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RESEARCH ARTICLE

Detailed Surface Photometry of the Spiral Galaxies NGC 7339, NGC 7537, and NGC 7541

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Abstract

The results of analyzing BVRI CCD photometry of the spiral galaxies NGC 7339, NGC 7537, and NGC 7541 are presented using the observations acquired with the 1.88m Kottamia telescope (Egypt). The overall structure of the galaxies is analyzed together with isophotal contour maps. The surface brightness profiles of the galaxies are decomposed to bulge and disk components by fitting a de Vaucouleurs law for the bulge and an exponential law for the disk to obtain photometric parameters for each component. The corrected total and absolute magnitudes and integrated color are also obtained and found to be close to the published values. The radial profiles of ellipticity, major-axis position angle, and color are also obtained and discussed.

1 Introduction

Surface photometry represents one of the most important and powerful tools to study the properties of galaxies. In this technique, ellipses are fitted to the isophotes of the galaxy. The derived radial profiles of surface brightness (SB), ellipticity, position angle and color provide basic information about galaxies. The associated higher order Fourier coefficients from the fits reveal the intrinsic "boxy" or "disky" appearance of the isophotes which can be used to uncover underlying stellar disks.

In this paper, we present a detailed SB analysis for the three galaxies NGC 7339, NGC 7537, and NGC 7541. The basic parameters for both galaxies are listed in Table 1. In Sect. 2, we outline the observation, data reduction, and photometric calibration. The analysis and discussion of the results are given in Sec. 3. The conclusions are summarized in Sec. 4. Throughout the paper we use $H_0 = 75$ kms^{-1} Mpc^{-1}. Any parameter taken from the literature and depend on H_0 has been recalculated here using the later value.

2 Observations, Data Reduction and Photometric Calibration

2.1 Observations

BVRI CCD observations of the three spiral galaxies NGC 7339, NGC 7537, and NGC 7541 were obtained on October 15-18, 2012 at the Newtonian focus (f/4.84) of the 1.88 m telescope of Kottamia Astronomical Observatory (KAO), Egypt. The observations were taken using a back illuminated and coated e2v 4240 CCD chip with 2048×2048 pixels. The pixel size, scale and total field of view are 13.5 μm, 0.305" pixel^{-1}, and 10×10 arcmin^2 respectively. The filters used were a standard UBVRI Johnson photometric system. Table 2 gives information about the observations.

Table 1 Basic parameters of the studied galaxies.

Characteristics	NGC 7339	NGC 7537	NGC 7541
type	SAB(s)bc?	SAbc?	SB(rs)bc?pec
B_T^o, mag	12.08	12.69	11.57
M_{BT}^o,mag	-19.21[a]	-21.16[c]	-21.99[c]
V_{hel}, km/sec	1313±8	2674±4	2689±5
D, *Mpc* (H_0 =75 km s^{-1} Mpc^{-1})	22.4	35.5	32.5
d_{25},arcmin minor	2.8	2.1	3.4
d_{25},arcmin major	0.8	0.5	1.1
inclination, deg	75[b]	77[b]	68[b]
b/a	0.29	0.24	0.32
P.A., deg	93	79[a]	102
RA(2000)	22h 37m 47.2s	23h 14m 34.5s	23h 14m 43.9s
DEC(2000)	+23° 47' 12"	+04° 29' 54"	+04° 32' 04"

[a]RC3, [b]Bottinelli et al. 1986, [c]Condon et al. 1987

Table 2 Observation log, air masses and seeing value.

Date	Galaxy	Filter	Exposure(sec)	Air mass M(z)	Seeing(arcsec)
Oct.17, 18 2012	NGC 7339	B	1×900	1.008	1.9±0.04
		V	1×600	1.006	1.7±0.03
		R	1×600	1.006	1.6±0.02
		I	1×900	1.018	1.7±0.01
Oct.18, 19 2012	NGC 7537 NGC 7541	B	1×600	1.046	2.0±0.05
		V	1×600	1.111	1.9±0.10
		R	1×600	1.108	1.6±0.08
		I	1×600	1.107	1.6±0.08

2.2 Data Reduction

All raw images were overscan corrected, bias subtracted, and flat-fielded using the standard IRAF[1] tasks. For each night, 25 bias frames are taken and then median combined into a master bias frame using the ZEROCOMBINE IRAF task. The images were flat-fielded using dome images taken in all filters at the end of each night. The sky background level was determined using IMSTAT IRAF task by taking the mean of four or five 25×25 pixel regions free of sources. Field stars were masked.

2.3 Photometric Calibration

Photometric calibration was achieved using the Landolt UBVRI standard star catalog (Landolt 1992). The Landolt standard stars fields PG2213-006 is observed at different air masses during each night to calculate the extinction coefficients and the zero points on and hence transforming our system to the Standard Johnson photometric system.

The magnitudes are corrected for Galactic extinction (based on NED). Given the adopted distances to the galaxies from Tully et al. (2009), the image scales are 109, 172, and 158 pc/arcsec for NGC 7339, NGC 7537, and NGC 7541, respectively.

[1] http://iraf.noao.edu

The IRAF package is written and supported by the IRAF programming group at the National Optical Astronomy Observatories (NOAO) in Tucson, Arizona. NOAO is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation (NSF).

3 Analysis and Results

3.1 The Galaxy NGC 7339

NGC 7339 is a highly tilted spiral galaxy characterized by an elongated, though dusty core, with asymmetrical extensions that are brighter though shorter to the west, faint but longer to the east. Dust patches are seen throughout the disk and prominent dust lane is visible along the northern flank (Bratton 2011). It is accompanied by the galaxy NGC 7332 at a projected distance of 5.2'. A supernova (SN 1989 L) has been discovered in NGC 7339 (Barbon et al. 1999). NGC 7339 is classified as Sbc (Giovanelli et al. 1986 and Courteau 1996), whereas Héraudeau and Simien (1996) classified it as barred spiral SBb galaxy. The bulge of this galaxy is close to box-shaped, not elliptical, as reported by Lütticke et al. (2000). The basic parameters of NGC 7339 are listed in Table 1.

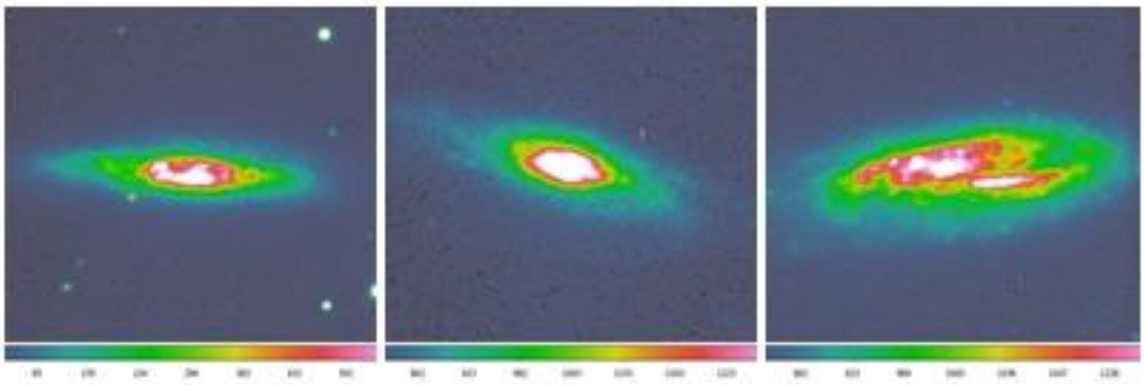

Fig. 1 Color display of the V-band images of NGC 7339 (left), NGC 7537 (middle) and NGC 7541 (right). North is up and East is at left.

3.1.1 Morphologies and Contour Maps of NGC 7339

The V-band image of NGC 7339 is displayed in Fig. 1 where it is clear that the galaxy has fragment, irregular and elongated central nucleus embedded in an nebulosity of size 22.9" × 6.1" with a position angle of about 85°. The galaxy is surrounded by a wounded spiral arms with size of 48.8" × 10.7". A trace of outer arms is also noticed with size of 73.2" × 18.3" nearly aligned EW.

The B, V, R and I isophotal contour maps of NGC 7339 are shown in Fig. 2 which reveal that the inner part is fragmented. The surface brightness levels are listed in Table 3.

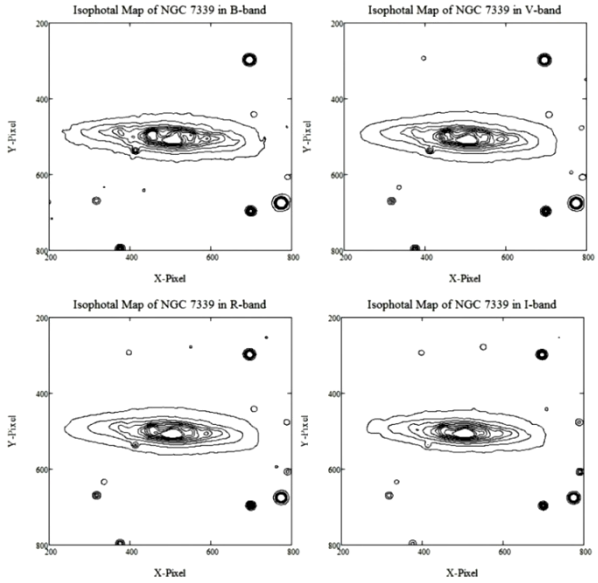

Fig. 2 Isophotal contour maps of NGC 7339 in BVR and I-bands.

Table 3 The SB of the outer isophot and the step between successive isophotes in each band for NGC 7339.

Band	SB(mag/arcsec^2)	Step(mag/arcsec^2)
B	24.251	0.998
V	23.141	1.103
R	22.905	1.15
I	22.175	1.007

3.1.2 Structural Profiles: Position angle, Ellipticity and B4 of NGC 7339

The position angle (P.A.), ellipticity (ε=1−b/a) and B4 (4th harmonic deviations from ellipse) of the galaxy isophotes were determined using the ellipse task of the STSDAS library in IRAF image-reduction system. The dependence of the position angle and ellipticity on the radius from the center of the galaxy is presented in Fig. 3a and b respectively. According to the present result, the position angle of the major axis of the galaxy grows smoothly from 72.4° near the center up to 99.25° at r=1.1", then decreases to about 83.56° at about 2.1", then increases to 90.6° at about 5.3" and then it becomes more or less flat (see Table 4 and Fig. 3a). Regardless the irregularity in the inner region, the P.A. profile of this galaxy looks consistent and steady in all bands especially for r > 11" (Fig.3a) with average value of 87.09±0.62° in the V-band.

Within the inner 5.0" region the ellipticity profiles of the galaxy fluctuate, followed by a small increase till r=10.0" and then became nearly flat in the outer parts with mean value of 0.74±0.029 (see Fig. 3b). This mean value of ellipticity is used to obtain the inclination of the disk from the equation of Lu (1998):

$$\cos^2 i = \begin{cases} \dfrac{(1-\varepsilon)^2 - 0.2^2}{1 - 0.2^2} & if\ \varepsilon \le 0.8, \\ 0 & otherwise. \end{cases} \qquad (1)$$

The inclination is found to be 81.1±3° at r > 10", (see Table 4). Determinations of the position angle (90°, 93°) and inclination (74°, 75°, 79°) of the galaxy by various authors (e.g., Giovanelli et al. 1986, Bottinelli et al. 1986, Persic et al. 1993, and see also NED) are in good agreement.

The B4 profile is presented in Table 4 and illustrated in Fig. 3c. The general trend of the galaxy is to be disky.

Table 4 Isophotal position angle and ellipticity for NGC 7339.

Band	r_1- r_2 (arcsec)	PA(°)	ε (1 – b/a)	Inclination(°)	r_1- r_2 (arcsec)	B4
B	9.86-45.389	86.9±0.569	0.75±0.029	81.5±3.1	11.57-45.389	-0.019
V	11.23-48.97	87.09±0.62	0.74±0.029	80.6±2.8	11.23-48.97	0.24
R	11.178-48.7	87.34±0.67	0.75±0.03	81.4±2.7	11.178-48.7	1.82
I	10.9-52.69	87.51±0.66	0.74±0.039	80.8±3.5	9.8-52.69	0.003
global value		87.2±0.63	0.75±0.03	81.1±3		0.51

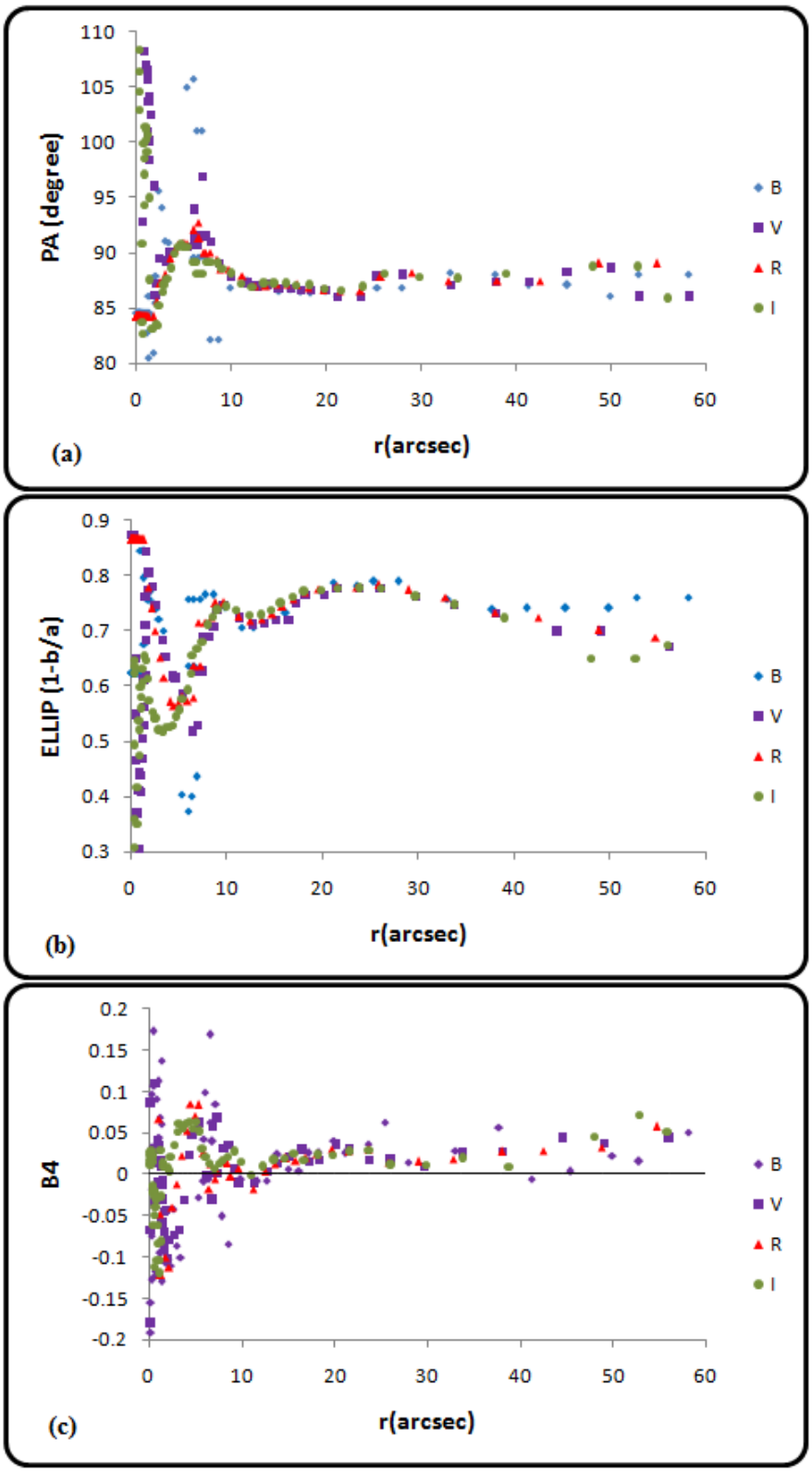

Fig. 3: Structural profiles of NGC 7339 in BVR and I-bands. (a) Position angle, (b) Ellipticity, and (c) B4 profiles.

3.1. 3 Luminosity Profile: Decomposition of NGC 7339

The B, V, R, and I luminosity profiles have been decomposed into the spheroidal ($r^{1/4}$) and disk (exponential) components using the technique of least square fitting. The results of the decomposition are given in Fig. 4 of B, V, R and I bands from upper left to right. The results are also summarized in Table 5. Because of the complex structure of the inner part of this galaxy, we are not able to fit the bulge component, so we only get the fitting parameters of the disk component (see Fig. 4 and Table 5).

The B-band luminosity profile shows the disk of this galaxy is of type I Freeman (Freeman 1970).

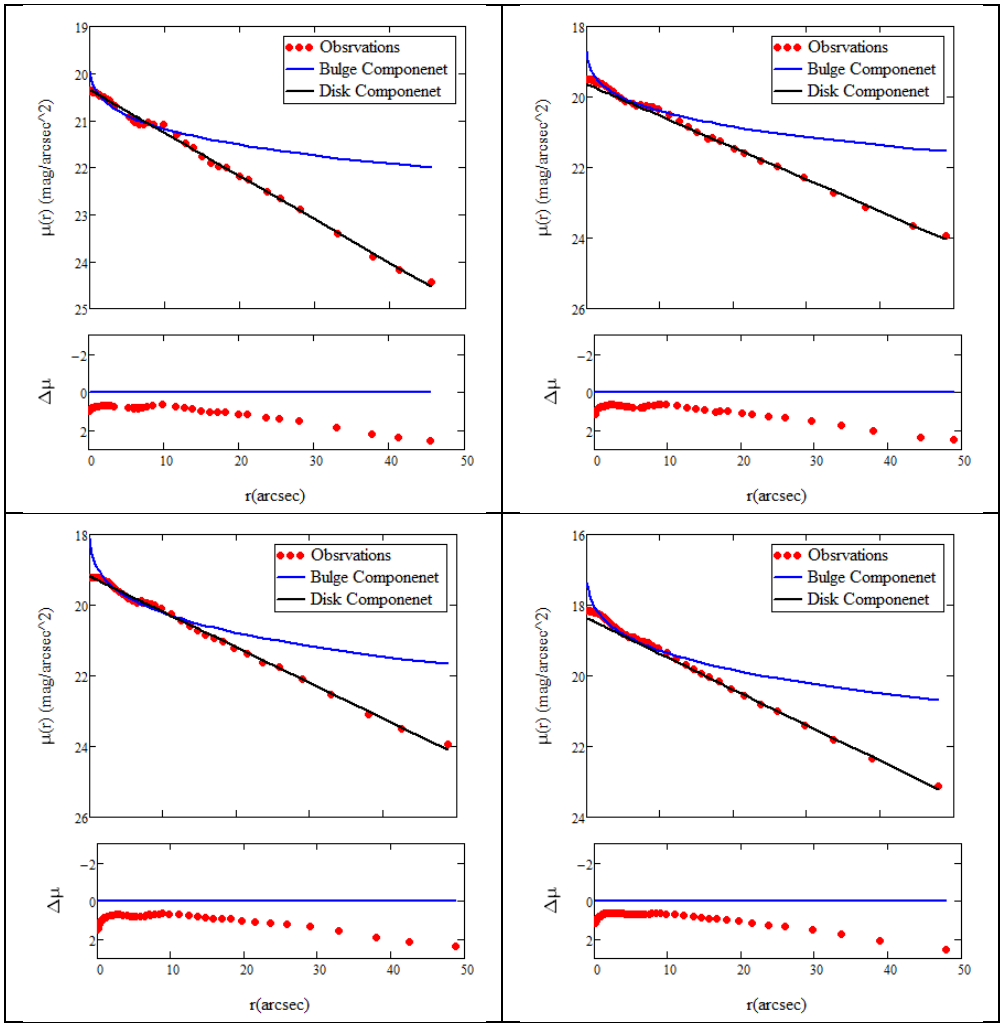

Fig. 4 Decomposition of surface brightness profiles of B, V, R and I-bands as well as the residual between the (Bulge + Disk) model and the observed data for NGC 7339 galaxy.

Table 5 Bulge and disk fitting parameters of NGC 7339.

Band	Disk			
	μ_0 (mag/arcsec^2)	r_0 (arcsec)	Standard error	LD_T (mag)
B	20.346	11.79	0.018	12.296
V	19.636	12.06	0.021	11.536
R	19.186	10.79	0.023	11.328
I	18.368	10.73	0.018	10.522

3.1.4 Color Profiles of NGC 7339

Profiles of the B−V, V-R, and R-I color indices, along the radius are shown in Fig. 5. This galaxy has a normal color distribution where the nuclear part ($r \leq 10''$) is red with $\langle B-V \rangle = 1.305 \pm 0.03$, $\langle V-R \rangle = 0.299 \pm 0.025$, and $\langle R-I \rangle = 0.574 \pm 0.057$. For the disk of this galaxy ($r > 10''$) $\langle B-V \rangle = 1.192 \pm 0.026$, $\langle V-R \rangle = 0.108 \pm 0.155$ and $\langle R-I \rangle = 0.362 \pm 0.129$.

The color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy (see Table 6).

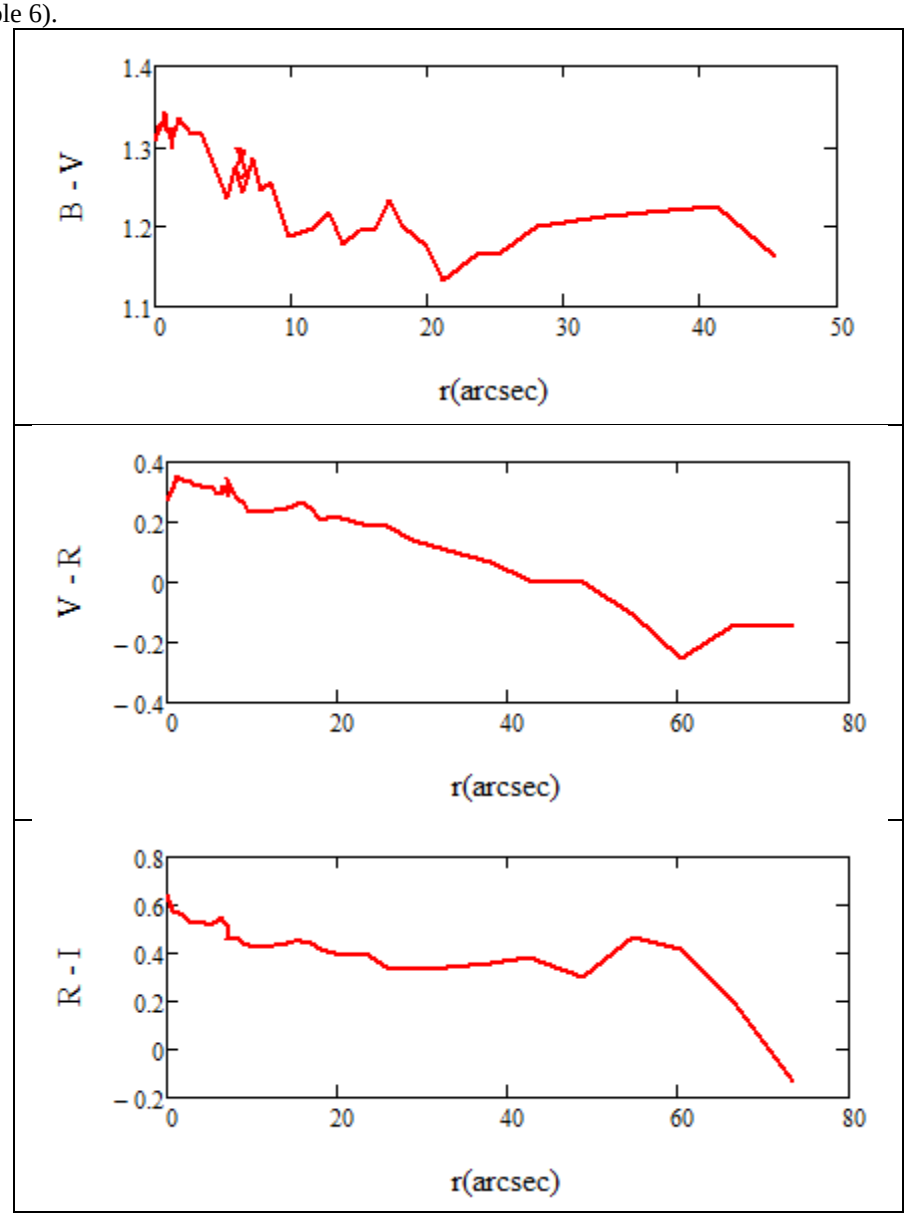

Fig. 5 B-V, V-R and R-I Color index profiles of NGC 7339.

Table 6 Color Profile of NGC 7339.

	Radius(arcsec)	Average value(mag)
B-V	45.388	1.278±0.056
V-R	73.319	0.245±0.121
R-I	52.695	0.514±0.127

3.2 The Galaxy NGC 7537

NGC 7537 galaxy is highly inclined spiral galaxy with a large, bright, elongated core and grainy spiral arms. Several dust patches and lanes are involved in the spiral structure. NGC 7537 is late-type galaxy having a well-developed disk and a prominent nucleus, no evidence has been found for appreciable noncircular gas motions in the galaxy. It is a fairly edge on, and multiarmed spirals, with a central bar. Further, the spiral arms are patchy with several discrete bright knots of emission along the arms. NGC 7537 has a strongly warped HI disk (Chengulur et al. 1994). The basic parameters of NGC 7537 are listed in Table 1.

3.2.1 Morphologies and Contour Maps of NGC 7537

Fig. 1 shows the V-band image of the galaxy, it is clear that the galaxy has an elongated central part of size about 10.7"×4.3" at position angle of about 77°. This central part is embedded in a disk of size (19.8"×7.6") at position angle 75° from which a trace of spiral arms is noticed. The B, V, R and I isophotal contour maps of NGC 7537 are shown in Fig. 6. The surface brightness levels are listed in Table 7.

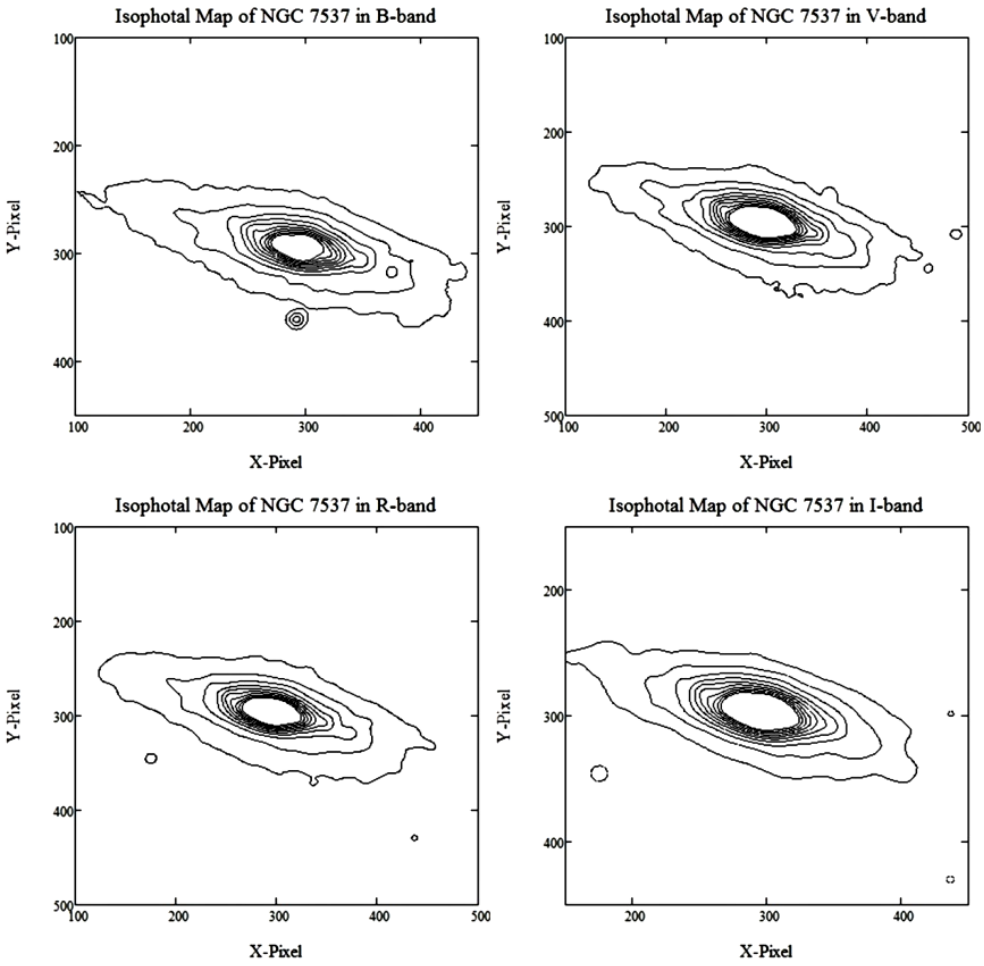

Fig. 6 Isophotal Contour Maps of the Spiral Galaxy NGC 7537 in BVR and I-bands, North is up and East is at left.

Table 7. The SB of the outer isophot and the step between successive isophotes in each band for NGC 7537.

Band	SB(mag/arcsec^2)	Step(mag/arcsec^2)
B	24.086	0.915
V	23.587	1.016
R	23.667	1.358
I	22.564	0.84

3.2.2 Structural Profiles: Position Angle, Ellipticity and B4 of NGC 7537

The position angle, ellipticity and B4 (4th harmonic deviations from ellipse) of the galaxy isophotes were determined and presented in Figs. 7a, b, and c respectively. The global value of the P.A. and ellipticity are found to be 76.4±2.33° and 0.6±0.05 respectively.

The position angle of the major axis of the galaxy is decreasing from 119° near the center to about 66° at 1.1", then increasing to 86° at about 2.5", and then decrease smoothly and become steady at 76.28°±2.6 (see Fig. 7 a).

Within the inner 3.6" region the ellipticity profile of the galaxy decreases to minimum of 0.19, then increases to about 0.52, and then increases steeply outward (see Fig. 7 b).

The inclination is calculated using equation (1) and found to have average value of 69.6±3.3° at r > 4", (see Table 8). Determinations of the position angle (77°-79°) and inclination (74°, 75°, 78°, 79°) of the galaxy by various authors (e.g., Condon et al. 1987, Lu 1998, Persic et al. 1993, Héraudeau and Simien 1996, Márquez and Moles 1996, and see also NED) are in good agreement.

The B4 profile is presented in Table 8 and illustrated in Fig. 7 c. The general trend of the galaxy is to be disky.

Table 8 Isophotal position angle and ellipticity for NGC 7537.

Band	**r_1- r_2 (arcsec)**	**PA(°)**	**ε (1-b/a)**	**Inclination (°)**	**r_1- r_2 (arcsec)**	B**4**
B	4.4-28.7	77.38±2.5	0.62±0.047	70.8±3.4	6.2-28.7	-0.007
V	3.93-37.5	76.28±2.6	0.6±0.046	69.1±3.3	5.69-37.5	0.014
R	4.29-32.5	76.15±2.06	0.6±0.04	69.3±3.07	4.68-24.34	0.014
I	3.55-29.8	75.7±2.16	0.6±0.05	69.2±3.6	3.9-29.8	0.015
global value		76.4±2.33	0.6±0.05	69.6±3.3		0.009

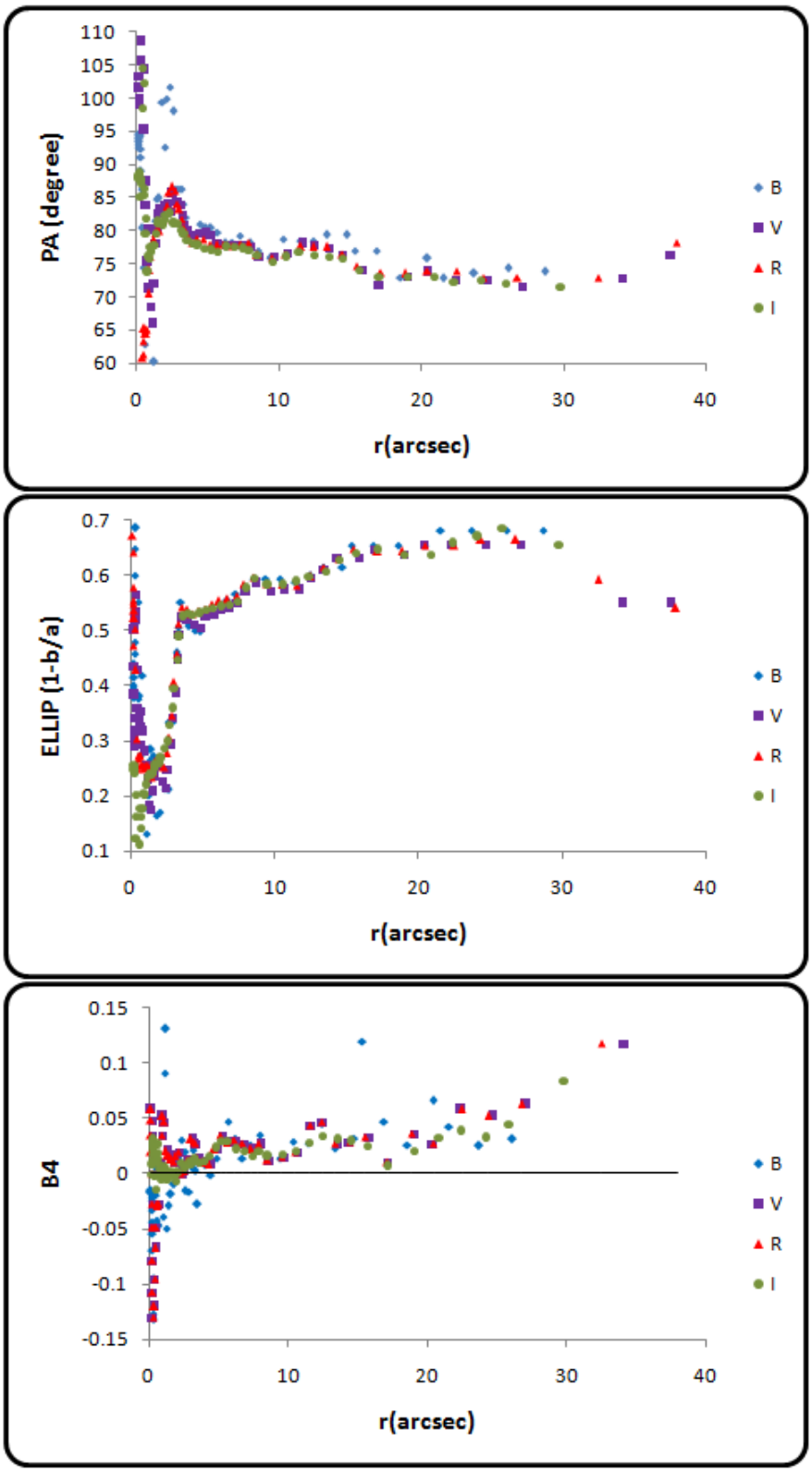

Fig. 7: Structural profiles of NGC 7537 in BVR and I-bands. (a) Position angle, (b) Ellipticity, and (c) B4 profiles.

3.2.3 Luminosity Profile: Decomposition of NGC 7537

The B, V, R, and I equivalent luminosity profiles have been decomposed into bulge ($r^{1/4}$ law) and disk (exponential) components using the technique of least square fitting. The results of the decomposition are given in Fig. 8 and also summarized in Table 9. The B-band luminosity profile shows the disk of this galaxy is of type I Freeman (Freeman 1970).

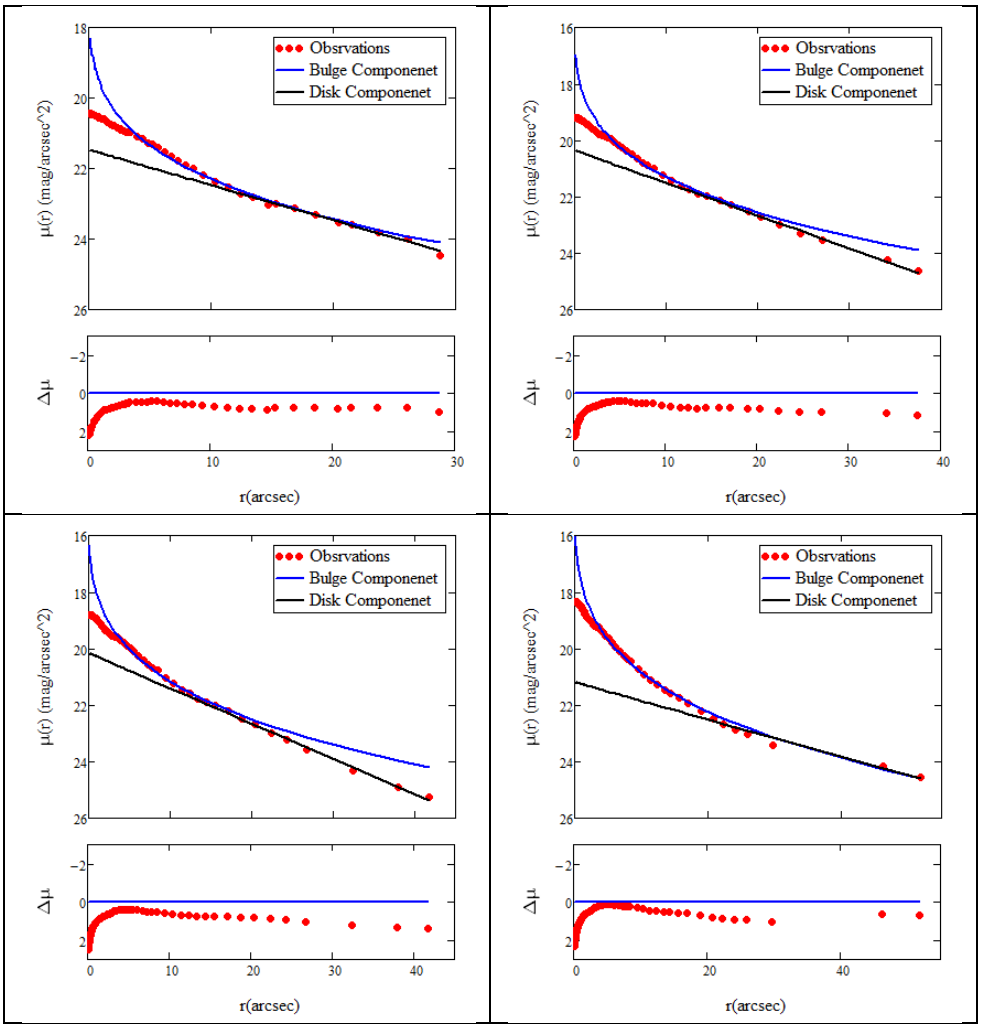

Fig. 8 Decomposition of surface brightness profiles of B, V, R and I bands as well as the residual between the (Bulge + Disk) model and the observed data for NGC 7537 galaxy.

Table 9 Bulge and disk fitting parameters of NGC 7537.

	Bulge				Disk				
Band	**range (arcsec)**	**μ_e (mag/arcsec^2)**	**r_e (arcsec)**	**Standared error**	**μ_0 (mag/arcsec^2)**	**r_0 (arcsec)**	**Standared error**	**LB_T (mag)**	**B/D**
B	3.303-13.387	24.593	36.469	0.029	21.471	10.873	0.028	13.394	1.205
V	3.34-13.446	23.016	25.052	0.028	20.361	9.394	0.023	12.634	1.169
R	3.28-15.495	22.365	18.705	0.028	20.163	8.715	0.029	12.616	1.151
I	3.354-17.056	21.812	16.411	0.026	21.197	16.48	0.068	12.348	1.068

3.2.4 Color Profiles of NGC 7537

The color index profiles, B−V, V-R, and R-I, as a function of radius are shown in Fig. 9. This galaxy has a normal color distribution where the nuclear part ($r \leq 5''$) is red with <B−V>= 1.217±0.058, <V−R> = 0.32±0.063, and <R−I>= 0.421±0.038. For the disk of this galaxy ($r > 5''$), the average color is <B−V> = 1.072±0.032, <V−R> = -0.016±0.17 and <R−I>= 0.314±0.02.

The color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy (see Table 10).

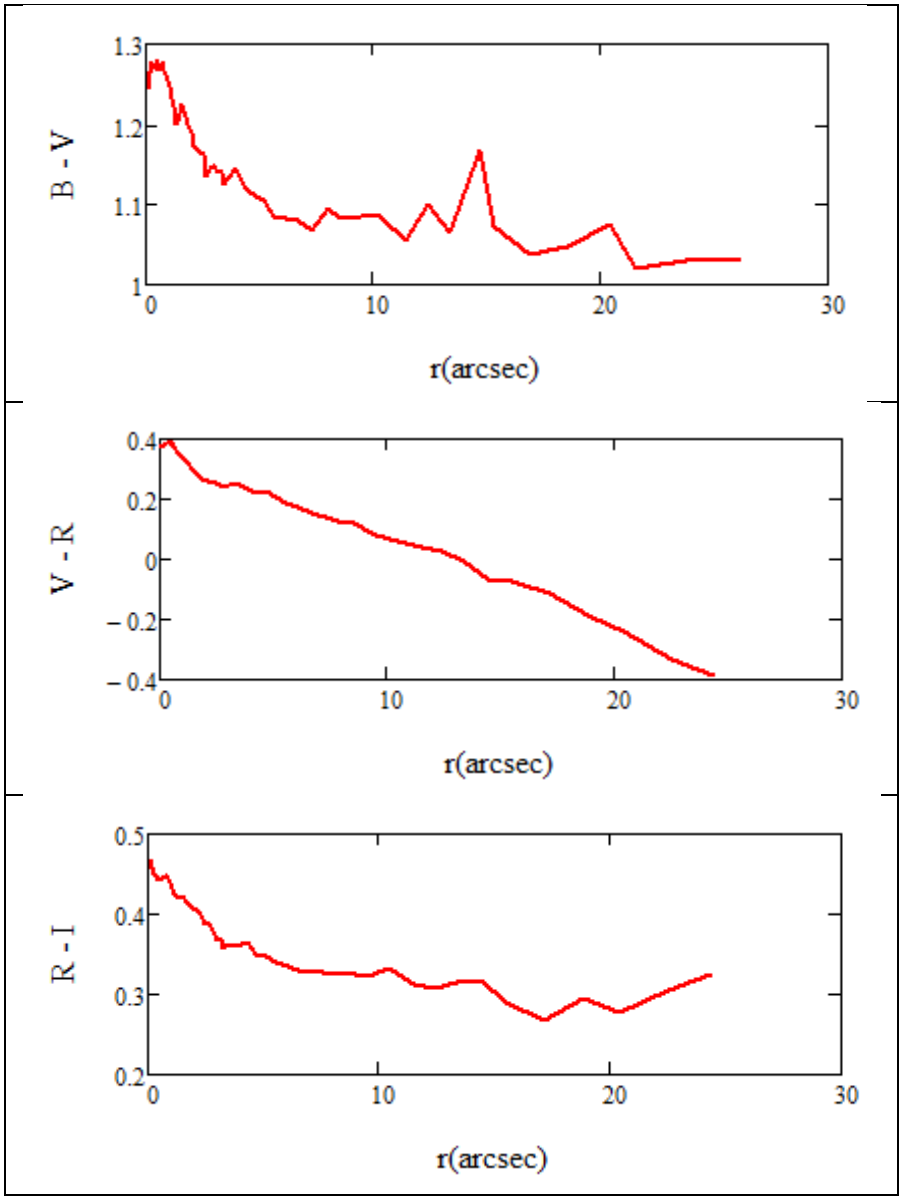

Fig. 9 B-V, V-R and R-I Color index profiles of NGC 7537.

Table 10 Color Profile of NGC 7537.

	Radius(arcsec)	Average value(mag)
B-V	26.1	1.171±0.085
V-R	24.339	0.217±0.189
R-I	24.339	0.389±0.06

3.3 The Galaxy NGC 7541

The spiral galaxy NGC 7541 is paired with NGC 7537 and has a similar radial velocity, so they are probably physically related but without evidence of tidal distortion. Images reveal a highly inclined spiral galaxy with a small core embedded in a bright spiral structure. NGC 7541 has a bright narrow bar: 0.55' x 0.5', many knotty, and filamentary arms with dark lanes (de Vaucouleurs & de Vaucouleurs 1964; Chengalur et al. 1994). NGC 7541 is nearly edge-on, with a strong absorbing lane in B, classified SB, but we see no evidence for a bar. Table 1 presents the basic parameters of NGC 7541.

3.3.1 Morphologies and Contour Maps of NGC 7541

Fig. 1 shows the V-band image of the galaxy, it is clear that the galaxy has a fragmented inner part but we can specify three fragmented regions, the size of the central one is about 5.5"×1.8". The most elongated one has a size 15.25"× 2.44" and is located to the SW of the central one. The third one has a circular shape of 6" diameter. The fragmented inner part is embedded in a disk of size 67"× 24".

The B, V, R and I isophotal contour maps of NGC 7541 are shown in Fig. 10. The surface brightness levels are listed in Table 11.

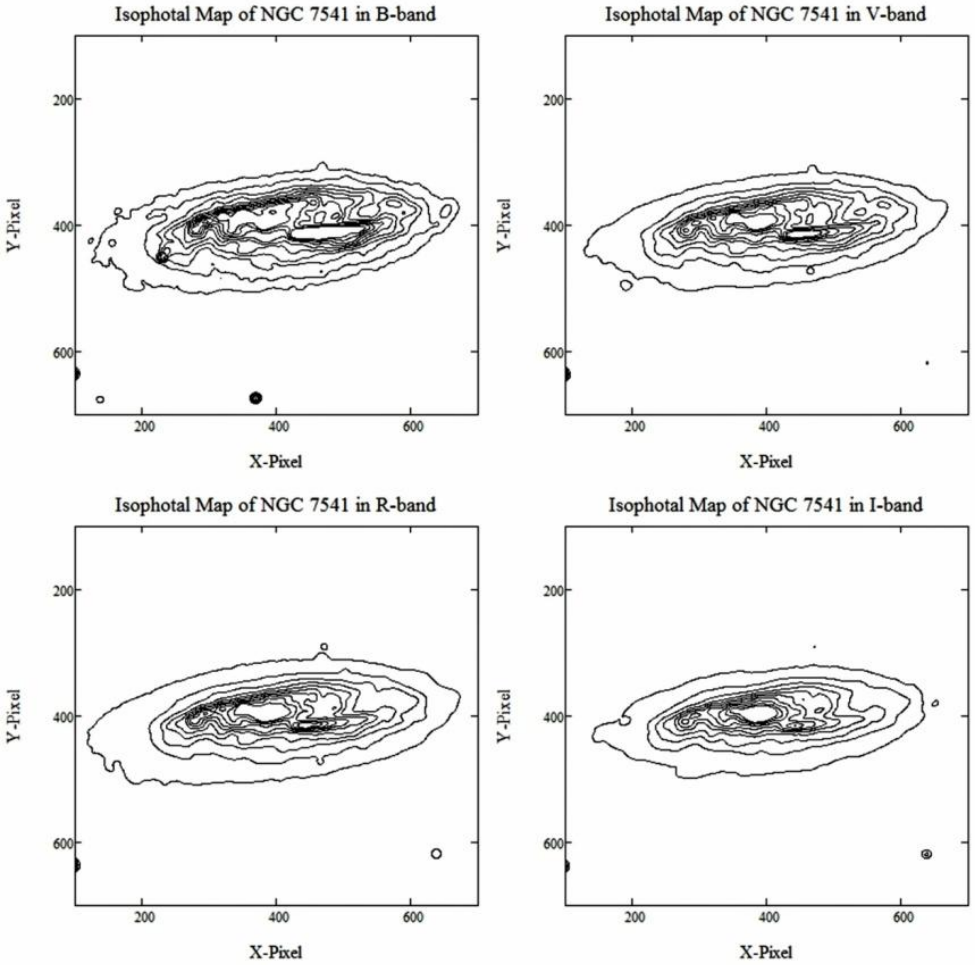

Fig. 10 Isophotal Contour Maps of NGC 7541 in BVR and I-bands, North is up and East is at left.

Table 11 The SB of the outer isophot and the step between successive isophotes in each band for NGC 7541.

Band	SB(mag/arcsec^2)	Step(mag/arcsec^2)
B	23.733	0.572
V	22.812	0.776
R	22.979	1.045
I	21.988	0.805

3.3.2 Structural Profiles: Position Angle, Ellipticity and B4 of NGC 7541

The position angle (P.A.), ellipticity (ε ≡1−b/a) and B4 (4th harmonic deviations from ellipse) of the galaxy isophotes were determined using the ellipse task of the STSDAS library in IRAF image-reduction system. The dependences of the position angle and ellipticity on the equivalent radius r(arcsec) from the center of the galaxy are presented in Fig. 11a and b respectively.

The global values of the P.A. and ellipticity are found to be 95.2±2.25° and 0.685±0.05 respectively. Within the 10" inner part, the position angle is fluctuating whereas it becomes steady outward (see Fig. 11a). Within the inner 7" region the ellipticity profiles of the galaxy fluctuate whereas in the outer parts it increases gradually (see Fig. 11 b).

The fluctuation in the inner part may be due to the fragmentation of the inner region. The inclination is calculated from equation (1) and found to have a global value of 76.1±3.95° at r > 17" (see Table 12). Determinations of the position angle (95°, 100°,102°) and inclination (72°, 74°, 79°) of the galaxy by various authors (e.g., Condon et al. 1987, Lu 1998, Persic et al. 1993, Héraudeau and Simien 1996, Márquez and Moles 1996, and see also NED) are in good agreement.

The B4 profile is presented in Table 12 and illustrated in Fig. 11 c. The general trend of the galaxy is to be disky.

Table 12 Isophotal position angle and ellipticity for NGC 7541.

Band	**PA(°)**	**r_1- r_2 (arcsec)**	**ε (1-b/a)**	**Inclination (°)**	**r_1- r_2 (arcsec)**	B**4**
B	95.6±3.4	22.45-68.6	0.66±0.06	73.7±4.7	22.45-68.6	0.56
V	95.03±1.78	19.3-53.11	0.7±0.04	76.9±3.3	19.3-53.11	-0.01
R	94.8±2.3	16.5-53.9	0.7±0.05	78.6±4.4	16.5-53.9	-0.005
I	95.4±1.53	16.5-61.02	0.68±0.04	75.2±3.4	25.04-61.02	0.052
global value	95.2±2.25		0.685±0.05	76.1±3.95		0.15

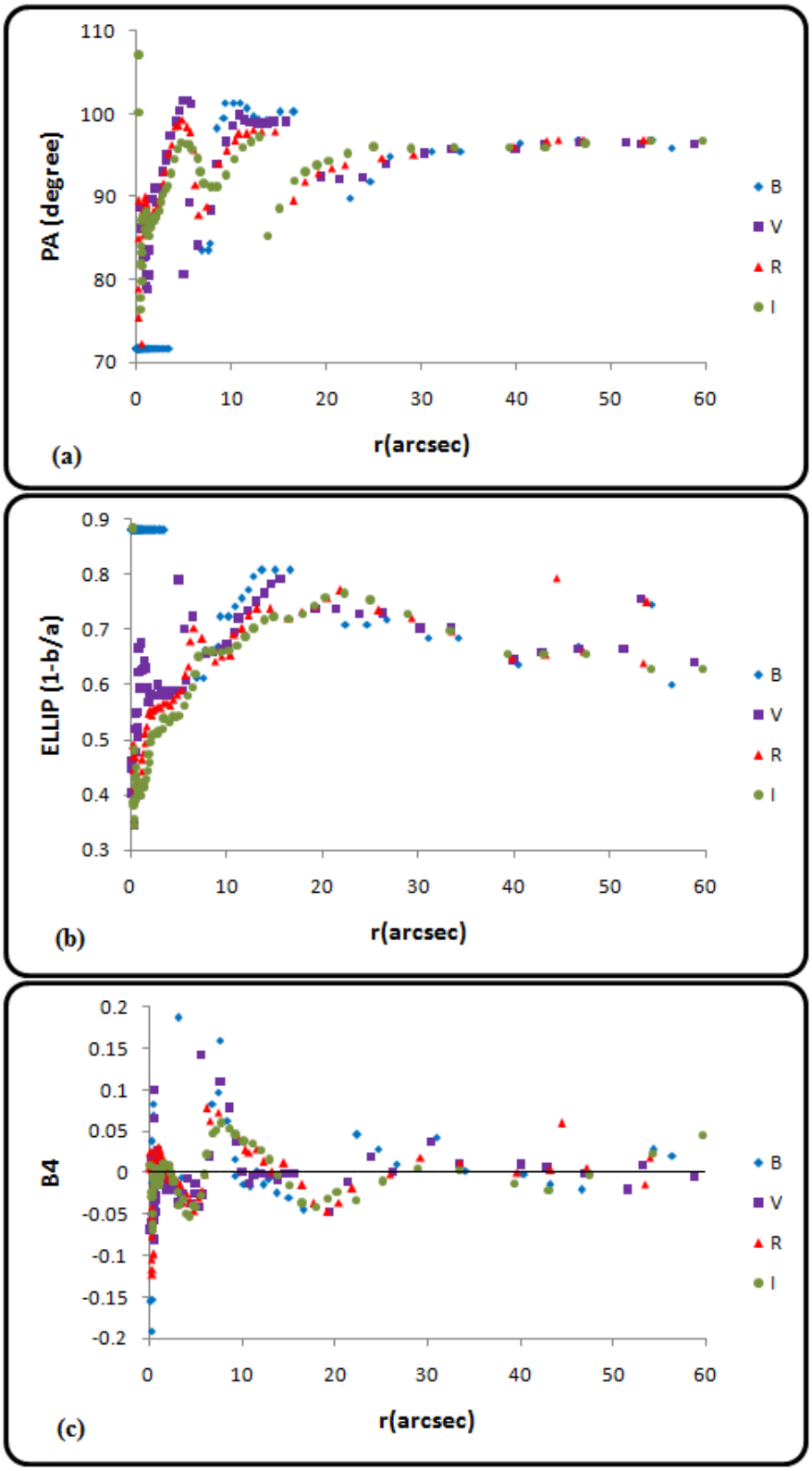

Fig. 11: Structural profiles of NGC 7541 in BVR and I-bands. (a) Position angle, (b) Ellipticity, and (c) B4 profiles.

3.3.3 Luminosity Profile: Decomposition of NGC 7541

The B, V, R, and I equivalent luminosity profiles have been decomposed into the spheroidal ($r^{1/4}$) and disk (exponential) components using the technique of least square fitting. The results of the decomposition are given in Fig. 12 of B, V, R and I bands from upper left to right. The results are also summarized in Table 13.

Due to the complex structure of the inner part of this galaxy, we are not able to fit the bulge component, so we only get the fitting parameters of the disk component (see Fig. 12 and Table 13). The B-band luminosity profile shows the disk of this galaxy is of type II Freeman (Freeman 1970).

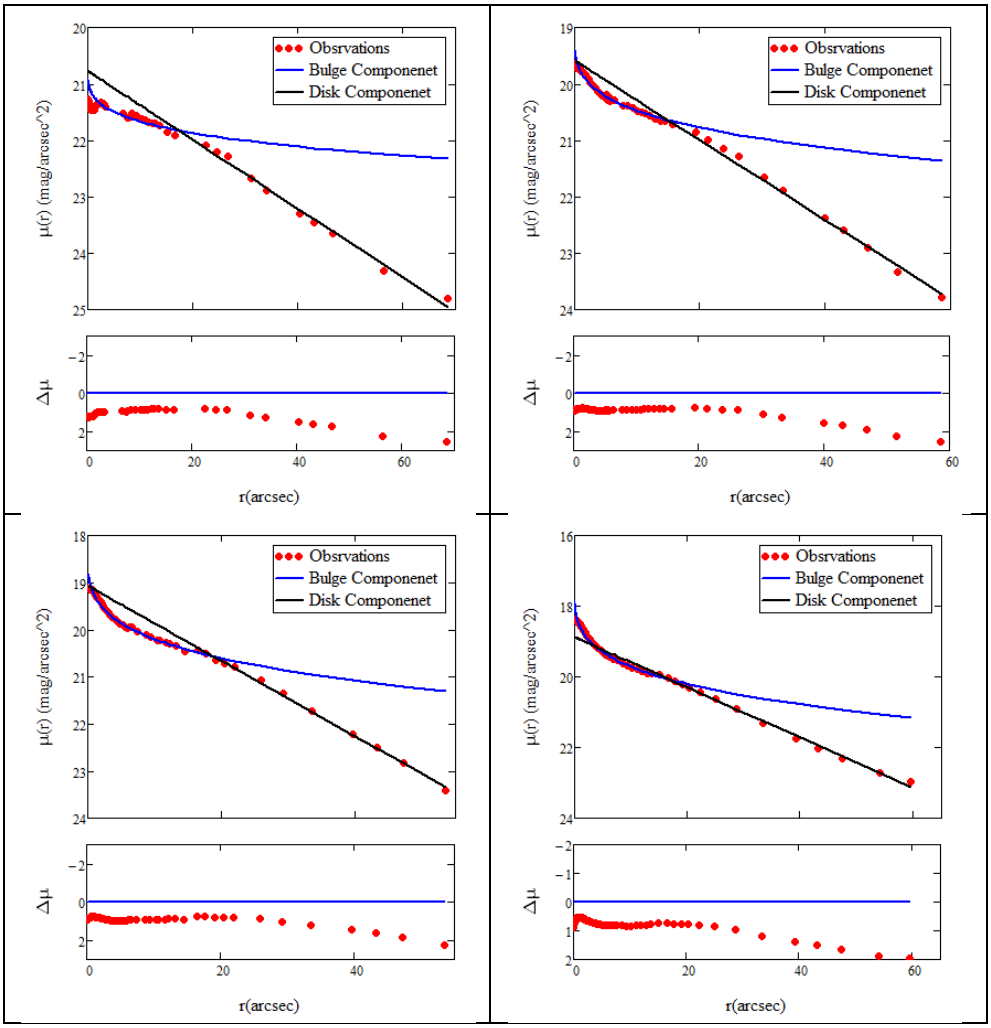

Fig. 12 Decomposition of surface brightness profiles of B, V, R and I bands as well as the residual between the (Bulge + Disk) model and the observed data for NGC 7541 galaxy.

Table 13 Disk fitting parameters of NGC 7541.

Band	Disk			
	μ_0 (mag/arcsec^2)	r_0 (arcsec)	Standared error	LD_T (mag)
B	20.772	17.82	0.038	11.824
V	19.588	15.395	0.038	10.958
R	19.068	13.605	0.018	10.707
I	18.882	15.273	0.026	10.269

3.3.4 Color Profiles of NGC 7541

Profiles of the B−V, V-R, and R-I color indices, along the radius r(arcsec) are shown in Fig. 13. This galaxy has a normal color distribution where the nuclear part (r ≤ 15") is red with <B−V>= 1.5±0.22, <V−R>= 0.46±0.1, and <R−I>= 0.64±0.1. For the disk of this galaxy (r >15") <B−V> = 0.92±0.13, <V−R> = 0.19±0.07 and <R−I>= 0.37±0.03. The color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy (see Table 14).

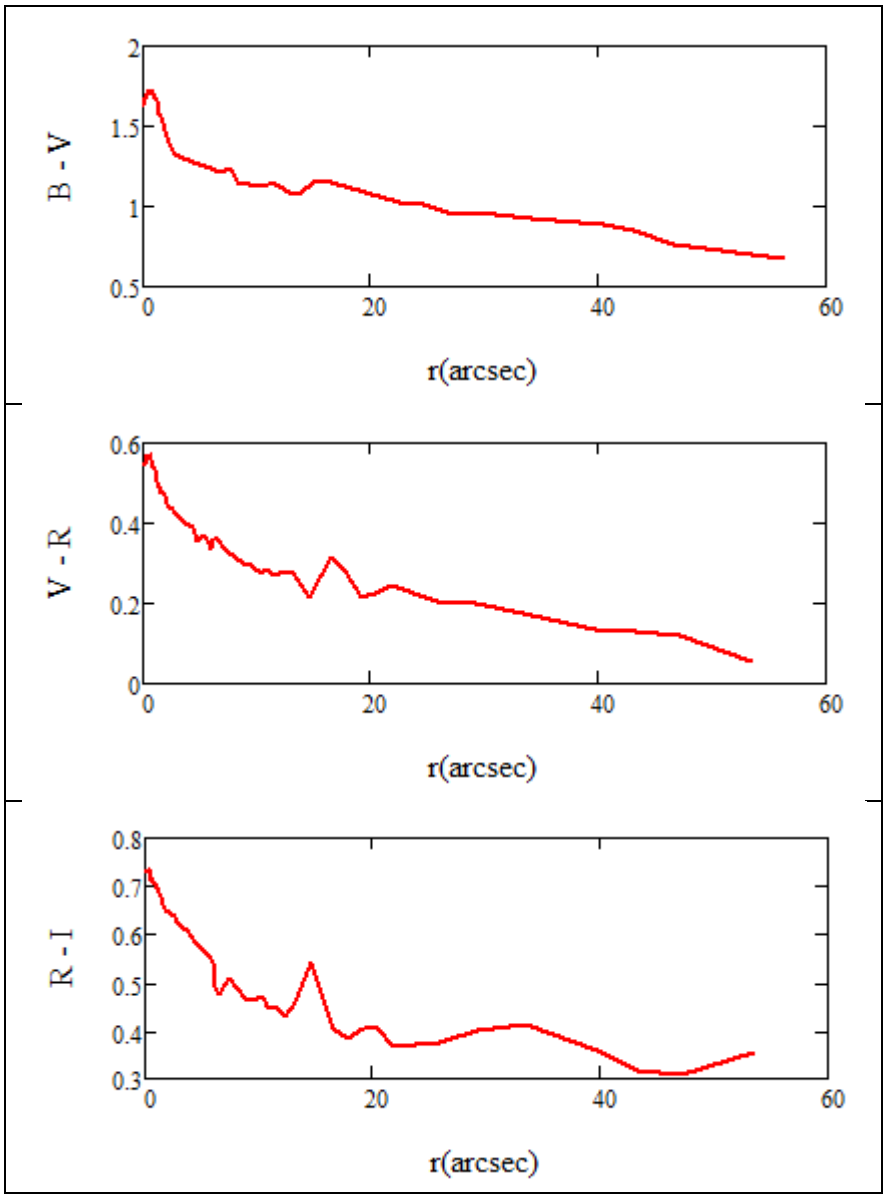

Fig. 13 B-V, V-R and R-I Color index profiles of NGC 7541.

Table 14 Color Profile of NGC 7541.

	Radius(arcsec)	Average value(mag)
B-V	56.391	1.424±0.298
V-R	53.466	0.41±0.143
R-I	33.375	0.59±0.135

4 CONCLUTION

Summarizing, we have obtained accurate surface photometry in the optical Johnson bandpass of a sample of 3 spiral galaxies observed using the 1.88m Kottamia telescope (Egypt). The surface brightness, ellipticity, and position angle profiles obtained from the isophotal fitting are also discussed together with the color index profiles for the galaxies in the sample.

The main results of this study include the following:

NGC 7339: it is clear that the galaxy has a fragmented and elongated central nucleus which is embedded in a larger nebulosity (of size 22.9" × 6.1"). The galaxy is surrounded by a wounded spiral arms with size of 48.8" × 10.7", also from the isophotal maps clearly show that the inner part is fragmented. The inner 5.0" region the ellipticity profiles of the galaxy fluctuate but look steady outward. And from the B4 profile the general trend of the galaxy is to be disky. Then due to the complex structure of the inner part of this galaxy, we are not able to fit the bulge component, so we only get the fitting parameters of the disk component. The B-band luminosity profile shows the disk of this galaxy is of type I Freeman (Freeman 1970). Finally the color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy.

NGC 7537: it is clear that the galaxy has an elongated central part of size about 10.7"×4.3", this central part is embedded in a disk of size 19.8"×7.6", from which a trace of spiral arms is noticed. From the B4 profile the general trend of the galaxy is to be disky, and also from the B-band luminosity profile shows the disk of this galaxy is of type I Freeman (Freeman 1970). The color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy.

NGC 7541: it is clear that the galaxy has a fragmented inner part but we can specify three fragmented regions, the size of the central one is about 5.5"×1.8", and the fragmented inner part is embedded in a disk of size 67"× 24". Also from the isophotal maps clearly show that the inner part is fragmented. Within the inner 7" region the ellipticity profiles of the galaxy fluctuate, the fluctuation in the inner part may be due to the fragmentation of the inner region. Also from the B4 profile the general trend of the galaxy is to be disky. Due to the complex structure of the inner part of this galaxy, we are not able to fit the bulge component, so we only get the fitting parameters of the disk component, then from the B-band luminosity profile shows the disk of this galaxy is of type II Freeman (Freeman 1970). The color indices in the inner and in the outer regions of this galaxy are quite characteristic of a normal spiral galaxy.

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