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HI in Early–Type Galaxies: First Results from HIPASS

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Abstract. The recent completion of the HI Parkes All–Sky Survey (HIPASS) provides a large and homogeneous set of HI spectra covering thousands of nearby galaxies. I present some first results from a HIPASS study of ∼2500 nearby E and S0 galaxies. The HI detection rate is at least 5% for RC3 elliptical galaxies and 12% for S0s, and most of the detected galaxies have HI masses between 10^9 and 10^{10} $M_\odot$ (H_o=50 km s^{-1} Mpc^{-1}). More than 50 new HI detections have already been made, and the number will increase after follow–up synthesis observations have been made to confirm marginal detections and sort out confusion.

1. Introduction

There are many reasons for studying the cool interstellar medium in early–type galaxies. Settled HI disks, though rare, provide one of the most powerful tracers of the mass distribution in the outer regions (e.g. Franx, van Gorkom & de Zeeuw 1994); and in luminous elliptical galaxies in particular, the presence of HI may indicate that the galaxy has undergone a recent interaction or merger (Knapp, Turner & Cunniffe 1985).

However, because detectable amounts of HI are rare in elliptical and S0 galaxies, dedicated HI surveys of these galaxies are time–consuming and often unrewarding (unless one uses other clues, such as the presence of dust, to select promising targets). Previous analyses of the HI properties of early–type galaxies (e.g. Knapp et al. 1985, Wardle & Knapp 1986, Bregman, Hogg & Roberts 1992) have therefore had to rely on inhomogeneous compilations of data from the literature. The HI Parkes All–Sky Survey (HIPASS; Barnes et al. 2000) now covers the entire southern hemisphere and makes it possible to study the HI content of early–type galaxies in a systematic way, using a large and homogeneous data set.

2. The galaxy sample

The galaxy sample used in this analysis comprises the 526 E and 2026 S0 galaxies in the Third Reference Catalogue of Bright Galaxies (RC3; de Vaucouleurs et al. 1991) which have declinations south of 0°. About 90% of these galaxies now have measured optical velocities.

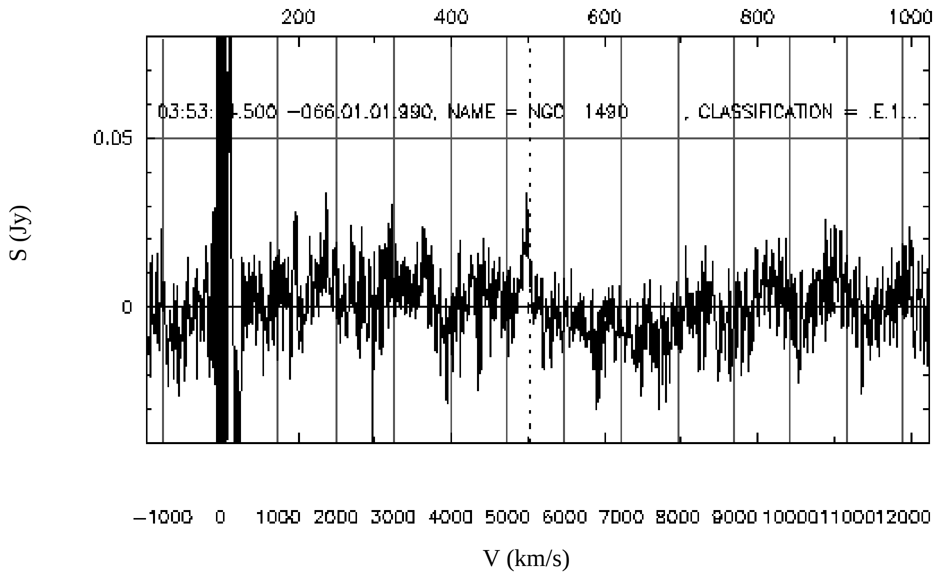

Figure 1. HIPASS spectrum at the position of the 13th magnitude elliptical galaxy NGC 1490, a new HI detection. The velocity range is -1280 to $+12{,}700\,\mathrm{km\,s^{-1}}$, and a vertical dashed line marks the galaxy's optical velocity of $5397\,\mathrm{km\,s^{-1}}$. The noise level for HIPASS spectra is typically 13 mJy rms. Galactic HI emission can be seen close to zero velocity.

Integrated HIPASS spectra at the position of each of these 2552 galaxies have been extracted from the HIPASS cubes and examined by eye for possible detections. Figure 1 shows a typical HIPASS spectrum.

3. First results

To date, about 1500 spectra have been inspected (RC3 S0s south of declination $-30°$ together with all the RC3 ellipticals). A galaxy was counted as an HI detection if (i) the measured HI velocity was close to the catalogued optical velocity, and (ii) the integrated HI flux was at least 2.6 Jy km $\mathrm{s^{-1}}$. This is a conservative set of requirements, and excludes some weaker detections which are almost certainly real. The detection rate for galaxies with velocities above than 6500 km $\mathrm{s^{-1}}$ was much lower than that for the rest of the sample, while galaxies with velocities less than 500 km $\mathrm{s^{-1}}$ can be lost in Galactic HI emission, so we restrict the discussion which follows to galaxies in the velocity range $500<\mathrm{V_h} < 6500$ km $\mathrm{s^{-1}}$.

Table 1 shows HIPASS statistics for the RC3 E/S0 galaxies examined so far. Half the elliptical galaxies whose spectra show HI emission have a nearby spiral companion with similar optical velocity, i.e. there is confusion in the 21 arcmin Parkes beam. For S0 galaxies, the confusion level is slightly lower at 35%. This high level of confusion is probably not surprising — we know that early–type

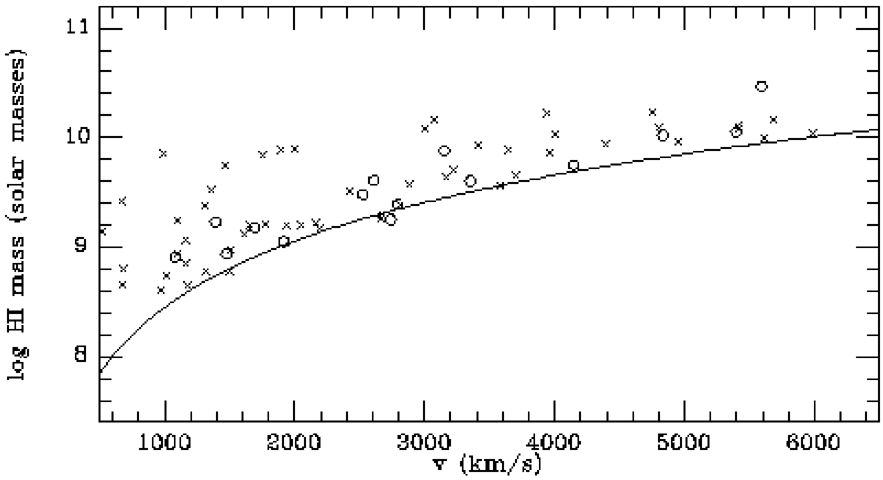

Figure 2. Plot of HI mass (for H_o=50 km s^{-1} Mpc^{-1}). versus recession velocity for galaxies with clear, unconfused HIPASS detections. Open circles show elliptical galaxies, and crosses S0s. The solid line corresponds to the adopted detection limit of 2.6 Jy km s^{-1}.

galaxies tend to be strongly clustered, and since many of those with HI are believed to have acquired it in a recent interaction or merger (e.g. Knapp et al. 1985), we might expect gas–rich groups to be the best place to detect HI–rich E/S0 galaxies. For the confused detections, follow–up synthesis observations will be needed to sort out the HI distribution. If we leave out all the confused detections and consider only galaxies with unambiguous HIPASS detections, we have a minimum HI detection rate of 5% and 12% for RC3 elliptical and S0 galaxies respectively.

Figure 2 shows the distribution of HI mass in the 72 unconfused HIPASS–detected galaxies measured so far. The detection limits are typically a few times 10^9 $M_\odot$, so these are relatively gas–rich galaxies. We find a significantly higher detection rate for low–luminosity galaxies (22±5% for $-18 > M_B > -20$) than for more luminous ones (10±2% for $M_B < -20$), in line with earlier findings that low–luminosity E/S0 galaxies are often HI–rich (e.g. Lake & Schommer 1984; see also Oosterloo, Morganti & Sadler, this meeting).

4. What next?

For a proper statistical analysis of this dataset, we need follow–up HI synthesis images to sort out the 'confused' HIPASS detections by determining how much flux originates from each of the galaxies in the Parkes beam. This should be reasonably straightforward, though it will require HI imaging of at least 75–80 fields with the VLA or ATCA. Once this has been done, we will have uniform

Table 1. HIPASS detections so far (RC3 galaxies with $500 < V_h < 6500$ km s^{-1})

	E	S0
Galaxies searched	302	516
HI detections:		
Already known	3	15
New	12	42
Confused	15	30
Total HI det.	30	87

data (detections or upper limits) on the HI content of some 2500 early–type galaxies. We expect to detect HI in at least 150 of these, of which ∼80% should be new detections.

The results presented above are based on bright catalogued galaxies, but optical galaxy catalogues are strongly biased towards optically–luminous objects (the well–known Malmquist bias). Automated galaxy finders (see the paper by Koribalski at this meeting) should eventually detect many uncatalogued galaxies in the HIPASS data cubes. Predictions based on the optical luminosity function and the HI detection rate for low–luminosity galaxies (Sadler 1997) suggest that as many as 100–150 uncatalogued HIPASS detections are likely to be low–luminosity E/S0 galaxies with apparent magnitudes in the range B=15–18. By combining these with the RC3 sample, we will be able to study the HI content of early–type galaxies over a wide range in optical luminosity.

In summary, HIPASS provides a unique data set which is large enough to derive a reliable HI mass function for nearby elliptical and S0 galaxies; to explore the effects of environment (e.g. local galaxy density) on gas content; and to identify a large set of suitable objects for follow–up dynamical studies.

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