A SEARCH FOR HI IN ELLIPTICAL GALAXIES WITH NUCLEAR RADIO SOURCES

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Many searches have been made in the last few years for 21 cm emission from neutral hydrogen in elliptical galaxies. Emission has been detected in several galaxies, which have 10^8 to 10^9 $M_\odot$ of HI (for H_o = 100 km $s^{-1}Mpc^{-1}$). Upper limits between 10^6 and 10^9 $M_\odot$ have been set for the HI mass in about 40 other galaxies. Why most E galaxies have so little gas, and why some few have detectable gas, remains a matter of great interest. Two of the galaxies with large HI mass, NGC 1052 and 4278, are known to have powerful nuclear continuum radio sources (P_{2380} $\sim 10^{22}$ WHz^{-1}). Since both of these attributes are fairly rare among elliptical galaxies, their coexistence in these galaxies is not likely to have occurred by chance. We have therefore observed twelve other elliptical galaxies with nuclear radio power $P_{2380} > 10^{22}$ WHz^{-1} at Arecibo Observatory, to determine whether a large mass of HI is a necessary auxillary to nuclear continuum emission.

In the Arecibo observing program, we detected one emission line and possibly one absorption line. An emission line $\sim$ 330 km s^{-1} wide was convincingly detected in UGC 09114. The implied HI mass is 7×10^8 $M_\odot$, which is one of the highest HI masses detected in an elliptical galaxy. We are fairly confident that 09114 is not a misclassified early spiral galaxy: 1) Photographs reveal no strong central concentration (K. Kingham, private communication). 2) The optical spectrum is that of a normal E galaxy, except for a fairly strong [OII]λ3727 emission line; the spectrum is thus typical of E galaxies with compact radio sources (O'Connell and Dressel 1978). 3) Finally, the radio spectrum of 09114 is remarkably inverted, with a spectral index of about +1.3 from 1400 to 5000 MHz. Flat and inverted spectra are typical of nuclear sources in E and S0 galaxies, but are rare among nuclear sources in spiral galaxies. We have possibly detected HI in absorption in UGC 06671, but a curved baseline makes this detection uncertain. No emission or absorption was detected in the remaining galaxies in the program. Upper limits between 1.5×10^8 and 7×10^8 $M_\odot$ of HI were determined for UGC 01308, 02112, 03063, 04859, 07378, 08779, 11718, 12269, and 12727.

To examine the relationship between HI content and nuclear radio

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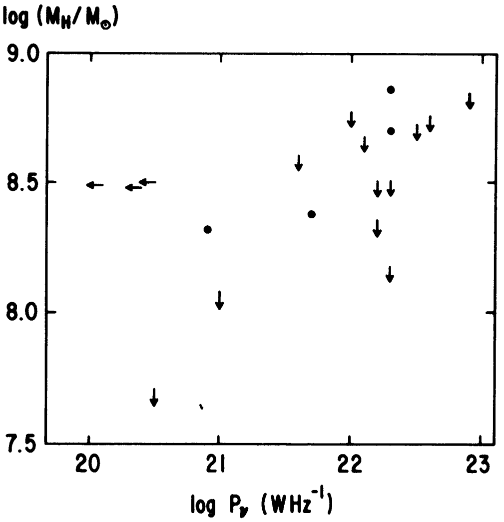

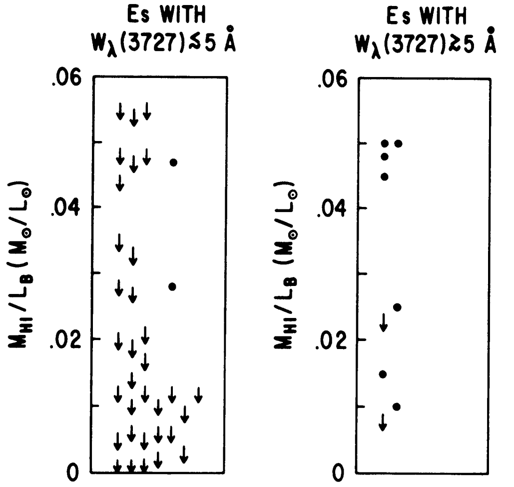

Fig. 1: HI mass as a function of nuclear radio continuum power

Fig. 2: HI mass to B luminosity ratios for Es with $W_\lambda(3727) < 5$Å, > 5Å

emission in E galaxies, we have combined our data with data for other galaxies (NGC 1052, 3904, 4105, 4278, 4552, 4636, 4649, 5322, 5846) which have detections or good upper limits for both HI content and nuclear radio power. (See Sanders 1980 for references.) HI mass versus nuclear 2380 MHz power is plotted for all of the galaxies in Figure 1. No correlation is evident in this figure. However, one cannot quite rule out the possibility that E galaxies with powerful nuclear sources are hydrogen-rich relative to most E galaxies: most galaxies with $P > 10^{22}$ WHz^{-1} have still not been observed with enough sensitivity to detect the amount of HI found in NGC 4278 ($\sim 2 \times 10^8$ $M_\odot$).

Our statistical investigations have revealed one parameter that is well correlated with HI content in E galaxies. This parameter is [OII] λ3727 line strength, which is indicative of the amount of ionized gas in a galaxy. Our sample of galaxies is drawn from Sanders' (1980) compilation of E galaxies searched for HI and from the Arecibo program. For most of these galaxies, the data of Humason et al. (1956) or of O'Connell and Dressel (1978 and in preparation) can be used to determine whether the equivalent width of the 3727 line is $\gtrsim$ 5Å. The strong correlation between large HI mass and prominent 3727 emission is evident in Figure 2.

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