RADIO EMISSION FROM LOW-LUMINOSITY ACTIVE GALACTIC NUCLEI

SCHUYLER D. VAN DYK

Dept. of Physics & Astronomy
UCLA, Los Angeles, CA 90095-1562 USA

AND

LUIS C. HO

Harvard-Smithsonian Center for Astrophysics
60 Garden St., Cambridge, MA 02138 USA

1. Introduction

"Low-luminosity" active galactic nuclei (LLAGNs) typically have $M_B \gtrsim -18$ mag, as opposed to -18 to -30 mag for luminous Seyfert 1 nuclei and QSOs. The physical origin of the class of emission-line nuclei known as low-ionization nuclear emission-line regions (LINERs; Heckman 1980) remains controversial. Based on the close resemblance of some LINERs to Seyfert nuclei, LINERs can arguably be considered another manifestation of the AGN phenomenon. An alternative view is that stellar processes account for LINER energy. The energetics alone do not provide a useful discriminator between the two possible mechanisms.

At least *some* LINERs are simply extensions of the Seyfert phenomenon. What is unknown is what fraction of all LINERs are actually AGNs. Since LINERs constitute $\sim 1/3$ of all galaxies in the present epoch (Heckman 1980; Keel 1983; Ho et al. 1997b), this question has important ramifications on knowledge of the very poorly-constrained faint end of the AGN luminosity function. If LINERs are indeed LLAGNs, then they will serve as an important "missing link" between normal and Seyfert galaxies.

Y. Sofue (ed.), The Central Regions of the Galaxy and Galaxies, 489-490.

2. Radio Observations

High-resolution, multi-frequency radio continuum observations can serve as a tool to diagnose LINER nuclei. Heckman (1980) discovered that compact, flat-spectrum radio cores tended to be LINERs, suggesting that LINERs are a manifestation of a nonstellar phenomenon, like "classical" AGNs. Subsequent VLA studies of nearby galaxies, however, indicated that LINERs tend to have *steep* spectra (Heckman et al. 1983; Keel 1984), although these early radio studies were based on rather small, radio-selected samples and relied largely on low-frequency data.

We have obtained high-resolution ($< 0.5''$), high-frequency (6 and 3.6 cm) VLA radio continuum "snapshot" images of a sample of emission-line nuclei selected from the optical survey of Ho et al. (1995, 1997a), which includes type 1 and 2 AGNs, including 29 LINERs, 21 transition objects (LINER + H II composites), and 8 Seyferts.

3. Results and Conclusions

Most sources have fluxes of ~1–3 mJy. Noise levels in our maps are very good (0.05–0.1 mJy rms). Our detection rates are as follows: LINERs, 84%, including 28% with cores $\gtrsim$10 mJy; transition nuclei, 45%, only 5% with cores $\gtrsim$10 mJy; Seyferts, 100% (although small and biased).

Although incomplete, our results indicate a high detection rate of compact cores in LINERs and a smaller detection rate of compact cores in transition objects. We find that (1) Type 1 AGNs (LINERs and Seyferts combined) appear to have a *lower* 6 cm power than Type 2 AGNs, (2) LINERs have greater 6 cm power than transition objects, and (3) no statistically significant differences exist in spectral index α (i.e., $S \propto \nu^{-\alpha}$) among the three classes.

We have detected flat spectrum cores ($\alpha < 0.4$) in 18% of all 6 cm detections. Most nuclei have very steep spectra ($\alpha > 1$). Possibly we are observing optically thin synchrotron from *aged* electrons, since relativistic electrons are only sporadically emitted, and the emitting region is simply not replenished fast enough. Among LINERs alone, an indication exists that α gets steeper as radio power decreases. Also, radio power is broadly correlated with optical line strength, but the scatter is large.

References

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