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Radio Observations of AGN in Low Surface Brightness Galaxies

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Abstract. We present preliminary results of a study of the low frequency radio continuum emission from the nuclei of Giant Low Surface Brightness (LSB) galaxies. We have mapped the emission and searched for extended features such as radio lobes/jets associated with AGN activity. LSB galaxies are poor in star formation and generally less evolved compared to nearby bright spirals. This paper presents low frequency observations of 3 galaxies; PGC 045080 at 1.4 GHz, 610 MHz, 325MHz, UGC 1922 at 610 MHz and UGC 6614 at 610 MHz. The observations were done with the GMRT. Radio cores as well as extended structures were detected and mapped in all three galaxies; the extended emission may be assocated with jets/lobes associated with AGN activity. Our results indicate that although these galaxies are optically dim, their nuclei can host AGN that are bright in the radio domain.

Keywords. galaxies: spiral, galaxies: active, galaxies: individual (PGC 045080, UGC 1922, UGC 6614), galaxies: jets, galaxies: nuclei

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1. AGN in Giant LSB Galaxies

LSB galaxies have diffuse stellar disks, large HI gas disks and low metallicities (Impey & Bothun 1997). Although rich in gas they are poor in star formation and appear less evolved compared to bright galaxies. Their lack of evolution may be due to the presence of massive dark halos that inhibit the formation of disk instabilities such as bars and spiral arms, which can trigger star formation activity in galaxies. Active Galactic Nuclei (AGN) have been detected at optical wavelengths in several bulge-dominated giant LSB galaxies (Sprayberry et al. 1993; Schombert 1998). This is suprising as AGN are generally associated with bright, star forming galaxies (Ho, Philipenko & Sargent 1997). Not much is known about the radio continuum emission from LSB galaxies. Several giant LSB galaxies such as UGC 1922 are bright in the NVSS VLA survey at 1.4 GHz (Condon et al. 1998), and a millimeter continuum source was detected in UGC 6614. These observations suggest that AGN in giant LSBs have properties similar to those found in bright galaxies even though the galaxy evolutionary histories are very different.

2. Galaxy Sample

This poster presents preliminary results of a larger study of giant LSB galaxies using the GMRT. (i) PGC 045080 is close to edge on and fairly distant ($v_{sys} = 12,264$ km s^{-1}). Early optical studies did not detect an AGN in this galaxy (Sprayberry et al. 1993) but weak AGN activity may be present (Das et al. 2007). The galaxy is poor in star formation, fairly isolated and has a lopsided, massive HI disk. (ii) UGC 1922 has a bright nucleus or bulge and a very low surface brightness disk. It is also fairly distant ($v_{sys} = 10,894$ km s^{-1}). It is one of the rare LSB galaxies that have been detected in CO and there is a significant concentration of molecular gas in the galaxy nucleus (O'Neil & Schinnerer 2003). The galaxy hosts an AGN that is visible in optical emission as well as radio continuum. (iii) UGC 6614 is a relatively nearby LSB galaxy ($v_{sys} = 6,351$ km s^{-1}).

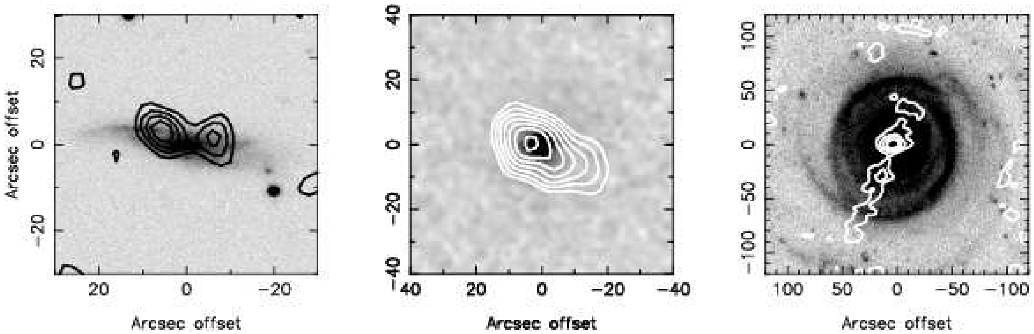

Figure 1. The panel shows 610 MHz observations of all three galaxies. From left to right (a) PGC 045080: Contours levels are 2, 3, 4, 5 times the noise level where the map noise is $\sigma = 0.12\ mJy\ beam^{-1}$ and beam is $7''$; (b) UGC 1922: Contours levels are 12, 14, 16, 18, 20, 22, and 24 σ where $\sigma = 0.49\ mJy\ beam^{-1}$ and the beam is $24''$; (c) UGC 6614: Contours levels are 3, 5, 7, 9 and 11 σ where $\sigma = 0.25\ mJy\ beam^{-1}$ and the beam is $15''$.

It is close to face on, has a prominent bulge and fairly distinct spiral arms that extend well into the disk. The AGN is visible in optical emission and appears as a compact core in the NVSS map and at millimeter wavelengths as well (Das et al. 2006).

3. GMRT Observations and Results

We observed all three galaxies from August, 2005 to March, 2006 using the GMRT, which is an array of thirty radio antennas arranged in a compact core and Y shaped configuration. (i) PGC 045080 was observed at 1.4 GHz, 610 MHz and 325 MHz (Das et al. 2007). The emission is extended and at 610 MHz appears to have two lobes associated with the nucleus (Figure 1a). The spectral index between 1.4 GHz and 325 MHz is α=-0.63 (where $S_\nu \propto \nu^\alpha$). (ii) The continuum emission at 610 MHz in UGC 1922 is also extended and the peak is offset from the galaxy center by a few arcseconds (Figure 1b). The spectral index between 1.4 GHz and 610 MHz is 3 suggesting that it may be a Giga-Hertz Peaked Spectrum (GPS) radio source. (iii) The 610 MHz continuum map of UGC 6614 reveals a radio jet that extends well into the disk (Figure 1c). One side appears brighter than the other and may represent the nearer jet. The core is bright and has a peak brightness of 3 mJy at 610 MHz. The spectral index is flat above 1.4 GHz but at 610 MHz is -0.53.

4. Conclusions

We have found extended radio continuum emission associated with AGN activity in 3 giant LSB galaxies. In at least two cases these represent radio jets/lobes. Thus though these galaxies are optically dim, their nuclei can host AGN and associated energetic activities.

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