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An Imaging Survey of Nearby Spiral Galaxies

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Abstract.

We describe the progress of a large optical and near-infrared imaging study of a complete sample of 57 spiral galaxies. We have obtained B, I, K' and Hα imaging to map stellar populations and massive star formation (SF) across the arm and interarm regions, in order to study the distribution of mass and SF in these different and distinct environments. We briefly describe the background to our program, the sample selection, observations, and the reduction procedures. We present a K' image and preliminary radial profiles of the SABcd (SXT6) galaxy NGC 1042. SF appears to induce differences between the arm and interarm profiles, and to enlarge the scale length of the exponential disk of the galaxy.

1. Introduction

The disk is the fundamental entity with which to characterise disk galaxies, not just at the current epoch but also at significant lookback times. One of the defining parameters of an exponential disk is its scale length, which is assumed to trace the structure of the disk, and by implication its mass. From previous work on a handful of galaxies (Knapen & Beckman 1996; Beckman et al. 1996) the interarm radial behavior of the exponential disk was found to be similar to that of the complete disk, but that of the arms alone was strikingly different. The increase in scale length in the arms can be interpreted as being due to the influence of enhanced SF, and would thus imply that whole-disk scale lengths do not always trace the underlying mass distribution of the disk. If confirmed generally, this effect would raise important questions about the complete disk scale length used in many global studies. Building upon our previous work, we are now in the process of determining the scale lengths of the exponential disks of a statistically meaningful sample of spiral galaxies to determine, firstly, the "true" underlying disk scale length, and, secondly, how this "true" scale length is influenced by local enhancements in the SF rate.

2. Sample Selection

We extracted our sample (Table 1) from the list of approximately 580 galaxies selected by Elmegreen & Elmegreen (1987). Our sample of 57 galaxies can be considered statistically complete and representative, covering a range of morphological types, and whose arm classes (Elmegreen & Elmegreen 1987) range from flocculent to grand design.

Table 1. Spiral galaxy sample: NGC number and Hubble type from de Vaucouleurs et al. (1991)

NGC	Type	NGC	Type	NGC	Type	NGC	Type
210	SX3	3227	SX1	4254	SA5	5247	SA4
337A	SX8	3344	SX4	4303	SX4	5248	SX4
488	SA3	3351	SB3	4314	SB1	5334	SB5
628	SA5	3368	SX2	4321	SX4	5371	SX4
864	SX5	3486	SX5	4395	SA9	5457	SX6
1042	SX6	3631	SA5	4450	SA2	5474	SA6
1068	SA3	3726	SX5	4487	SX6	5850	SB3
1073	SB5	3810	SA5	4535	SX5	5921	SB4
1169	SX3	4030	SA4	4548	SB3	5964	SB7
1179	SX6	4051	SX4	4579	SX3	6140	SB6
1300	SB4	4123	SB5	4618	SB9	6384	SX4
2775	SA2	4145	SX7	4689	SA4	6946	SX6
2805	SX7	4151	SX2	4725	SX2	7727	SX1
2985	SA2	4242	SX8	4736	SA2	7741	SB6
3184	SX6						

3. Observations and Data Analysis

We obtained a complete set of B, I, Hα and K' images for our galaxies. The optical images were obtained either from the Isaac Newton Group (ING) data archive (about a third of the images), or from the ING's 1-m Kapteyn or 2.5m Newton Telescopes. The near-IR observations were made with the INGRID camera on the 4.2m Herschel Telescope for all except four galaxies. Their scale is $0.24''$ per pixel, giving a $4.1' \times 4.1'$ field of view. The K_s filter (central wavelength 2.150 μm) was used for these observations, and mosaics were made of the larger galaxies. As an example, we show in Fig. 1 the K' image of the SABcd galaxy NGC 1042. A complete description of the optical and near-IR data sets is forthcoming (J. H. Knapen et al., in preparation).

We developed a number of new IRAF scripts to combine the different images for each galaxy, made using different telescopes and cameras, into sets of images with identical pixel scale and orientation. We produced color index images, and, using IRAF's ELLIPSE task, fitted ellipses to make sets of radial profiles of

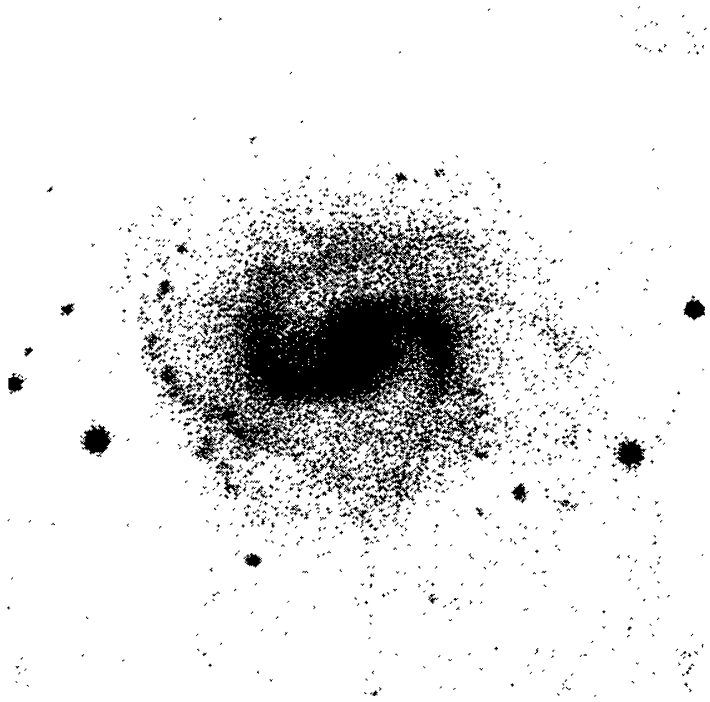

Figure 1. K'-band image of NGC 1042, obtained with the INGRID camera on the WHT. North is up, east to the left, and the area shown here is $4'$ on a side. The seeing was rather bad, about $2''$.

position angle (P.A.) and ellipticity (ϵ). The runs of P.A. and ϵ were then used to fix the ellipse-fitting parameters at each point of major changes across the disk. The ELLIPSE task was repeated to produce azimuthally averaged radial surface brightness profiles of each galaxy.

In order to determine the underlying mass distribution across the arm and interarm regions, we constructed a model of the smooth axisymmetric bulge and disk component from the isophotal brightness profile, and subtracted this from the original galaxy image. Masks were constructed to separate the arm and interarm regions for detailed radial-profile analysis of these regions. Using the parameters determined in the previous steps of the analysis, we ran ELLIPSE on the arm-only and interarm-only images to produce the full set of radial surface brightness profiles in all bands.

Figure 2 shows the set of radial profiles determined from our data for the SABbc (SXT6) galaxy NGC 1042. The most pronounced differences between the arm and interarm profiles, at $r \sim 40''$ and $80''$, coincide spatially with regions with enhanced SF at the end of the bar, and in the spiral arms. Figure 2 shows that the disk profile is also influenced by these SF regions, and that the disk scale length is in fact increased by the SF. Our sample will allow us to confirm and study this effect statistically.

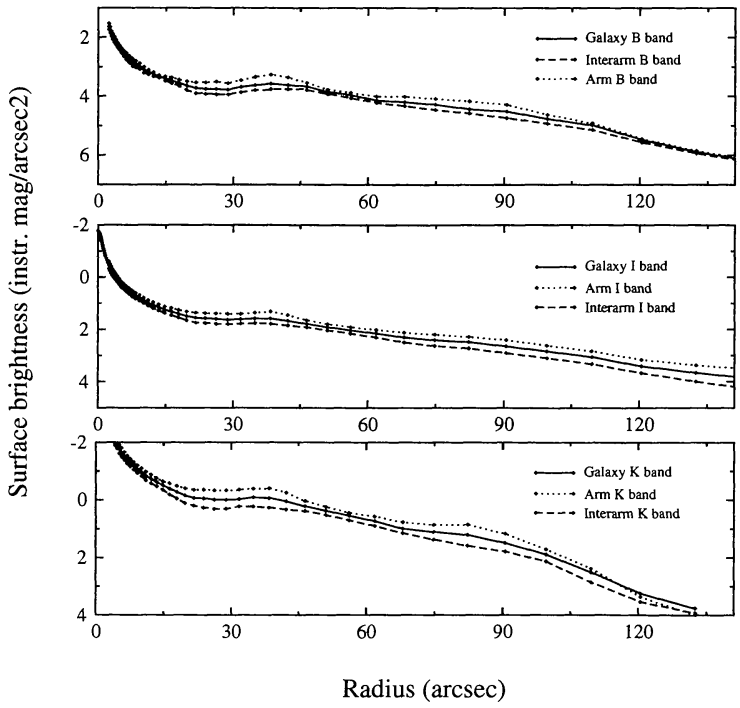

Figure 2. Radial, azimuthally averaged, profiles of P.A., ellipticity ϵ, and surface brightness, for the complete disk and for arm and interarm regions only, in the galaxy NGC 1042.

4. Conclusions

Our multiband imaging of a carefully selected sample of 57 spiral galaxies of all types will allow us to study the influence of SF on the exponential scale lengths of the disks and to correct the measured all-disk scale lengths for SF effects.

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