NEAR INFRARED PHOTOMETRY OF FAINT RADIO GALAXIES

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This paper describes the first results of systematic near IR photometry of radio galaxies in the Leiden Berkeley Deep Survey. The LBDS contains ∿ 400 radio sources with $S_{1.4\ GHz} \geq 0.22$ mJy (for details see van der Laan et al., this symposium), 50% of which have reliable optical identifications on deep multicolor KPNO 4^m plates, being mainly faint blue radio galaxies (Windhorst et al., 1982). The aim of the present IR photometry program is to study their IR properties and to obtain clues as to the nature of these faint blue radio galaxies, which may be either ellipticals, possibly with recent star formation, or spirals with exceptionally high radio power. The additional optical-IR color baseline will help to solve these questions.

A complete subsample, with an m_V distribution representative for the total LBDS, was photometered in the passbands J(1.2μ), H(1.65μ) and K(2.2μ) with the $3^m\!.8$ UK and the $3^m\!.0$ NASA Infrared Telescopes (Puschell et al., 1983). Out of 48 objects, 45 were detected in K with errors typically between $0^m\!.05$ and $0^m\!.25$. The (J-H) vs (H-K) color-color diagram (fig. 1) shows the LBDS radio galaxies together with the 3CR radio galaxies of Lilly & Longair (1982). The IR color distribution of the mJy LBDS radio galaxies is similar to that of the 10^3x more powerful 3CR. The straight line is the locus of non-thermal spectra for different spectral indices. The IR colors of about half the LBDS sample are within the errors consistent with a non-thermal spectrum, as are all the 3CR N-galaxies. The other half of the LBDS sample differs significantly from the non-thermal locus and has IR colors that local E+Sp galaxies would have at redshifts in the range $0.2 \lesssim z \lesssim 0.6$, applying Bruzual's (1981) K-corrections.

The optical-IR color-magnitude diagram (V-K) vs K for the LBDS and the 3CR is shown in fig. 2. The errors in the still preliminary LBDS V-magnitudes may be uncertain by $\sim 0^m\!.75$, but precise photometry will be provided by Kron, Koo & Windhorst (1983). The hatched line shows the effective optical plate limit. The drawn lines are the predictions by Bruzual (1981) for a passively (C) and exponentially (μ=0.5) evolving elliptical and a non-evolving spiral (Sbc) galaxy, all three calculated for one single luminous $M_V=-23^m\!.9$ ($H_o=50$, $q_o=0$). (So galaxies with similar spectra, but with lower optical and IR

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luminosities, will in first order appear to the right of the drawn lines). While most of the 3CR radio galaxies with K $\lesssim 16^m$ have (V-K) colors similar to these luminous ellipticals, this seems only true for a minority of the LBDS. Most mJy radio galaxies have (V-K) and also (R-K) colors up to 3^m redder - more than can be explained by the errors - than any of the models. The explanation could be, that they are overluminous in K. However, for a subsample spectroscopic redshifts have been measured (Koo, this symposium), yielding for only about half of the sample an M_K as luminous as the 3CR ellipticals and up to $\sim 2^m$ less luminous for the other half of the sample. In order to explain the very red (V-K) colors their M_V should be even more underluminous. The most likely explanation is that these objects have M_V's much fainter than the 3CR giant ellipticals, an UV upturn causing the blue optical colors and some IR excess causing the very red (V-K) and (R-K) colors. If this near IR excess is thermal, then the dust should be very hot ($\gtrsim$1000 K), or very dense, which is not very likely, if they were ellipticals. If the IR excess is non-thermal, the underlying galaxy is probably not elliptical either, because ellipticals with low radio power have generally not a strong non-thermal nucleus. It seems likely that a substantial fraction of the mJy LBDS radio galaxies with the very red optical-IR colors are spiral galaxies with some non-thermal IR emission like in Seyferts, or with thermally radiating hot dust.

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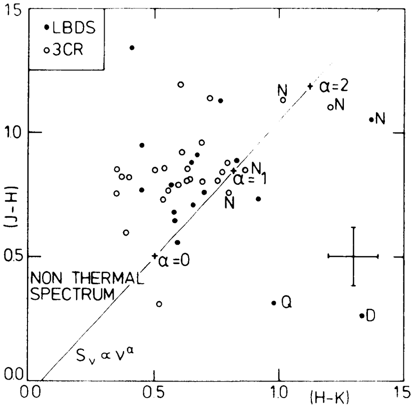

Fig. 1. IR color-color diagram.

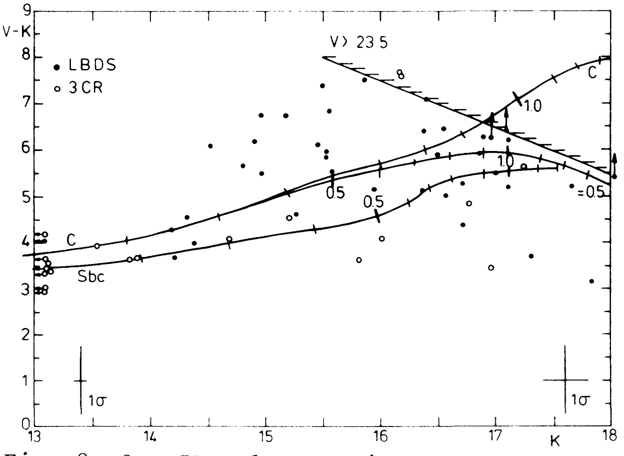

Fig. 2. Opt-IR color-magnitude plot.

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