Abstract

We present Spitzer images of the SB0/a galaxy NGC 1291 and the SAa galaxy NGC 4594. Both galaxies contain dust rings. At 24 µm, the nuclei of both galaxies are the brightest sources in the galaxies, and dust emission from the rings is relatively weak. At 160 µm, however, the dust rings are more prominent sources; in NGC 4594, the dust ring is the source of virtually all of the 160 µm emission. We examine whether the dust emission from the rings is related to star formation activity, and we study the relation between dust emission and PAH emission. For NGC 4594, we also present submillimeter data that show that the nucleus dominates the 850 µm emission. These results demonstrate that the 850 µm emission cannot come from the same cool dust that dominates the 160 µm emission. We examine the possible mechanisms that could be generating the 850 µm emission.

Correspondence between Hα, PAH, and dust emission

The images below show the upper right side of the dust ring in the Hα, 8 µm, 24 µm, and 160 µm bands. All four bands represent potential tracers of star formation. The best correspondence is between the 8 and 24 µm bands; this correspondence demonstrates that PAH emission is linked with very small grain emission. However, neither the 8 µm PAH emission, the 24 µm very small grain emission, nor the 160 µm large cool grain emission correlate well with the Hα emission. Consider, for example, regions A and B. Region A is the brightest Hα source in the dust ring, yet it produces only modest PAH and dust emission. In contrast, region B is relatively bright in all infrared wavebands, yet the source is absent in the Hα image.

Correspondence between Hα and 24 µm emission

The images below show the right side of the dust ring. A substantial part of the 24 µm emission in the dust ring does not originate from the HII regions that are detected in the Hα image. Furthermore, the 24 µm emission does not necessarily peak in the HII regions. Note regions A, B, C, and D. All four regions have similar Hα fluxes, yet the 24 µm flux only strongly peaks in region C.

The source of the 850 µm emission

Clearly, the 850 µm emission in this galaxy does not originate from the ~20 K dust that dominates the 160 µm emission. An alternative mechanism must be the source. 850 µm emission mechanisms that were considered first in the analysis but then rejected include:

- **CO emission.** Data from Young et al. (1995 ApJS 98, 219) show no central peak in CO emission.
- **Synchrotron radiation.** An extrapolation from radio data (from Hummel et al. 1984 A&A 134, 207) to 850 µm can only account for 1/4 of the nuclear emission, although we caution that additional millimeter measurements are necessary to securely rule this out as a source.
- **Very cold (~9K) dust.** The strong dust heating evident in the enhanced 24µm/160µm colors make it appear unlikely that dust at 9K could exist in a sufficient mass in the nucleus to produce the flux seen at 850 µm.

Other possible 850 µm emission mechanisms include:

- **Bremsstrahlung radiation.** This is a known source of short-wavelength radio emission (e.g. Condon 1992 ARA&A 30, 575).
- **Dust with exotic emissivity properties.** This has been proposed to explain the millimeter excess seen some galaxies (e.g. NGC 4631; Dumke et al. 2004, A&A 414, 475).
- **Unidentified spectral line emission.** Clearly, more data in other wavebands is needed to identify the source of the 850 µm emission.