on a set of ultraviolet (UV), infrared (IR), and H I surface brightness profiles, combined with published molecular gas profiles and metallicity gradients. The internal extinction, derived from the total-IR (TIR)-to-far-UV (FUV) luminosity ratio, decreases with radius, and is larger in Sb-Sbc galaxies. The TIR-to-FUV ratio correlates with the UV spectral slope β, following a sequence shifted to redder UV colors with respect to that of starbursts. The star formation history (SFH) is identified as the main driver of this departure. Both L TIR/L FUV and β correlate well with metallicity, especially in moderately face-on galaxies. The relation shifts to redder colors with increased scatter in more edge-on objects. By applying physical dust models to our radial spectral energy distributions, we have derived radial profiles of the total dust mass surface density, the fraction of the total dust mass contributed by polycyclic aromatic hydrocarbons (PAHs), and the intensity of the radiation field heating the grains. The dust profiles are exponential, their radial scale length being constant from Sb to Sd galaxies (only ~10% larger than the stellar scale length). Many S0/a-Sab galaxies have central depressions in their dust radial distributions. The PAH abundance increases with metallicity for 12 + log(O/H) < 9, and at larger metallicities the trend flattens and even reverses, with the SFH being a plausible underlying driver for this behavior. The dust-to-gas ratio is also well correlated with metallicity and therefore decreases with galactocentric radius. Although most of the total emitted IR power (especially in the outer regions of disks) is contributed by dust grains heated by diffuse starlight with a similar intensity as the local Milky Way radiation field, a small amount of the dust mass (~1%) is required to be exposed to very intense starlight in order to reproduce the observed fluxes at 24 μm, accounting for ~10% of the total integrated IR power.

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