



## Photometric Investigations of Peculiar spiral galaxy NGC 2608 Using Multiband CCD Camera

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### Abstract

The structural of peculiar spiral galaxy NGC 2608 have been studied using multiband CCD surface photometry of the observations that have been obtained by the 1.88 m optical telescope of Kottamia Astronomical Observatory (Egypt). We studied the structure and radial brightness distribution of the galaxy. The surface brightness distribution indicate that the center of the galaxy consist of two nucleus. The photometric parameters of its components and the color distribution over the galactic are estimated and stellar populations in different regions of the galaxy are analyzed using color diagram. The distributions of the color indices show that the observed photometric symmetry in the inner part of the galaxy, including the bar, is due to a symmetric distribution of absorbing material. The bluest regions of star formation are located in Eastern side of the bar. From the observations, the surface brightness, Ellipticity of the isophotes, Major axes position angle and color indices are discussed.

**Keywords:** spiral galaxy, surface photometry, ellipticity. color index

### التحقيقات الفوتومترية للمجرة الحلزونية الغريبة NGC 2608 باستخدام كاميرا الشحن المزدوج

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#### الخلاصة

تم دراسة تركيب المجرة الحلزونية الغريبة NGC 2608 بواسطة الارصادات الفوتومترية متعددة الحزم باستخدام كاميرا الشحن المزدوج (CCD Camera) الملحق بالتلسكوب البصري والذي قطره 1.88 متر في مرصد القطامية الفلكي ( مصر) . تم دراسة تركيب وتوزيع المعان القطري للمجرة . أن توزيع المعان السطحي أظهر وجود نواتين في مركز المجرة. تم تقدير المعاملات الفوتومترية لمركبات المجرة والتوزيع اللوني لها ومن خلال الرسم البياني اللوني تم تحليل الجمهرات النجمية للمناطق المختلفة للمجرة واظهر التوزيع اللوني التماثل في الارصاد الفوتومترية للجزء الداخلي من المجرة ومن ضمنها قضيب (bar) المجرة بسبب التوزيع المتماثل للمواد الماصة. المناطق الاكثر زرقة (bluest) لتكوين النجوم موجودة في الجزء الشرقي من قضيب المجرة. ومن خلال الارصادات تم مناقشة المعان السطحي (surface brightness) ومقدار التقلطح لل (isophotes) وزاوية الموضع (position angle) للمحور الكبير والدليل اللوني.

### Introduction:

The surface photometry of galaxies provides the fundamental and essential information for the study of their structures and dynamics. The recent advances in CCD device technology and image processing techniques allow us to deal the photometric data of faint objects of great deal with high precision. In this study, we performed the multiband surface photometry of galaxies with a CCD camera equipped on 1.88 m optical telescope of Kottamia Astronomical Observatory (Egypt).

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The specific characteristics of their photometric structures will provide the essential information not only of the relations of stellar kinematics to configurations but also of the origin of the bar structure. The goal of our study is to perform detailed multiband surface photometry of the spiral galaxy NGC 2608 and its brightest star-forming regions. Surface photometry is an important tool in the understanding of galaxy mass and structure. Galaxy luminosity measures the primary baryonic component, (i.e. stellar mass) and structural information traces the gravitational potential. Galaxy formation scenarios make specific predictions on the light distribution of galaxies, so accurate reduction of a galaxy image into a total magnitude and scale length are important parameters to understanding the fundamental plane and the star formation history of galaxies. Obtaining the structural characteristics and the total luminosity of a galaxy requires knowledge of its surface brightness profile to a significant depth. In order to extrapolate a total luminosity, isophotal analysis is required to determine how far one needs to integrate a galaxy's light plus to provide sufficient information to extrapolate the light profile. During a surface photometry project to explore the structure of galaxies by morphological Type [1].

NGC 2608 (also known as Arp 12) is a barred spiral galaxy located 93 million light-years away in the constellation Cancer (the Crab). It is 62,000 light-years across; about 60% of the width of the Milky Way. It is considered a grand design spiral galaxy and is classified as SB(s)b, meaning that the galaxy's arms wind moderately (neither tightly nor loosely) around the prominent central bar. It was classified by Halton Arp (1927-) under "galaxies with split arms" in his 1966 Atlas of Peculiar Galaxies who noted that the "nucleus may be double or superposed star." NGC 2608 is now considered to be a pair of interacting galaxies as shown in Figure-1 [2].



**Figure 1-** spiral galaxy NGC 2608 (Google)

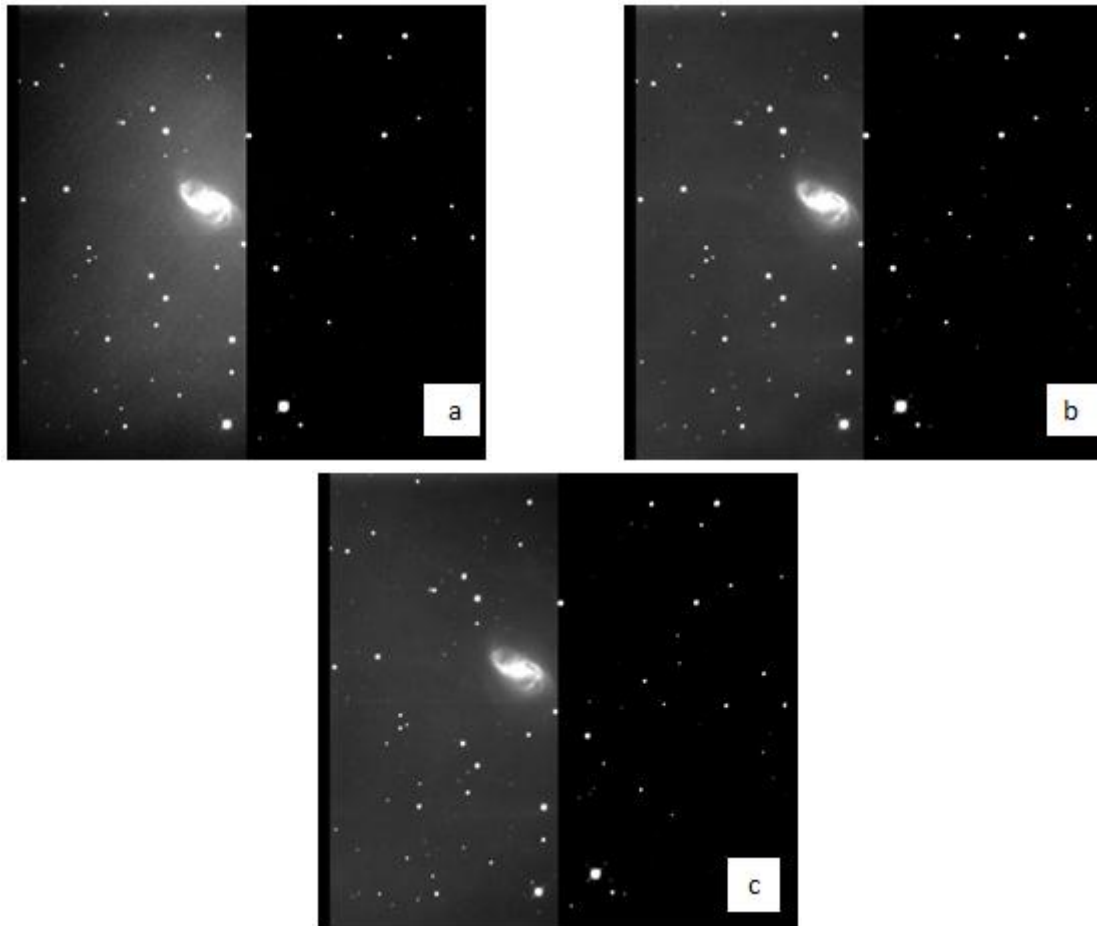
### Observations

The observations have been carried out in April 2011 at the Newtonian focus of the (1.88 m) reflector telescope equipped with CCD camera at Kottamia Astronomical Observatory (KAO), Egypt. With multiband B, V, and R filters. Table-1 demonstrates an observing log.

**Table 1-** Log of observations

Date of observation	The name of the Galaxy	Filters	Time exposure (sec)	Seeing	airmass
2011/4/4-5	NGC 2608	B	3 x 900	1.56"	1.008
		V	3 x 900	1.36"	1.032
		R	3 x 900	1.26"	1.004

The images of spiral galaxy NGC2608 have been recorded on CCD camera using B, V and R filters. These images are demonstrated in Figure-2.



**Figure 2-** CCD images of NGC 2608 before reduction (a) In B filter (b) In V filter (c) In R filter

### **Data reduction**

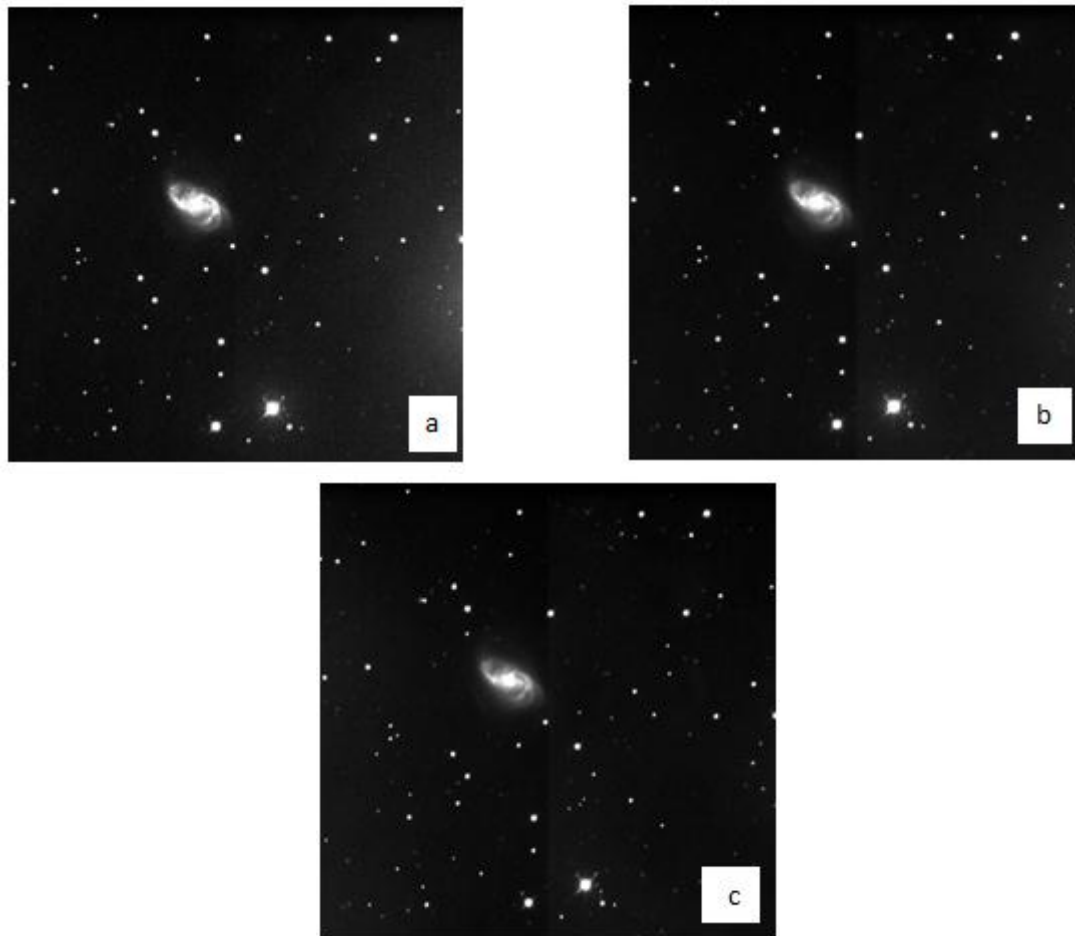
We carried out the further reduction of the CCD Images using the standard procedure and the IRAF software package image-reduction. The main stages of the reduction included bias subtraction and flat-fielding, removal of cosmic-ray traces, determining and subtracting the sky background for each image correcting for the air mass [3, 4].

### **Photometric calibration**

Photometric calibration was achieved using the Landolt UBVRI standard star catalog (Landolt 1992) [5]. The Landolt standard stars fields PG 1047+003, and SA 95 were observed on the same night at different air masses to calculate the atmospheric extinction and the zero points on and hence transforming our system to the Standard Johnson photometric system.

### **Results and Discussion**

The output of the data reduction process for the galaxies NGC 2608 are shown in Figure-3. The results illustrate a clean background [6,7].



**Figure 3-** CCD image of NGC 2608 after reduction (a) In B filter (b) In V filter (c) In R filter

Figure-4 represent the photometric profiles along the major axis of the galaxy NGC 2608 using B, V and R filters which are symmetric around the center. It's clear that the galaxy has a large bright core where the diameter of the nucleus and the bulge were estimated equal to (8 arcsec) and (14 arcsec) respectively. The surface brightness at the center of the galaxy is  $m_B = 19.1 \text{ mag/ (arcsec)}^2$ ,  $m_V = 18.4 \text{ mag/ (arcsec)}^2$  and  $m_R = 17.2 \text{ mag/ (arcsec)}^2$ . Also from this figure we can see two small peaks around the central peak it's belong to the two nucleus which the galaxy consist of them the first one at the right side of the central peak it's surface brightness is  $m_B = 20.7 \text{ mag/ (arcsec)}^2$ ,  $m_V = 19.4 \text{ mag/ (arcsec)}^2$  and  $m_R = 17.8 \text{ mag/ (arcsec)}^2$ , and the second peak at the left side it's surface brightness is  $m_B = 21.2 \text{ mag/ (arcsec)}^2$ ,  $m_V = 19.4 \text{ mag/ (arcsec)}^2$  and  $m_R = 18.1 \text{ mag/ (arcsec)}^2$ .

The surface brightness of the bar at V filter is  $m_V = 21.1 \text{ mag/ (arcsec)}^2$ . Two long bright spiral arms emerge from the bar at 20 arcsec from the center and it's surface brightness at V filter is  $m_V = 20.8 \text{ mag/ (arcsec)}^2$ .

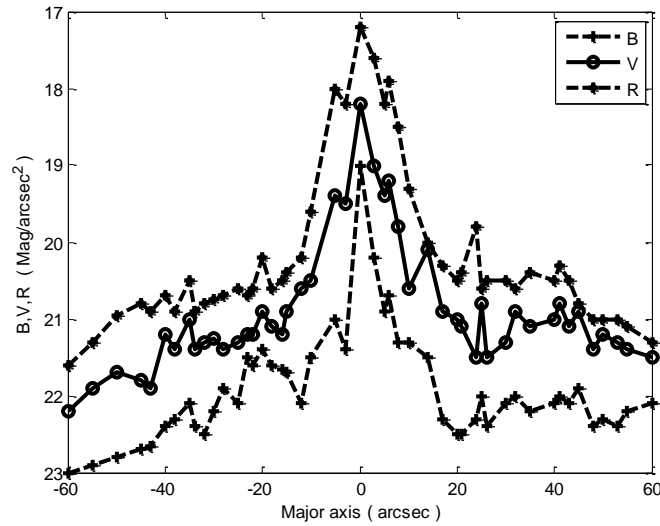


Figure 4- Photometric profiles along the major axis of NGC 2608

Figure -5 illustrate the isophotes (a contour map joins points of equal brightness) of the spiral galaxy NGC 2608.

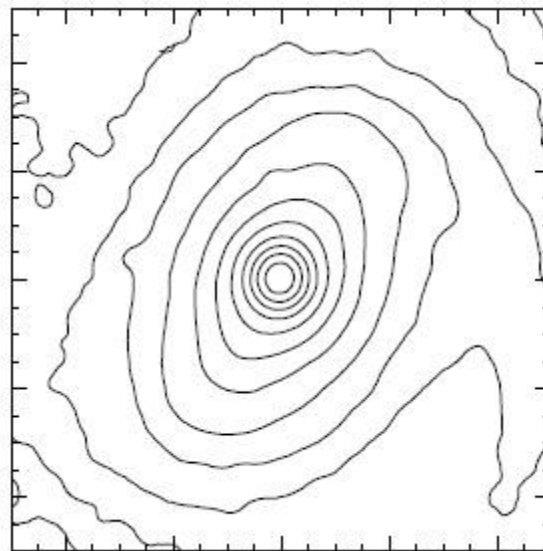


Figure 5- The isophotes of spiral galaxy NGC 2608

Figure-6 demonstrate the ellipticity ( $e=1-b/a$ ) of the isophotes as a function of the distance from the center of the galaxy where  $b$  and  $a$  are respectively the minor and major axes of the galaxy. Within the inner 5.0" region the ellipticity profiles of the galaxy fluctuate, followed by a sharply increase till  $r=20.0''$  this mean that the isophotes become more elliptical and then at  $r > 25''$  became nearly flat in the outer parts.

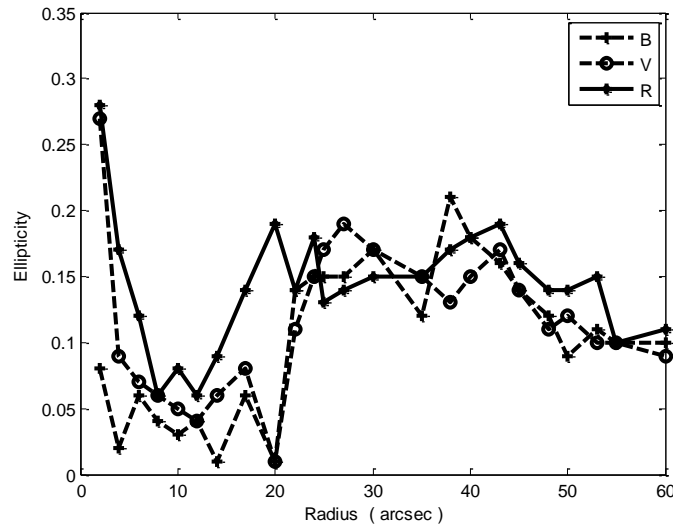


Figure 6- Isophote ellipticity as a function of the distance r from the center of NGC 2608

The dependence of the position angle (P.A) on the radius from the center of the galaxy is presented in Figure-7 the position angle of the major axis of the galaxy grows sharply from  $15^{\circ} \pm 5^{\circ}$  near the center up to  $55^{\circ} \pm 5^{\circ}$  at  $r=8''$ , then decreases to about  $43^{\circ} \pm 8^{\circ}$  at  $r=12''$ , then inereases smoothly to  $61^{\circ} \pm 5^{\circ}$  at  $r=35''$  and then it becomes more flat.

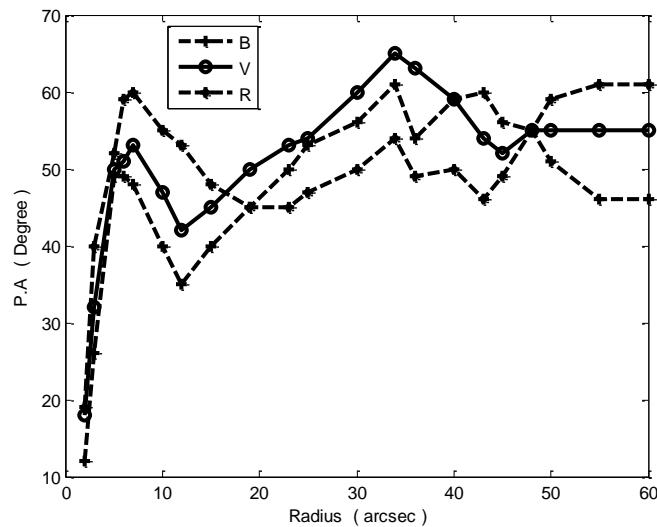
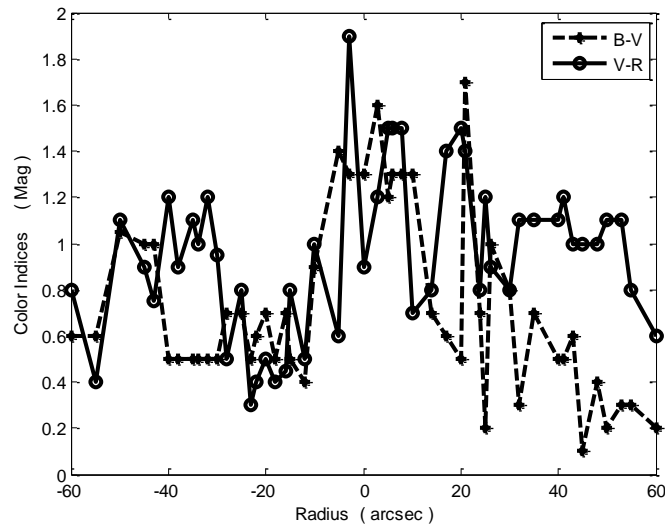


Figure 7- Position angle of the galaxy P A as a function of the distance r from the center of NGC 2608

Figure-8 illustrate the (B-V) and (V-R) color indices along the major axis of the spiral galaxy NGC 2608. The nuclear part ( $r \leq 15''$ ) is blue with  $(B-V) = 0.9$  mag and  $(V-R) = 1.3$  mag for the disk of the galaxy ( $r > 15''$ )  $(B-V) = 0.7$  mag and  $(V-R) = 0.9$  mag. The Eastern bar of the galaxy is bluer than the Western bar.



**Figure 8-** Profiles of the color indices along the major axis of the galaxy NGC 2608

### Conclusion

The photometric profile indicate that the center of the spiral galaxy NGC 2608 consist of two nucleus and it's so clear that for this reason the galaxy showed a large and bright core . The Eastern side of the bar is bluest than the Western side and this mean that the efficiency of star formation in this region is biggest than the West.

### References:

1. Schombert, J. and .Smith, A.K.2011. Systematic Bias in 2MASS Galaxy Photometry. *astro-ph.IM*.arXiv: 1107.1728v1.
2. Halton, A. 1966. Atlas of Peculiar Galaxies. *Astronomy and Astrophysics Journal*. 14.1A. doi:10.1086/190147.
3. Hernandez, H.M, Zendejas, J.D. and Avila.R.V.2007. BVRI Surface Photometry of Isolated Spiral Galaxies. *The Astronomical Journal*, (134), pp: 2286-2307.
4. Ali, S.H. and Albakri, S.A. 2014. BVR CCD Photometry of Spiral Galaxy IC 467. *Iraqi Journal of Physics*, 12(24), pp:81-86.
5. Landolt, A.U. 1992. UBVRI photometric standard stars in the magnitude range 11.5-16.0 around the celestial equator. *Astronomy Journal*. 104(1), p:340.
6. Gusev, A.S. and Kaisin,S.S.2002. Multicolor CCD photometry of The Dusty Giant -Late type Spiral Galaxy NGC 5351. *Astronomy Reports*, 46(9), pp: 712–720.
7. Ali, S.H.2015.Photometric Properties of Isolated Spiral Galaxies NGC 4800 and NGC 2715.*Iraqi Journal of Science*, 56(3A), pp:2096-2103