LOW–POWER RADIO SOURCES IN THE NUCLEI OF NEARBY E/S0 GALAXIES: EVIDENCE FOR ACTIVE NUCLEI AND FOR CURRENT STAR FORMATION

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SELECTING NEARBY E/S0 GALAXIES: Galaxies were selected from the CfA redshift survey (Huchra *et al.* 1983, Ap.J.Suppl., 52, 189; Tonry 1984, private communication) according to: Decl.(1950) $\geq 0°$; photographic or B(0) magnitude ≤ 14 mag; heliocentric velocity ≤ 3000 km s^{-1}; and de Vaucouleurs morphological type $T \leq -1$. The third criterion roughly corresponds to a distance limit of 40 Mpc for $H_0 = 75$ km s^{-1} Mpc^{-1}. The fourth criterion is equivalent to a Hubble morphological type of elliptical (E) or lenticular (S0), collectively referred to as E/S0 galaxies hereafter. 213 galaxies satisfy the above selection criteria, after 3 Local Group dwarf spheroidals are excluded. Various galaxy catalogs and the recent literature were consulted to check the CfA morphological classifications and to divide the galaxies into Es and S0s. These galaxies comprise a volume– and optical–magnitude–limited sample that is ideally suited to systematic searches in all spectral domains for low–power nuclear activity (Wrobel 1988, A.J., in press).

E/S0 GALAXIES KNOWN TO HAVE ACTIVE NUCLEI: VLA images existed for the 12 galaxies NGC 3665, NGC 3998, NGC 4261 (3C 270), NGC 4278, NGC 4374 (3C 272.1), NGC 4472, NGC 4486 (3C 274), NGC 4552, NGC 4636, NGC 4649, NGC 5322, and NGC 5353. Each of these 12 exhibits a flat–spectrum, parsec–scale radio core, and some also show kpc–scale radio jets (Wrobel 1988). These flat–spectrum cores and jets are signposts of a low–power active nucleus.

A NEW VLA SURVEY: Wrobel and Heeschen (in preparation) used the NRAO VLA to obtain snapshots of the remaining 201 galaxies. The survey was done at 6 cm with $\sim 5''$ FWHM. These new VLA images reveal 55 detections, the vast majority of which are unresolved ($< 2''$ or 400 pc) or slightly resolved, and coincide closely with the optical nuclei. As the figure on the next page shows, some galaxies have powers as low as $P_{6cm} \sim 2 \times 10^{19}$ W Hz^{-1}, or only an order of magnitude higher than that of the Galactic Center source Sgr A. Thus among 213 nearby E/S0 galaxies, 67 (or 31 %) are now known to harbor low–power radio continuum sources in their nuclei.

8 NEW KPC–SCALE RADIO SOURCES: The new VLA images of 8 galaxies show obviously extended emission (Wrobel and Heeschen 1988, Ap.J., in press). All 8 galaxies have diffuse or linear radio morphologies. The radio image of one S0 galaxy, the Seyfert 1 NGC 3516, features a jet–like structure adjacent to a compact core. For 5 other galaxies the kpc–scale radio sources are associated either with known star–forming regions, or with regions that can be expected to be star formation sites. An example is the linear radio source in the S0 galaxy NGC 4710. This elongated radio source is aligned with the galaxy's edge–on stellar disk, similar to the situation in the nuclei of flattened spiral galaxies thought to be undergoing rapid star formation (Condon *et al.* 1982, Ap.J., 252, 102).

FIR PROPERTIES OF RADIO–LOUD E/S0 GALAXIES: Radio spectral indices will soon be available to establish which galaxies have flat–spectrum cores that signal active nuclei (Wrobel, Briggs, and Heeschen, in preparation). In the meantime, existing radio and far–infrared (FIR) data can be used to determine whether current star formation or an active galactic nucleus dominates the radio emission. Galaxies known to be forming stars exhibit a relation between their FIR luminosities (L_{FIR}) and their 6 cm power (Wunderlich *et al.* 1987, Astr.Ap.Suppl., 69, 487). Many of the E/S0 galaxies surveyed with the VLA are FIR sources due to the presence of cool dust. Wrobel and Heeschen (1988) and Walsh, Knapp, Wrobel, and Kim (1988, submitted to

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Ap.J.) find that some (primarily S0) galaxies roughly conform to the relation shown by the star–forming galaxies, while some (mainly E) galaxies depart from this relation, presumably due to the presence of radio emission from active galactic nuclei.

CONCLUSIONS: A volume– and optical–magnitude–limited sample of E/S0 galaxies is ideally suited to systematic searches in all spectral domains for low–power nuclear activity. A new VLA survey of 201 of these galaxies shows that low–power radio continuum sources are commonly found. Most of these radio sources are unresolved ($< 2''$ or 400 pc) or slightly resolved, and coincide closely with the optical nuclei. The radio emission can arise from an active galactic nucleus and/or from current star formation. Radio spectral indices are needed to establish which galaxies harbor flat–spectrum cores that signal active nuclei. In the meantime, existing radio and FIR data suggest that star formation is responsible for the radio sources in many S0 galaxies, while the radio emission from many E galaxies originates from an active galactic nucleus.

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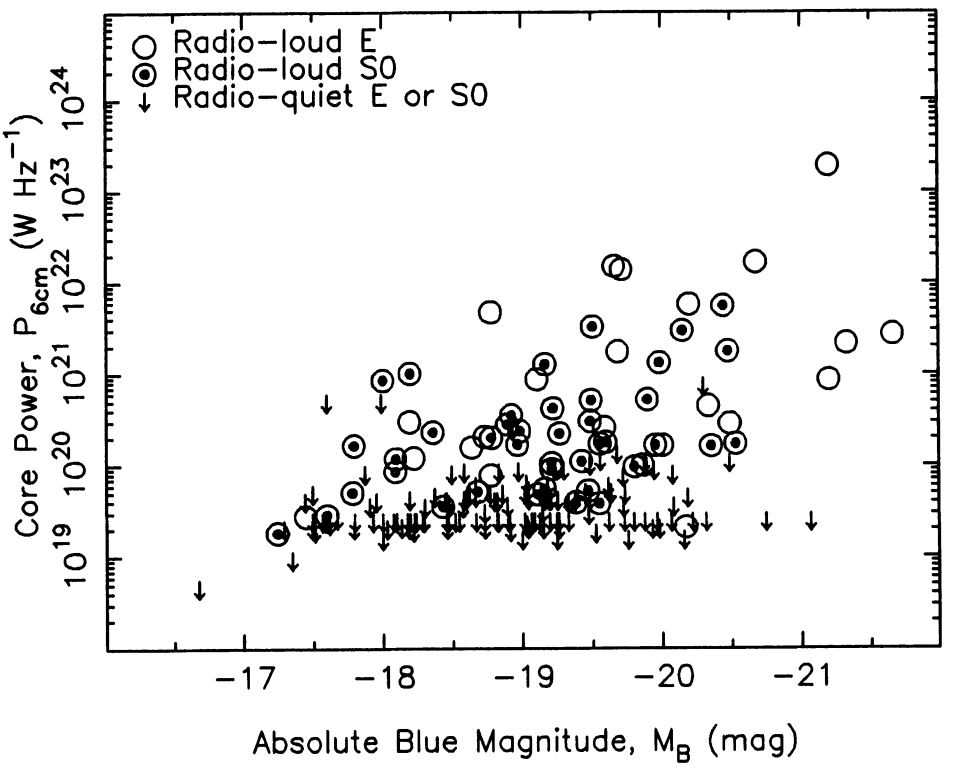

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