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MASSIVE LOW SURFACE BRIGHTNESS GALAXIES

by

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We have completed a multi-wavelength study of an extreme type of galaxy which will assist us in our attempts to understand the formation and evolution of galaxies. In particular, we have observed a subset of low surface brightness ($\overline{\mu}_B \gtrsim 25$ mag arcsec^{-2}), giant galaxies (LSBGs) which contain large amounts of atomic gas (M(H I) $\gtrsim 10^{10}$ $M_\odot$), have blue optical diameters similar to those of giant spiral galaxies ($D_{25} \gtrsim 30$ kpc), but which do not seem to have prodigious amounts of ongoing star formation. Our sample was drawn from the first and second Palomar Sky Surveys. This population of galaxies has been largely ignored because of selection effects which make it difficult to detect optically. We address the question of how these massive systems differ from the higher surface brightness 'normal' spiral galaxies. Using B and R surface photometry, in conjunction with Hα, H I, ^{12}CO and far-infrared data, we attempt to determine if these galaxies had an early epoch of star formation that has since faded, have ongoing star formation with an unusual IMF, or are perhaps galaxies which have never efficiently formed stars due to a lack of molecular clouds.
Preliminary results of our observations indicate that:

- LSBGs show a variety of optical morphologies, ranging from well-ordered spiral systems to patchy irregulars with no obvious nuclei.

- LSBGs in general have very blue disks ($< B - R > \sim 0.8$) relative to higher surface brightness, actively star-forming systems.

- LSBGs have $B - R$ color gradients ~ 0.5 mag in their disks in the sense that the disks get bluer with distance from the nucleus.

- LSBGs have little Hα emission, and H II regions which are present are weak, and generally far out in the disk.

- LSBGs have low metallicites, $\sim 1/5$ solar, but there has been some chemical enrichment.

- LSBGs have H I linewidths, which along with their optical images, suggest they have dynamical masses similar to high surface brightness giant spirals (HSBGs).

- LSBGs have H I fluxes similar to HSBGs with the same optical size, and the H I does not appear to extend well beyond the optical disk. Thus, they have H I surface densities which are $\sim 10^{21}$ atoms cm^{-2}, similar to HSBGs.

- LSBGs have little FIR and ^{12}CO emission.

- LSBGs have a significantly lower fraction of massive neighbors than do HSBGs.

We conclude that the evidence collected to date is inconsistent with a scenario of LSBGs as faded disk remnants. We suggest that LSBGs represent a population of galaxies which have had inhibited star formation and slowly evolving disks, perhaps due to their relative isolation in the universe. Thus, in a global context, star formation in disks is partly an environmentally driven phenomena. The determination of the true frequency and distribution of these systems is of interest, since they could represent a significant fraction of the baryonic matter in the universe.

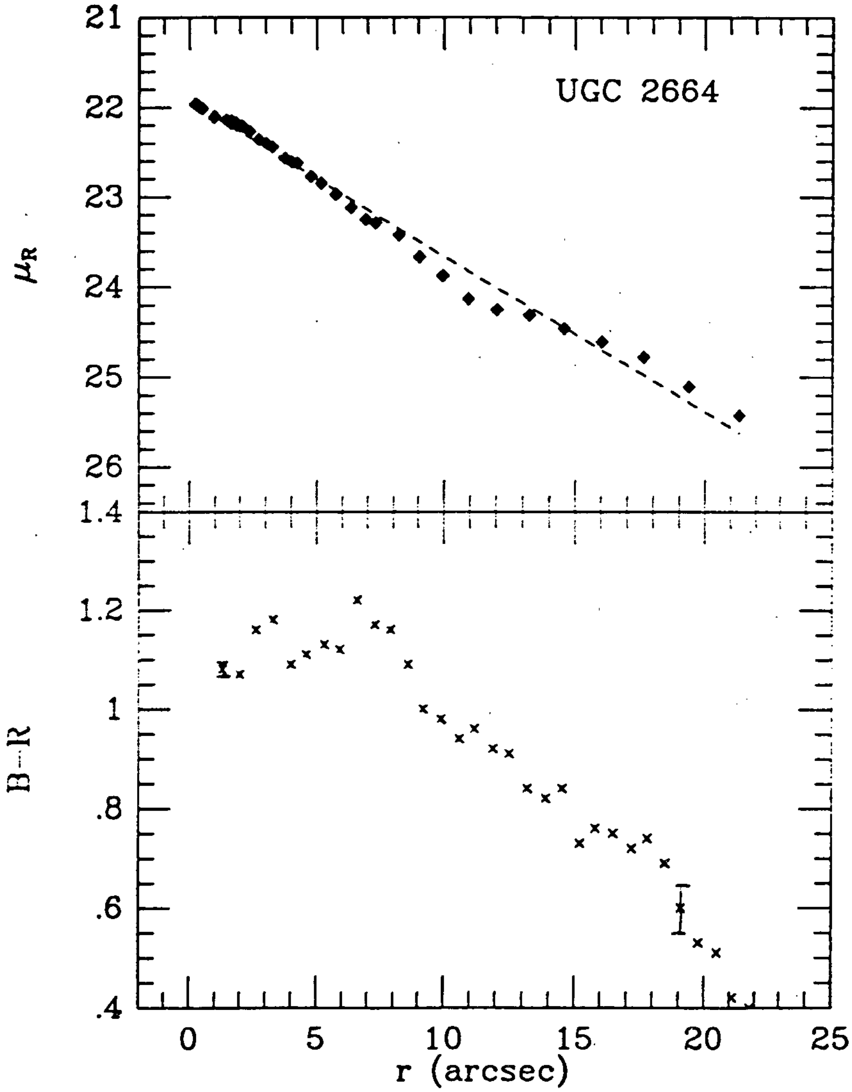

Figure 1 is the R surface brightness in mag/arcsec^{-2} vs. radius (top), and azimuthally averaged $B-R$ colors vs. radius (bottom) for the LSBG galaxy UGC 2664. The statistics for this galaxy are: $B_T = 18.0$:, $v_\odot = 6067\,\mathrm{km\,s^{-1}}$, $w_{50} = 147\,\mathrm{km\,s^{-1}}$, $M(\mathrm{H\,I}) \sim 10^{10}\,M_\odot$, $\mu_B \sim 27\,\mathrm{mag\,arcsec^{-2}}$, and $D_{25} \sim 50\,\mathrm{kpc}$. All of these numbers assume $H_0 = 50\ \mathrm{km\,s^{-1}}$ $\mathrm{Mpc^{-1}}$.