MILLIMETER OBSERVATIONS OF OPTICALLY SELECTED QUASARS

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We have observed a group of optically selected quasars at a wavelength of 1.25mm with the Caltech Submillimeter Observatory in 1988 May. Except for Mrk 231, they were chosen from the PG sample of quasars (Schmidt and Green 1983) and are thus UV bright objects. All of them, except for PG 2209+184, were also detected at 60μm by IRAS.

Of the seven quasars, only Mrk 231 and PG 2209+184 were detected above the 3σ noise level. The results are listed in Table I.

TABLE I

Quasar	Radio Spectrum	F_ν(1.25mm) (mJy)	Spectral Index[a]
Mrk 231	Quiet	30 ± 8	2.8
PG 1351+640	Quiet	6 ± 5	> 1.7
PG 1613+658	Quiet	8 ± 6	> 1.6
PG 1700+518	Quiet	13 ± 21	> 0.8
PG 1704+608	Steep	7 ± 9	> 0.6[b]
PG 2130+099	Quiet	16 ± 19	> 0.7[b]
PG 2209+184	Flat	134 ± 10	− 0.14[c]

[a] 1.25mm to 100μm spectral index unless not detected by IRAS at 100μm. Limits are calculated from 3σ upper limits at 1.25mm.
[b] 1.25mm to 60μm spectral index.
[c] 6cm to 1.25mm spectral index.

The most straightforward interpretation of these results (see Figure 1) is that the far-infrared flux of radio-quiet and steep-spectrum radio-loud quasars is due to thermal emission from dust. An emission peak near 100μm with a longward sharp drop in flux density is a ubiquitous feature of warm Galactic HII regions (e.g. M42, W51; Gordon 1987), cool dust clouds (e.g. B335; Keene 1981), normal spiral galaxies (e.g. M51, Smith 1982), and luminous Seyfert 2 galaxies (e.g. NGC 1068, Telesco *et al.* 1984). There is no need to invoke a more speculative mechanism for the same spectral shape in radio-quiet quasars.

An alternative explanation (Edelson and Malkan 1986; Edelson 1986) is that the infrared emission is predominantly synchrotron radiation and that the steep drop to millimeter wavelengths is due to synchrotron-self absorption, with an upper limit of 2.5 to the spectral index. In our view this latter is less likely. A few quasars have already been detected with a spectral index greater than the upper limit of 2.5 (Mrk 231 and IRAS 13349+2438; this paper; Krügel *et al.* 1988; Chini, Kreysa, and Salter 1987). Moreover, the upper

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limit of 2.5 is valid only in homogeneous sources, inhomogeneities in a source would cause the spectrum to be less steep.

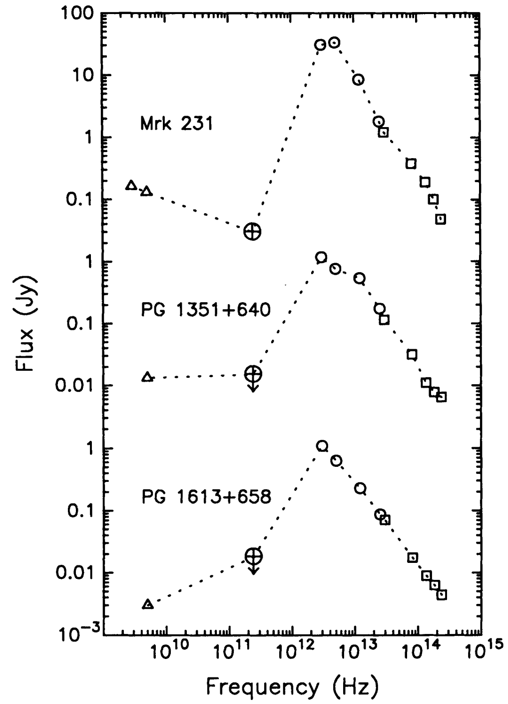

Figure 1. The spectra of the three brightest quasars (at 100μm) in our sample. Data from this paper are shown as open circles with crosses. The rest of the data are from Neugebauer *et al.* (1987, squares), Neugebauer *et al.* (1986, circles), Kellerman *et al.* (1969 and 1988, triangles).

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