Abstract

"Research is to see what everybody else has seen, and to think what nobody else has thought."

– Albert Szent-Gyorgyi

The interstellar medium (ISM) of a galaxy is a reservoir of gas and dust. The dust grains, in turn, play a vital role in determining the astrophysics of the ISM. Most importantly, dust controls our view of the universe due to the fact that energy emitted by stars as shorter wavelength optical/ultraviolet radiation is attenuated by it and re-radiated in the longer infrared. In order to determine the intrinsic properties of an astrophysical object, it becomes highly crucial to correct the effects of this attenuation comprising of dust absorption and scattering, referred to collectively as extinction. The discovery of spectroscopic features complemented by laboratory study of materials for dust candidates has led to an increasing interest in the study of interstellar dust in the last decade. With the launch of space-based telescopes ranging from the *Far-Ultraviolet Spectroscopic Explorer (FUSE)* and the *Galaxy Evolution Explorer (GALEX)* in the ultraviolet (UV) to *Spitzer Space Telescope* and the recent *AKARI telescope* in the infrared (IR), a huge amount of data has become available, revealing the universal nature of interstellar dust grains.

Despite the importance of dust, determining the physical properties and amount of interstellar dust in other galaxies has been a very challenging task with much left to explore and understand. In this thesis, we have studied the interstellar dust grain characteristics at various locations in the Milky Way and nearby galaxies, with a special interest towards dust in the Magellanic clouds. The first half of the thesis has been focussed towards multi-wavelength correlation studies which have been used to identify the particular grain population responsible for the observed emissions at our dust locations. The second half of the thesis reports the use of various dust grain models to study the extinction in our local universe.

We begin by investigating the rank correlation coefficients in the Milky Way (MW) by comparing the far-ultraviolet (FUV) diffuse dust observations with archival mid-infrared (MIR) data. Earlier studies have not found any correlation among the diffuse FUV and cold dust emission in the Galaxy. However, by separating our observations into low and high latitude locations, we found a good negative correlation between FUV and cold dust emissions with significantly better UV-IR correlations for the lower latitude locations, indicating a decreasing abundance of Polycyclic Aromatic Hydrocarbons (PAHs) and very small dust grains at high latitudes. We have proposed an extra-galactic origin of dust for the observed emissions at high latitude locations in the Galaxy.

Beyond our Milky Way, the Magellanic clouds have long served as ideal nearby laboratories to study dust properties and abundances in high-redshift galaxies owing to their nearly face-on orientation and closeness to the MW. We have studied the FUV-IR rank correlations in the Large Magellanic Cloud (LMC) at various dust locations including two HII regions, namely N11 and 30 Doradus. We have observed better UV-IR correlations for the former and found a higher FUV/IR(90 μm) intensity ratio for 30 Doradus due to the high unresolved star density at the observed LMC locations. After LMC, we have probed the low-metallicity regions of the Small Magellanic Cloud (SMC) using UV-IR correlation studies with an aim to provide a suitable justification for the absence of the 2175 Å feature by studying the abundance of PAHs. We found the larger sized dust grain emissions in the far-infrared (FIR) to be better correlated to the FUV emissions as compared to the MIR data which indicates a lack or absence of PAHs at our observed locations. After comparison with the correlation trends in the LMC, we have attributed the weakness of MIR emissions to the destruction of PAHs and very small grains in the low-metallicity environments of the SMC.

We have used the Orion nebula as our sample of study to further investigate the optical properties of dust grains in the Galaxy. The FUV-FIR correlation studies in a 10 degree radius around the Orion center revealed that the emissions at our observed locations were caused by larger dust grains belonging to colder environments with the smaller dust grains possibly getting destroyed or photo evaporated by high radiation coming from the Trapezium star cluster at the center of the nebula. We followed this by modelling the dust grains responsible for the FUV scattering in front of Orion's veil and obtained a high value of albedo ($\sim$0.7) and scattering phase function asymmetry factor ($\sim$0.6) at our observed locations which might be attributed to the presence of larger sized dust grains leading to high extinction values. We also determined the distances to individual dust locations observed between us and the Orion central region in a 100-400 pc range, which allowed us to construct a 3D distribution of dust around Orion.

At the end of this thesis, we have studied the polarization caused by dust grains around young stars using composite dust grain models. We have compared the results from our Discrete Dipole Approximation (DDA) and Effective Medium Approximation (EMA) T-Matrix based models with actual observed polarimetric data in an attempt to constrain the dust grain composition and properties in our sample of stars. Very interestingly, we report the possible existence of silicon carbide (SiC) in the outer disk/envelope around one star in our sample which has been interpreted based on the shape, size, composition and fraction of inclusions by volume in our composite dust grain models.