The Dust Content of ELAIS-N1 Galaxies

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Most of the mid-infrared (MIR) emission (3-40μm) from star-forming galaxies is due to thermal emission from dust grains heated by stellar radiation. The dust emission consists of two different components, i.e., broad emission features at 3.3, 6.2, 7.7, 8.6 and 11.3μm from molecules of sizes in the 6-20 Å range (Leiger and Puget 1984; Allamandola, Tielens & Barker 1985) and continuum emission from very small dust grains (15-40 Å, sometimes referred to as VSGs) (Sellgren 1984). The molecules as well as the VSGs are most likely to be made up of polycyclic aromatic hydrocarbons or PAHs which are known to have vibrational transitions at these wavelengths. They are excited by single photon heating and their MIR intensities are therefore independent of the radiation field density (Draine 2003). Their emission is correlated with cold dust emission at 160μm (Bendo et al. 2008), making them good tracers of the neutral ISM in galaxies (Peeters, Spoon & Tielens 2004). Laboratory studies have shown that neutral PAHs are excited mainly by UV photons (see Sellgren (2001) and references therein) and there have been several observations of these emission features in regions of intense UV radiation.

However, the detection of these emission features in regions with little UV radiation as well as in some early-type galaxies showed that they could also be excited by evolved stellar populations (for a recent review see Calzetti (2011)). The 8μm emission from PAHs is found to be strong outside HII regions where the smaller PAHs can survive and where they are irradiated by the general interstellar radiation field (ISRF) (Gordon et al. 2008; Helou et al. 2004). Since the PAH emission lines are associated with the diffuse ISM (Boulanger & Perault 1988) they are not good tracers of the current star formation rate of galaxies (Calzetti 2011).

On the other hand, the continuum emission from VSGs can only be excited by highly luminous UV emitting stars and is found to be associated with the centres of HII regions. Large ionized PAHs are the most likely carriers in this case as they are more stable than neutral ones in regions of high radiation fields. This is because larger PAHs are easily ionized making them better survivors in harsh environments, such as found near O-type stars. Zhu et al. (2008) have found a tight correlation between the 24μm (continuum emission from VSGs) and 70μm luminosities both of which are associated with hot dust. The 24μm continuum emission is one of the best indicators of the current star formation rate in the galaxy, since it is associated with hot massive stars.

These results suggest that the line and continuum emission are associated with different types of dust grains in different environments. Therefore using a combination of the MIR emission from VSGs and PAH molecules together with the UV emission from stars, we may expect to classify galaxies based on their stellar and dust content. In this work we have classified galaxies based on their UV and MIR emission in a region where there are observations in both the UV (from GALEX) and IR (from Spitzer) – the ELAIS-N1 field of the Spitzer Wide-area InfraRed Extragalactic Survey (SWIRE, Lonsdale et al. (2003)). We find that the PAH molecules are the main absorbers of UV radiation in galaxies where the strength of the radiation field is low while the absorption is split equally between PAHs and small grains in galaxies where the radiation field is high.