The HI Surface Density in Low Surface Brightness Galaxies

J. M. VAN DER HULST
Kapteyn Astronomical Institute, Groningen, The Netherlands
E. D. SKILLMAN
Department of Astronomy, University of Minnesota, U.S.A.
G. D. BOTHUN
Department of Astronomy, University of Oregon, U.S.A.
and
T. R. SMITH
Department of Astronomy, University of Washington, U.S.A.

Abstract. The HI surface density of 8 low surface brightness galaxies falls below the critical density for star formation. This may explain why these galaxies appear so unevolved and are generally deficient in molecular gas.

Key words: low surface brightness galaxies, HI content of galaxies

Low Surface Brightnes (LSB) galaxies are galaxies whose light distributions are dominated by an exponential disk, with a central surface brightness at least 1.5 mag fainter than the canonical value of 21.6 mag arcsec $^{-2}$ exhibited by "normal" galaxies. One of the puzzling question regarding these objects is why they exhibit such a low current star formation activity despite their apparently large gas-to-star ratios. We observed 8 LSB galaxies in the 21-cm HI line at the VLA and briefly report the results here.

The HI distributions are fairly normal, but exhibit low peak column densities. Typical values are 4 - 6 $M_\odot$ pc^{-2}, a factor 2 lower than what is found in normal galaxies. The HI masses are, however, not abnormally low: the HI disks are simply extended. A comparison with optical diameters determined from radial surface brightness profiles shows that the HI to optical diameter ratios are systematically larger than found for galaxies with normal surface brightnesses.

We estimated rotation curves from velocity - position cuts along the major axis of the galaxies and calculated epicyclic frequencies as a function of radius. From these we evaluated the critical density for star formation as a function of radius following Kennicutt (1989). The observed HI surface densities fall below the critical density throughout the entire disk of the galaxies studied. This strongly suggests that the ISM does not fulfill the necessary conditions to sustain continuous, massive star formation, thus strengthening the idea that low surface brightness galaxies are objects in which active star formation ceased some few billion years ago. Moreover, it may be unlikely that molecular clouds can form under these low surface mass density conditions. This may explain the observations of Schombert et al. (1990) who noted significant CO deficiency in a sample of 12 LSB disk galaxies.

References

Kennicutt, R. C. 1989, Ap.J., **344**, 685.
Schombert, J. M., Bothun, G. D., Impey, C. D. and Mundy L. G. 1990, A.J., **100**, 1523.