A study of 2MASS Low Surface Brightness galaxies

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Abstract. A study is being made of a sample of about 4,000 Low Surface Brightness (LSB) galaxies detected in the 2MASS all-sky near-infrared survey. These objects have similar central K-band surface brighnesses as optically selected LSBs. About 1,000 of them were observed in H I, and one third of these were detected. BVRI CCD photometry was obtained of 65 objects. These multi-wavelength data provide us with important information on a large, homogenous sample of LSB galaxies (e.g., colors, gas content). They will be used to construct models of the star formation histories and evolution of LSBs, and for a study of their Tully-Fisher (TF) relation, particularly to search for deviations from the 'classical' TF relation.

Keywords: Galaxies: low surface brightness – Galaxies: Tully Fisher relation – Galaxies: near-infrared color – Radio lines: galaxies

Low Surface Brightness galaxies (LSBs) have remarkable properties which distinguish them from the more familiar 'classical' high surface brightness (HSB) objets, like: (1) they seem to constitute at least 50% of the total galaxy population in number, which has strong implications for the galaxy luminosity function, baryonic matter density and galaxy formation scenarios; (2) their disks are among the less evolved objects in the local universe; (3) they are embedded in dark matter halos which are of lower density and more extended than the halos around HSBs.

A generally used selection criterium to separate LSB from HSB galaxies is a central B-band surface brightness in the of 22 mag arcsec^{-2}, corresponding to about 18 mag arcsec^{-2} in the K-band - which is the selection limit we used in our near-infrared survey. Basically all previous studies of LSBs were made in the optical and most objects studied are blue. However, a class of rare, red (B-I$\sim$1) LSBs has been identified with hitherto unknown properties: record H I contents, $M_{HI}/L_B \sim 40 M_\odot/L_\odot$, and objects which do not follow the 'standard' Tully-Fisher relation at all.

In order to further investigate the often baffling properties of the LSB class of galaxies, we are at present undertaking the first large-scale study of LSBs selected in the near-infrared (J, H and K_s bands), using a homogeneous sample of about 4,000 potential LSBs selected from the Two Micron All Sky Survey (2MASS). We compared (see Fig. 1) some basic 2MASS photometric properties of the following subsets of our 2MASS LSB sample with those of other samples, of both LSB and HSB objects: (1) 2MASS L: our LSB galaxies from the 2MASS survey catalogue with a 20 mag arcsec^{-2} K_s-band isophotal radius $r_{k20} \geq 20''$; (2) 2MASS S: same, with $20arcsec \geq r_{k20} \geq 10''$, (3) 2MASS algo 2: 2MASS sources with lower surface brightness, extracted using a dedicated algorithm; (4) NGC L: "classical" HSB galaxies from the NGC, with $r_{k20} \geq 20''$; (5) NGC S: same, with $r_{k20} \leq 20''$; (6) LSB opt.: optically selected LSB galaxies from UK Schmidt plates (Impey et al. 1996; ApJS 105, 209), detected by 2MASS. These plots show that our 2MASS LSB sample has the same range of central surface brightness in the K_s band as the sample of optically selected LSBs.

We have observed a subsample of about 1,000 objects in the 21-cm H I line using the Nançay and Arecibo radio telescopes and we have clearly detected about one third of them. A first analysis of their Tully-Fisher relation has not shown any galaxies which are severly underluminous for their total mass. We have also obtained optical BVRI CCD photometry of about 65 objects at the San Pedro Martir Observatory. Models of the chemo-spectro-photometric evolution of LSBs are under development in collaboration with S. Boissier and N. Prantzos.

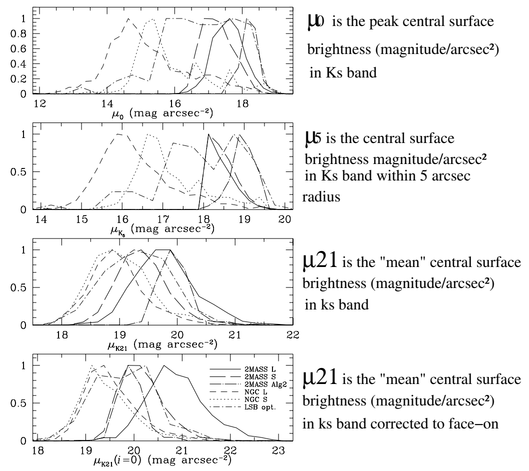

Figure 1. Comparison between the K_s-band surface brightness of subsets of our 2MASS LSB galaxies and those of other samples of LSBs and HSBs (see text). Plotted are: μ_0 is the peak central surface brightness (in mag arcsec^{-2}); μ_{K_5} is the mean central surface brightness within a radius of $5''$ around the source's center; μ_{K21} is the 'mean' surface brightness, within the 21 mag arcsec^{-2} isophote; μ_{K21}(i=0), same but corrected to face-on.