Dust in the wind: the mineralogy of newly formed dust in Active Galactic Nuclei

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The detection of large amounts of dust (Priddey et al. 2003; Beelen et al. 2006) in the early universe still remains largely unexplained. The traditional (stellar) dust sources do not produce enough dust during the first Gyr to explain the reservoir of dust observed (Morgan & Edmunds 2003; Rowlands et al. 2014), and, furthermore, the extinction curves at high redshift are markedly different from those observed in the local universe (Maiolino et al. 2004; Stratta et al. 2007). Therefore, additional dust sources have been invoked, such as interstellar grain formation and grain growth (Martini et al. 2013). Additionally, by comparison with the dust forming environments around evolved low mass stars, Elvis et al. (2002) argue that the conditions in the wind coming off Active Galactic Nuclei (AGN) accretion disks allow for the formation of significant amounts of dust. This dust source would not only help explain the so-called *dust budget crisis* at high redshift, but also provides a natural explanation for the origin of the dusty AGN torus (Elitzur & Shlosman 2006).

We have started a rigorous program to determine the dust mineralogy towards a number of quasars where the dust features are seen in emission, which is predicted to be the case for certain viewing angles (Pier & Krolik 1992). We follow our earlier analysis of broad absorption line (BAL) quasar PG 2112+059 for which we have determined the mineralogical composition of dust using mid-infrared spectroscopy obtained with the Spitzer Space Telescope (Markwick-Kemper et al. 2007). From spectral fitting of the solid state features seen towards this object, we identify Mg-rich amorphous and crystalline silicates with olivine stoichiometry, as well as the more primitive condensates alumina (Al_2O_3) and periclase (MgO), probing the conditions in the dust condensation zone.

We have selected a sample of Palomar Green (PG) quasars with Herschel and AKARI photometry from the sample of Petric et al. (2015), and required their archival Spitzer spectra to show the 9.7 micron silicate feature in emission. The Herschel photometry will constrain the far-infrared continuum, enabling us to repeat the analysis by Markwick-Kemper et al. (2007) for this sample. We will chart the variety in mineralogy present in quasar winds, and compare the results with other work present in the literature (e.g. Köhler & Li 2010; Smith et al. 2010; Xie et al. 2014), studies which all have targeted single objects, or very small samples.