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Crystalline silicates in external galaxies

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Observational evidence has long supported that most of the interstellar silicates in galaxies are amorphous. While crystalline silicates may form around evolved stars at temperatures sufficiently high to allow for annealing, it is thought that the harsh interstellar environment quickly amorphitizes any crystalline silicates, most likely through bombardment by the heavy ions in cosmic rays (Demyk et al. 2001; Jäger et al. 2003; Brucato et al. 2004; Bringa et al. 2007; Szenes et al. 2010), and a firm upper limit of 2% on the crystalline fraction of silicates was derived based on the absence of substructure in the 9.7 μm feature (Kemper et al. 2004; Kemper et al. 2005).

The first detection of crystalline silicates in external galaxies was reported by Spoon et al. (2006) in 12 out of a sample of 77 starbursting Ultraluminous Infrared Galaxies (ULIRGs), with later detections of further galaxies reported by Roussel et al. (2006), Willett et al. (2011), Stierwalt et al. (2014), and Aller et al. (2012). The only one of these studies quantifying the crystalline fraction is the work by Spoon et al. (2006), who report a crystalline fraction of 6-13% in the interstellar silicate reservoirs. A very simple model of the production of crystalline silicate dust by evolved stars, at a level of 10-20% of the total silicate dust production by these stars, is able to explain the observed crystallinities at about 30 Myr after the start of a starburst (Kemper et al. 2011). In general, the model can be used to estimate the transition time and interstellar conditions, such as cosmic ray fluence, based on observational constraints on the crystalline fraction.

However, the small number of known interstellar crystalline silicate fractions in star-forming galaxies limits the usefulness of such a model. We have devised a method to measure the crystalline fraction of silicates in a large number of galaxies quickly and easily. For this purpose, we are performing radiative transfer models of starburst galaxies, with varying crystalline fractions of their interstellar silicates using the SKIRT radiative transfer code (Camps & Baes 2015), and identified a method to determine the crystallinity of silicates in starburst galaxies directly from (archival) infrared spectroscopy.

Consider for a poster?

Yes

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