

SURFACE BRIGHTNESS DISTRIBUTION OF NGC 7755¹

Mun-Suk Chun and Seong-Min Sohn

Department of Astronomy and Atmospheric Science
Yonsei University, Seoul 120-749, Korea
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ABSTRACT

Isophote map and luminosity profile of the barred spiral galaxy NGC 7755 are obtained from PDS scanning of PAL 0-471 plate. From the isophote map, NGC 7755 can be classified SBbc(r) with asymmetric bar ring. We get several physical parameters (M_T^0 , $U(R)_{CB}$, $U(R)_{CD}$, D/B , C_{ij} , M/L) of NGC 7755 from the analysis of the luminosity distribution.

1. INTRODUCTION

Morphological classification of NGC 7755 was made as SAB by de Vaucouleurs *et al.* (1976) and SBb(r) by Sandage (1975). Sandage and Brucato (1979) confirmed the structure of bar and ring of this galaxy. Although NGC 7755 locates in the same direction of the Sculptor Group, it is not the member of the Sculptor Group when we consider the distance of this galaxy. Sandage estimated the distance of NGC 7755 as 59.4 Mpc while Bottinelli *et al.* (1984, 1985) assumed this distance as 26.2 Mpc from the observation of 21cm.

There are several HII regions in NGC 7755. The nuclei of NGC 7755 is classified as the stellar photoionization group and the HII region in the nuclei area is the result of hot stars in this region (V'eron-Cetty and V'eron 1986). Elmegreen and Elmegreen (1982, 1984, 1987) classified extra galaxies from the correlation between the morphology and spiral arm pattern. They classified NGC 7755 as the arm class 4 which has a single arm. This galaxy can be defined as the flacculent galaxy which has non-symmetric spiral arms. Usually this kind of galaxy has a small size diameter and a faint luminosity. Table 1 gives physical characters of NGC 7755.

¹이 연구는 연세대학교 1991년도 학술연구조성비로 수행된 것임.

Table 1. Physical parameters of NGC 7755.

Coordinate (1950)	R. A.	23 ^h 45 ^m .26	
	DEC	-30°47'.9	
	l	15°48	
	b	-75°68	
	SGL	262°.5	
	SGB	5°.9	
Morphological type	Hubble type	SBbc(r) (T=4)	(1)
Luminosity class	DDO type	L = 3	
Isophotal diameter	$\text{Log}D_{25}$	1.57±0.036	
Corrected diameter	$\text{Log}D_0$	1.57	
Axial ratio	$\text{Log}R_{25}$	0.10±0.032	
Corrected B magnitude	B_T^0	11 ^m 73	(1)
Absolute B magnitude	M_{BT}^0	-22 ^m 14	(1)
Inclination	i	38°	
Distance	D	59.4Mpc	(1)
Corrected recession velocity	V_0	299 km/s	(1)

- (1) A Revised Shapley-Ames Catalog of Bright Galaxies (Sandage and Tamman 1981). The others comes from the 2nd Reference Catalog of Bright Galaxies (de Vaucouleurs *et al.* 1976)

2. SURFACE BRIGHTNESS DISTRIBUTION

2.1 Reduction

Paloma Sky Survey 471 blue plate was scanned using PDS micrometer at the Mt. Stromlo Observatory. The plate scale is 67.7 arcsec mm^{-1} and the separation between the scanning points was 16 μm which is equivalent with 1.08 arcsec. The total scanning points were 1000 \times 1000 and the scanning aperture was 14 μm (0."95). The scanning speed was 40 PDS unit. All reductions were made using VAX/VMS computer at ANU.

2.2 Contour Map

Figure 1 is the contour map of NGC 7755 with the pixel coordinate 301 *times* 301 which is equivalent with 5'.43 \times 5'.43 area. This map is the intensity contour from the luminosity scale 0.6 to 7.68 with the interval 0.2. This contour map clearly shows non-symmetric bar structure and the elongated ring around the bar. NGC 7755 has single major arm and this arm is connected with the ring near the end of the bright bar.

Barred spiral galaxies usually have the axial ratio (a/b) of 1.1 to 3.7 with the average of 1.9. From the contour of NGC 7755 we can estimate the a/b of bar as 2.3. The inner ring

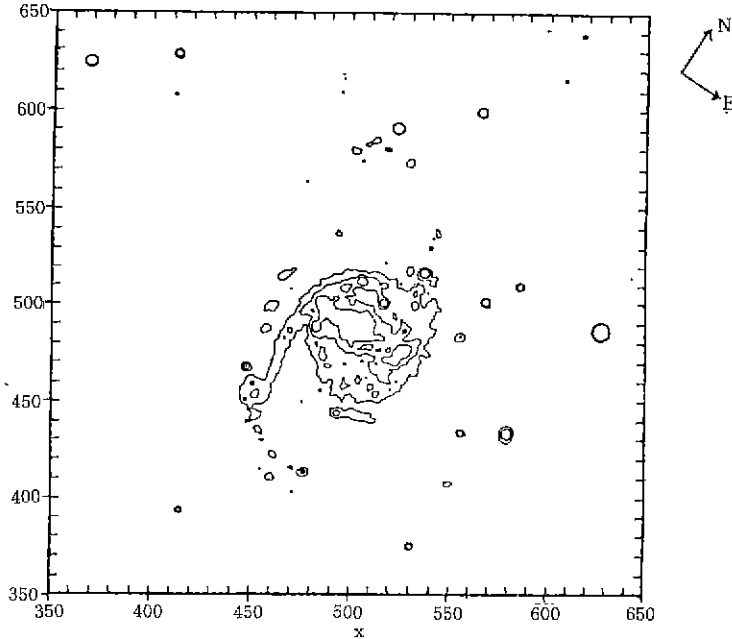


Figure 1. Contour map of NGC 7755.

structure of NGC 7755 is a common phenomenon of the late type spiral galaxy. The axial ratio of the inner ring was 0.9 which is identical to that of the normal barred spiral galaxy (Oldershaw 1985), and a long axis of the inner ring was positioned parallel to that of the bar (Athanasoula *et al.* 1982, Schwarz 1984). We measured the size of nuclear bulge as 0.4 arcmin which is equivalent to 6.9 Kpc, and the size of the bar as 1.24 arcmin (21.4 Kpc).

2.3 Surface Brightness Distribution

Surface brightness distribution to the radial distance in NGC 7755 was plotted in Figure 2. Surface magnitudes are the result of corrections of the galactic absorption, internal absorption and the effect of redshift (de Vaucouleurs *et al.* 1976). From this distribution we can see a steep decline of the nuclear bulge area, a flat bar region until $R = 0.61$ arcmin and a slight increase of the luminosity in the ring structure. The surface distribution in the bulge region indicates that NGC 7755 is the Freeman's (1970) type II galaxy group.

2.3.1 Nuclear Bulge

We have made a least square fitting of the surface luminosity distribution of the nuclear bulge to the de Vaucouleurs' $R^{1/4}$ law values in Figure 3. The size of the nuclear bulge was defined as $R = 0.19$ arcmin, which value comes from the radial distance to the point where the $R^{1/4}$ law is well fitted to the surface distribution. The central surface brightness was defined as $15^m76/\square''$ and the effective radius of the nuclear bulge was 0.1 arcmin where the brightness was $20^m29/\square''$.

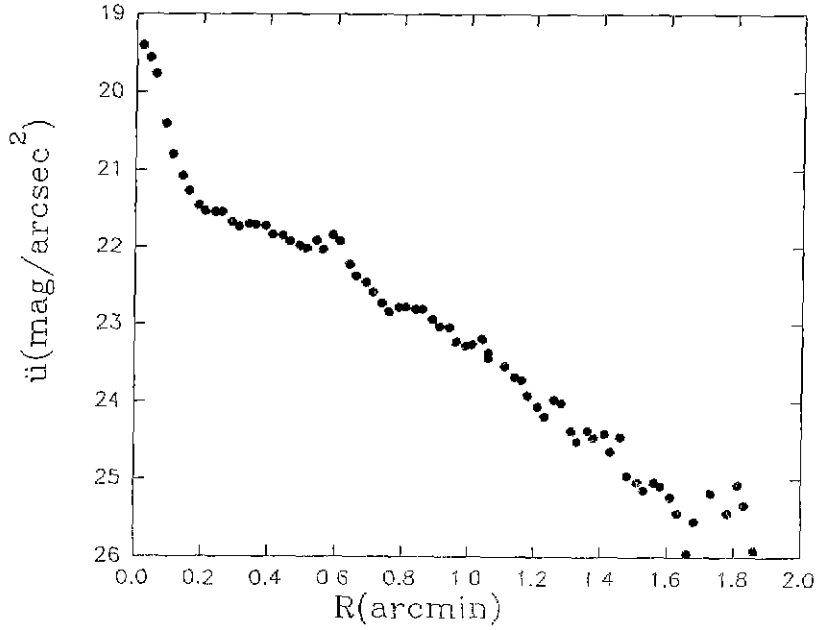


Figure 2. Surface brightness distribution to the radial distance in NGC 7755.

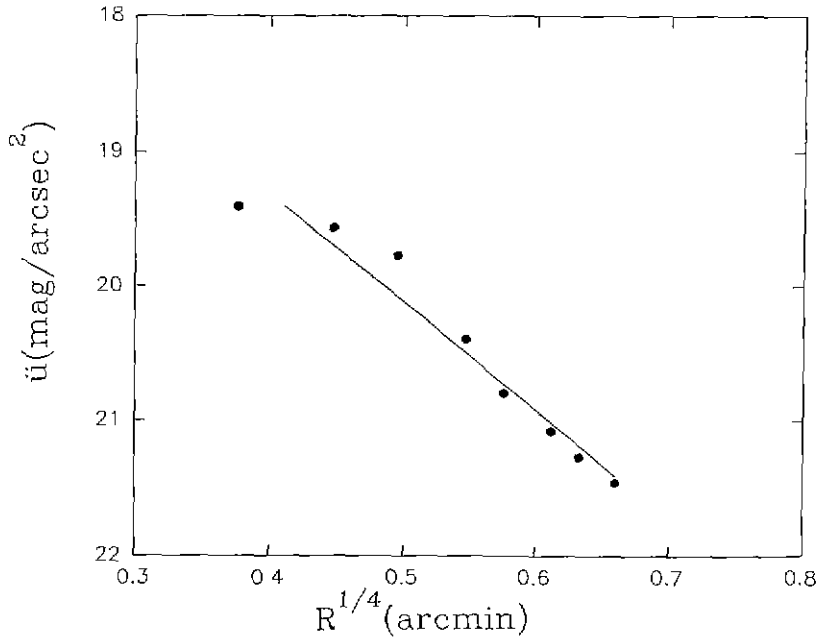


Figure 3. Fitting the de Vaucouleurs' $R^{1/4}$ law (solid line) to the observed surface brightness.

2.3.2 Disk Region

The radial surface brightness in the disk region of NGC 7755 can be expressed from the least square fitting as the equation of

$$U(R)_{CD} = 20.03 + 2.97R.$$

We plotted the fitting line and the observed surface magnitude (with filled circles) in Figure 4. From Figure 4 we estimated the central brightness of the disk as 20^m03 and the scale length as $\alpha^{-1} = 0'37$.

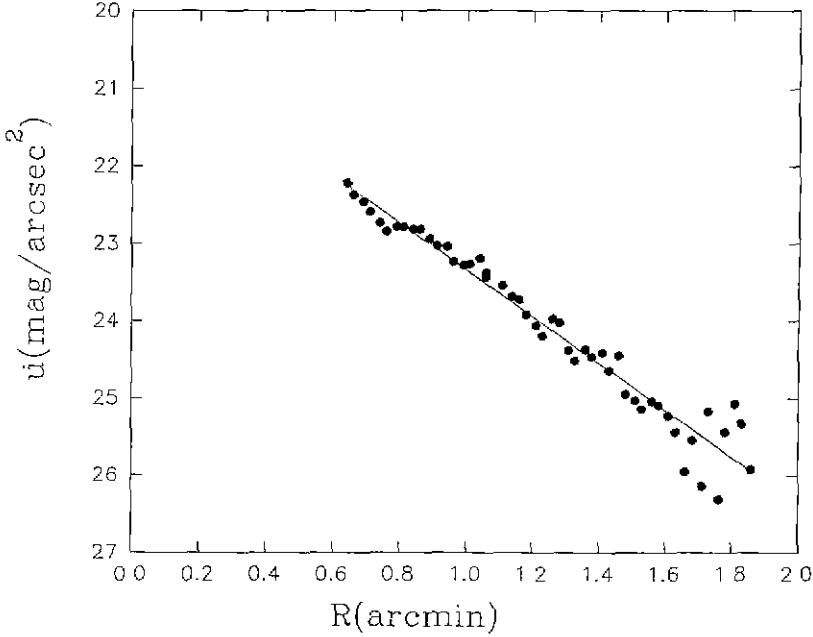


Figure 4. Fitting the disk region (solid line) to the observed surface brightness.

2.4 Physical Parameters

In Figure 5 we plotted the accumulated luminosity distribution to the equivalent radius of NGC 7755. The total magnitude to the isophotal radius was calculated as 11^m74 .

The total light fraction K can be defined as

$$K(R) = 10^{0.4[B_T^0 - B_T^0(R)]}$$

where B_T^0 is the total magnitude of a galaxy and $B_T^0(R)$ is the accumulated magnitude to the equivalent radius R . We plotted the total light fraction of NGC 7755 in Figure 6. Concentration index can be defined as

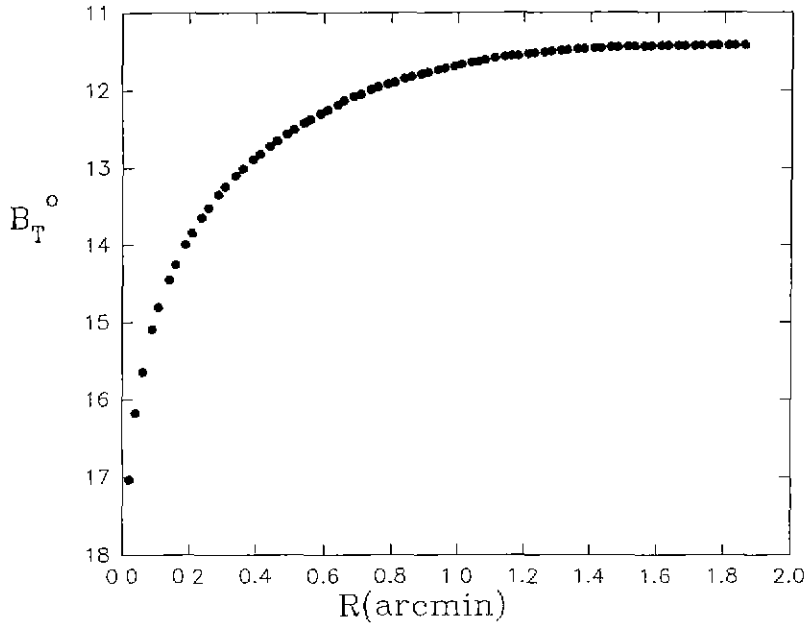


Figure 5. Accumulated luminosity distribution to the equivalent radius.

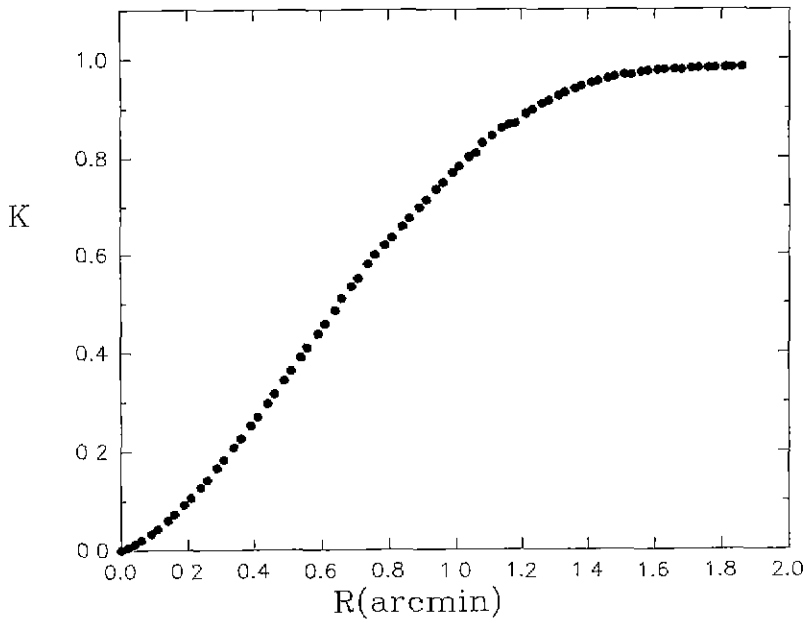


Figure 6. Total light fraction of NGC 7755.

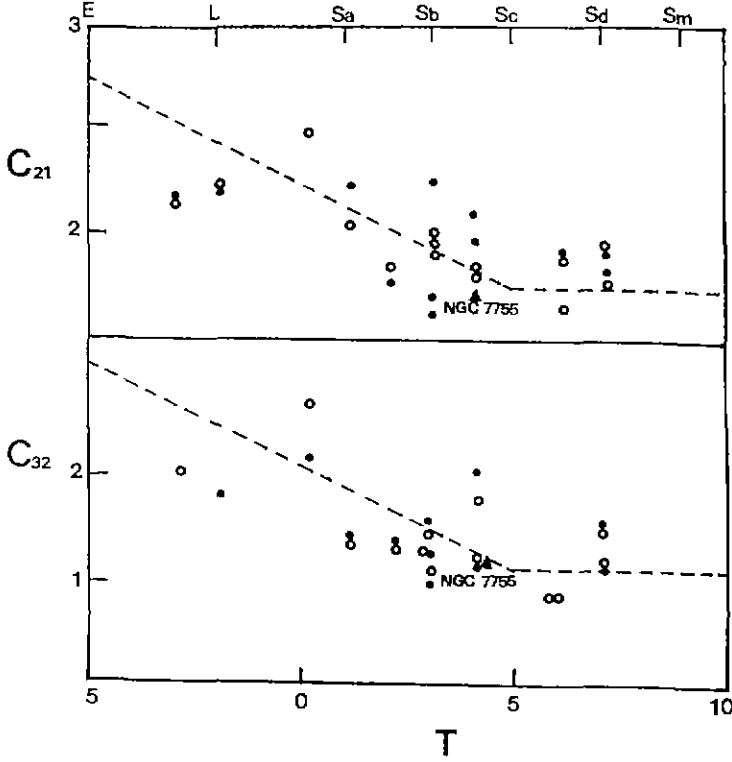


Figure 7. Concentric indices of NGC 7755 (filled triangle).

$$C_{ij} = R_i/R_j \quad i = 2, 3 \quad j = 1, 2.$$

R_1, R_2 and R_3 are the equivalent radii where K values are 0.25, 0.5 and 0.75. Calculated concentration indices are $C_{21} = 1.67$, $C_{32} = 1.57$ and $C_{31} = 2.62$ where the equivalent radii are $R_1 = 0.39$, $R_2 = 0.65$ and $R_3 = 1.02$. We plotted concentration indices of NGC 7755 versus stage along Hubble sequence in Figure 7. Here we can see that indices of NGC 7755 are well fitted to the mean line (plotted in dotted line).

The luminosity ratio of the nuclear bulge (B) to the disk (D) region can be defined as

$$D/B = \frac{1 - K_B}{K_B}$$

where K_B is the total light fraction of the nuclear bulge. D/B value of NGC 7755 was estimated as 8.08.

2.5 Decomposition

Decomposition of the luminosity distribution of the spheroidal and disk parts of NGC 7755 were made using methods described by many authors (Kormendy 1977, Burstein 1979, Boroson 1981, Blackman 1983, Nieto and Tiennot 1984). After decomposition we can get the correlation equations of luminosity of the nuclear bulge as

$$U(R)_{CB} = 14.86 + 11.72R^{1/4}$$

and the disk as

$$U(R)_{CD} = 20.06 + 3.20R.$$

After decomposition the effective radius R_e of the nuclear bulge becomes smaller as $0'.25$, and its luminosity is 23^m19 which is brighter than the before. However the effect of decomposition in the disk is marginal (central brightness is 20^m06 and α^{-1} is $0'.34$).

Figure 8 is the brightness distribution profile after decomposition. Filled circle represents the observed brightness, thin lines are the spheroidal and disk components and thick line represents the combined fitting surface brightness distribution.

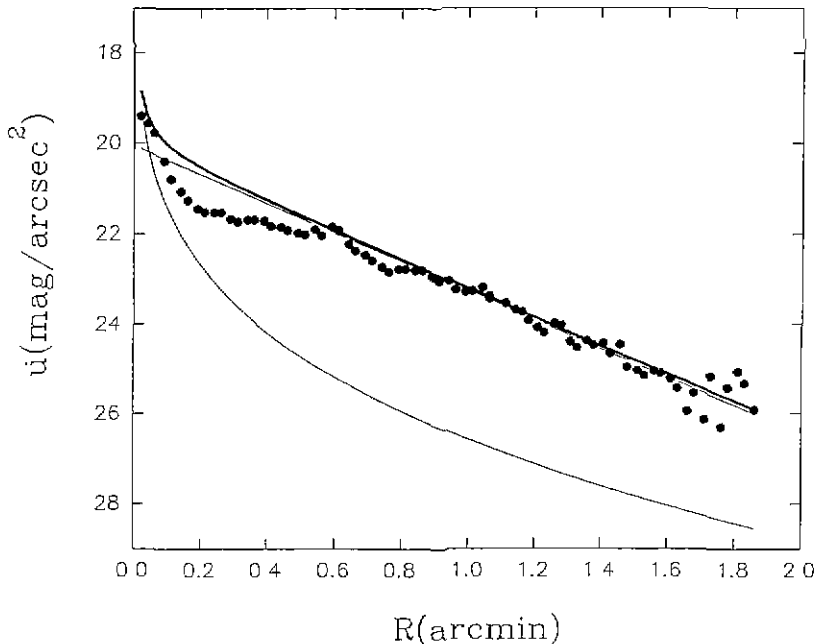


Figure 8. Radial brightness distribution profile after decomposition. Thin lines are fittings to the spheroidal and disk components and thick line represents the combined fitting surface brightness distribution.

is the combined model fitted one which is represented the surface brightness of NGC 7755. From this figure we can see that the luminosity profile of the spheroidal component becomes steeper and the central brightness of the disk component becomes brighter.

We calculated the D/B value of NGC 7755 as 5.23 using methods by Mihalas and Binney (1982), and Kormendy (1977).

3. CONCLUSION

From the PDS scanning of NGC 7755 plate we can get contour, density gray maps and a surface brightness distribution. Physical parameters were calculated using these observed materials. NGC 7755 can be classified as SBbc(r) from the bar and ring structures. The steep decline of the luminosity profile in the spheroidal component of NGC 7755 indicates that this galaxy is the typical Freeman's type II. The central brightness of the disk component is estimated as 20^m06 , which value is brighter than the Freeman's universal one. This difference may be the result of peculiar bar and ring structures of NGC 7755.

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