All-sky dust modelling with Planck, IRAS and WISE observations

G. Aniano, B. T. Draine, M.-A. Miville-Deschenes, F. Boulanger, Planck collaboration

We present an all-sky dust modeling of the high resolution , *IRAS* and *WISE* infrared observations using the physical dust model presented by Draine & Li (DL07). We study its performance in modeling the observational data, and present implications for future dust modelling. The present work extends to the full sky the dust modelling done on nearby galaxies with *Herschel* and *Spitzer* data.

We employ the DL07 dust model to generate maps of the dust mass surface density Σ_{M_d}, the dust optical extinction A_V, the polycyclic aromatic hydrocarbon (PAH) molecules mass fraction q_PAH, and the starlight intensity heating the bulk of the dust, parametrized by U_min. We test the model by comparing these maps with independent estimates.

The DL07 model reproduces the observed spectral energy distribution (SED) satisfactorily in most of the sky, with small deviations in the inner Galactic disk, and in low Ecliptic latitude areas, presumably due to zodiacal light contamination. In the Andromeda galaxy (M31), the present dust mass estimates agree remarkably well (within 10 %) with DL07 estimates based on independent *Spitzer* and *Herschel* data. The DL07 A_V estimates agree with those generated by Planck Collaboration XI using a modified black body approach, although DL07 suffers from a global normalization discrepancy. In molecular clouds, we compare the DL07 A_V estimates with maps generated from stellar optical observations from the 2MASS survey. The DL07 A_V estimates are a factor ~ 3 larger than values estimated from 2MASS observations. In the diffuse interstellar medium (ISM), we compare the DL07 optical extinction A_V estimates with optical estimates from $\sim 2 \times 10^5$ quasi stellar objects (QSOs) observed in the Sloan digital sky survey. The DL07 A_V estimates are larger than those estimated from the QSOs, and this discrepancy depends strongly on U_min. The shape of the optical extinction curve appears to be independent of U_min.

We investigate the dependence of the A_V mismatch as a function of the DL07 fitted parameters. We propose an empirical renormalization of the DL07 A_V estimate, dependent of U_min, that compensates for the systematic differences found here. The renormalization, bringing into agreement the A_V estimates on QSOs, also brings into agreement the A_V estimates on molecular clouds. In the diffuse ISM, the DL07 fitting parameter U_min, effectively determined by the wavelength where the SED peaks, appears to trace variations in the FIR opacity of the dust grains. We find strong evidence for dust evolution.

We provide a family of SEDs per unit optical reddening, parameterized by U_min; these will be the constraints for a next generation of dust models. In order to generate the first all-sky q_PAH maps, we had reprocessed the full WISE 12 μm dataset, removing artifacts caused by the Moon, solar system objects and other artifacts. We publicly release the corresponding artifact -free WISE maps.