0.3 TO 100 μm CONTINUA OF SEYFERT 1 GALAXIES*

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The questions we wish to address with this work are: What is the shape of the continuum spectrum of an active nucleus? Can we identify thermal and non-thermal components? Previous work on this subject studied different non-overlapping samples in narrow frequency bands. A significant step forward was taken by Malkan and Sargent (1982) who studied the IR (10μm) through UV continuum of a small sample of objects. We report here results for the first part of the study of the complete continuum for a hard X-ray selected sample of 37 Seyfert 1 galaxies. This selection criterion ensures a sample unbiased for optical-IR studies, as the hard X-rays are not affected by reddening (Lawrence and Elvis 1982). The data consist of our own 1-20 μm ground-based IR observations, 100 and 60 μm IRAS fluxes and optical UBVR photometry.

We found that the continuum spectra can be simply classified in three families by means of IR (60μm/12μm) and optical (1.2μm/0.3μm) colors (Figure 1). Class A galaxies, or "bare AGN" are non-reddened and do not present any significant amount of cool dust or galaxy IRAS component. These galaxies also tend to be brighter in X-rays, in agreement with the conclusions of Lawrence and Elvis (1982) and Mushotzky (1982) and have lower Balmer decrements than the other two classes. Class B galaxies are "reddened AGN". Class C galaxies are both reddened and present large "galaxy disk" cool dust components. Class B and C galaxies are low luminosity X-ray objects.

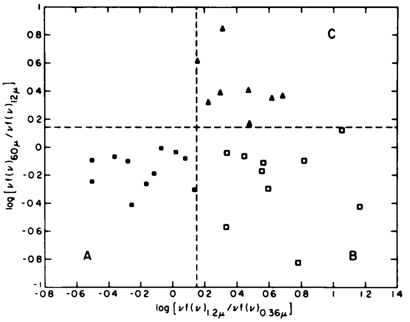

Figure 1.
The Classification.

* Discussion on p.93

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To study the continuum, we excluded Class C galaxies and we restricted ourselves to the 100μm to 1μm region, to minimize the effects of reddening. We also made the working hypothesis that the spectra can be represented by an "underlying power law", plus IR excesses and we define this power law as the highest possible power law component allowed by the data. This hypothesis seems to have some meaning. We found that the power law fits for Class A galaxies (bare AGN) cluster tightly around a slope of 0 (in $\nu f\nu$) (or 1 in $f\nu$). The allowed power laws for Class B (reddened AGN) are instead more spread. Since a flat power law is suggested by the IR continuum, we define P_{below} as the power below a maximum power law α=0 ($\nu f\nu$) and we explore the possibility that P_{below} could be a good estimate of the non-thermal continuum. Malkan (1984) found a tight correlation between the 3.5μm and the hard X-ray emission that led him to suggest that the 3.5μm emission is mainly non-thermal. If we use P_{below} instead of L(3.5μm), we find an even tighter correlation (Figure 2).

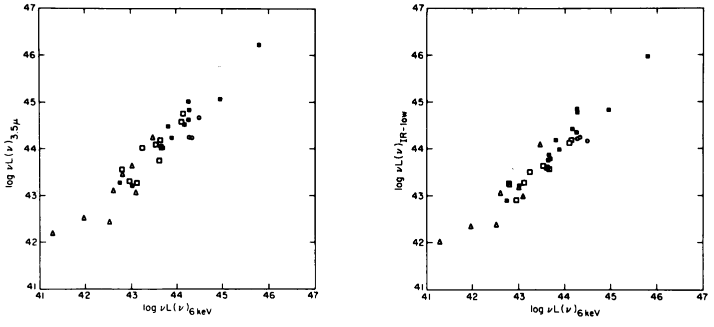

Figure 2.
Left: The Malkan correlation.
Right: Correlation of P_{below} with hard x-rays.

Therefore P_{below} is a better estimator of the non-thermal continuum than the 3.5μm emission. Finally, where does the thermal component originate from? We addressed this question by studying correlations of broad emission lines (Hα) which originate within 0.1 pc of the nucleus and narrow emission lines ([OIII]), which originate from farther out (~100 pc) with 20μm and 3.5μm emission. We find that Hα is strongly correlated with the 3.5μm emission, while [OIII] is correlated instead with the 20μm emission: the hotter dust is nearer to the nucleus.

Concluding, using broad band photometry over a wide baseline covering 2-1/2 decades in frequency we can isolate "bare" nuclei, we can define thermal and non-thermal continuum components contributing to various degrees in different objects and we can have a first cut at the study of the dust distribution. We now have a new tool to explore further the temperature and spatial distribution of the IR emitting dust by studying the "thermal" component. This is work for the future, but we can already say that this distribution is not smooth and must have "temperature gaps" since we can define a meaningful non-thermal component. We plan to expand this work by including radio, UV, and X-ray data.

Lawrence, A. and Elvis, M, 1982, Ap.J., **253**, 410.
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Mushotzky, R. 1982, Ap.J., **256**, 92.

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