REDSHIFT ESTIMATES FOR DISTANT RADIO GALAXIES BASED ON BROADBAND PHOTOMETRY

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Calculations modeling the effects of stellar evolution on elliptical galaxies (e.g., Bruzual and Kron 1980, Bruzual 1981) suggest that the shape of the spectral flux distribution should remain almost constant in the red and near-infrared out to at least $z \sim 2$. Thus, it should be possible to derive the redshift of a distant elliptical galaxy by fitting a model galaxy spectrum to broadband near-infrared (RIJHK) photometry.

In order to test this idea, we have begun a program of JHK photometry of elliptical galaxies with high measured redshifts and optically identified and unidentified faint steep-spectrum radio sources believed to be elliptical galaxies, using the NASA 3-m IRTF at Mauna Kea. Details of the observations and interpretation will be discussed by Puschell, Owen and Laing (1981). Eight of nine optically unidentified sources have been detected in at least one infrared band. The infrared data are consistent with these objects being elliptical galaxies, although observations shortward of 1 μm are needed before this is certain. By combining our measurements with published visual and infrared photometry (e.g., Gunn et al. 1981, Lebofsky 1981, Kristian, Sandage and Westphal 1978), we have derived the results shown in the table. Spectroscopic redshifts were taken from Spinrad, Kron and Hunstead (1979), Minkowski (1960), Spinrad (private communication) and Spinrad, Stauffer and Butcher (1981). The model galaxy spectral energy distribution consisted of the M31 nuclear bulge spectrum of Coleman, Wu and Weedman (1980) from 0.14-1.00 μm and a synthesized spectrum from 1-4 μm. The agreement between photometric and spectroscopic redshifts is good for the two galaxies with $z < 0.5$. The redshifts of the more distant objects, which are bluer than expected in the optical band, are systematically underestimated. This is in accord with the predictions of Bruzual (1981). A surprising result is that both of the galaxies with substantial discrepancies between photometric and spectroscopic redshifts, 3C 13 and 3C 368, have anomalous infrared colors of $J - K = 0.9$ and 1.4, respectively (note that 3C 13 has an alternative spectroscopic redshift of 0.4). Both our non-evolving s.e.d. and the evolving models of Bruzual (1981) predict that

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$J - K \simeq 2$ at $z = 1$: either the effects of stellar evolution extend to the infrared colors or there is some non-stellar source of radiation. Objects like 3C 368, whose spectra cannot be fitted at the correct redshift by our model, should be recognizable from their positions on a plot of $J - K$ against K.

Galaxy	z_{SPECT}	z_{PHOT}	χ^2
0442 - 18	0.28	$0.31^{+0.08}_{-0.05}$	0.4
3C 295	0.46	$0.43^{+0.06}_{-0.07}$	2.7
JB 1647 + 43	-	$0.56^{+0.18}_{-0.27}$	0.8
3C 34	0.69	$0.48^{+0.07}_{-0.12}$	0.8
3C 184	0.99	$0.64^{+0.04}_{-0.09}$	1.1
3C 13	1.05 (Alt: 0.4)	$0.55^{+0.12}_{-0.12}$	5.5
3C 368	1.13	$0.22^{+0.10}_{-0.04}$	0.04
3C 427.1	1.18	$0.91^{+0.16}_{-0.10}$	1.9
3C 289	-	$1.11^{+0.12}_{-0.27}$	2.7
3C 65	-	$1.08^{+0.36}_{-0.14}$	2.6

References

Bruzual A., G. 1981, Ph.D. dissertation, Univ. of California, Berkeley.

Bruzual A., G., and Kron, R. G. 1980, *Ap. J.* 241, 25.

Coleman, G. D., Wu, C., and Weedman, D. W. 1980, *Ap. J. Suppl.* 43, 393.

Gunn, J. E., Hoessel, J. G., Westphal, J. A., Perryman, M.A.C., and Longair, M. S. 1981, *Mon. Not. R. astr. Soc.* 194, 111.

Kristian, J., Sandage, A., and Westphal, J. A. 1978, *Ap. J.* 221, 383.

Lebofsky, M. 1981, *Ap. J. (Lett.)* 245, L59.

Minkowski, R. 1960, *Ap. J.* 132, 908.

Puschell, J. J., Owen, F. N., and Laing, R. 1981, submitted to *Ap. J. (Lett.)*.

Spinrad, H., Kron, R. G., and Hunstead, R. W. 1979, *Ap. J. Suppl.* 41, 701.

Spinrad, H., Stauffer, J., and Butcher, H. 1981, *Ap. J.* 244, 382.