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CCD photometry of the Markarian galaxy Mrk 1043

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Abstract. CCD photometric observations of Mrk 1043 have been obtained in BVRI filters. The integrated magnitude and colours of the galaxy have been estimated. The B-V colour of the Mrk 1043 is much bluer than the average colour of Markarian galaxies. Both B-V and B-I indices of the galaxy indicate the presence of large number of early type stars.

Keywords: photometry - Markarian galaxy

1. Introduction

Markarian galaxies are excess UV continuum galaxies having varying degree of activity in and around their nuclei. Detailed surface photometry carried out for a few of these galaxies shows the presence of double or multiple nuclei, giant H II regions, emerging jets and other peculiar shapes in them (e.g. Hutchings and Neff 1987; 1989; Mazzarella and Boroson 1993). Surface photometry of a large number of these galaxies is important for understanding the various physical processes undergoing in these objects leading to their peculiarities.

In the present work, we report the results of the surface photometry of Mrk 1043. This galaxy has been designated as 'pair' in the catalogue of Markarian galaxies (Mazzarella and Balzano, 1986). It is classified in reference catalogue of galaxies (RC3) as SBTOP (a barred spiral with T=0 and having peculiarity). The heliocentric recession velocity of the galaxy is given as 2430 kms per sec. Mazzarella and Boroson (1993) have given the grey scale representation of stacked BV and R images and contour map in B filter along with photometry and image properties of the galaxy. They have also given the spectroscopic properties.

2. Observations

The observations were obtained at the Cassegrain focus of the 104-cm Sampurnanand telescope of the Uttar Pradesh State Observatory, Nainital on 11 Nov 1990 using a CCD detector which is a Thomson metachrome coated chip having 384×576 pixels. The spatial scale at the detector is 0.33 arcsec per pixel. The images were obtained in 2×2 binned mode through standard

BVRI filters. The total exposures were 2100, 600, 480 and 780 seconds in BVRI respectively. Landolt's (1983) standard stars were also observed on the same night for calibration and extinction correction. The FWHM of star images in the frame of the galaxy was found to be 1.5 arcsec.

The image analysis was done using the IRAF package. Images were bias subtracted and flat fielded. Cosmic rays were removed. For cosmic ray removal we used detection threshold as five times of mean standard deviation of the background pixels around the pixels which were cosmic ray candidates. We used six percent as the threshold value for the ratio of intensity of cosmic ray pixel to intensity of surrounding pixels. The sky brightness was removed by subtracting a constant computed from selected blank regions around the galaxy. Photometry was carried out on the images of the galaxy through concentric circular apertures. The centre for placing the circular aperture on the galaxy image was identified by the centre of the brightest portion of the galaxy in B magnitude. For other filters the same centre has been retained. A minor variation in the coordinates of the centre of the aperture does not affect the results. The growth curve in BVRI filters were obtained. The result of B, V and B-V filters is shown in Fig. 1. Similar curves were obtained in V, R and I filters. The total magnitude of the galaxy in each filter were measured and corrections for the galactic reddening, inclination effect and K correction were applied to these magnitudes. The RC3 catalogue lists the galactic and internal absorption values for the galaxy in B band as 0.03 and 0.13 respectively. The correction for other bands were derived from the interstellar absorption law. The K corrections for B, V and R filters were taken from Oke and Sandage (1968). The K correction in the I band has not been applied, as this correction is expected to be quite small. These K corrections, however, refer to the nuclear regions of elliptical galaxies.

The corrected total magnitudes and colour indices are listed in table 1. Using the recession velocity of 2430 km per sec and Hubble parameter of 75 km per sec per Mpc, we obtain a distance of 32.4 Mpc for the galaxy. The absolute B magnitude of the galaxy Mrk 1043 with the above distance is -19.71 and the blue luminosity is $5.65 \times 10^9 L_\odot$. The B-V colour of Mrk 1043 is much bluer than average B-V colour of Markarian galaxies (Huchra 1977). The mean B-V colour of Markarian galaxies in the photometry sample of Huchra is given as +0.54.

Table 1. Corrected colours and magnitudes of Mrk 1043 in BVRI filters.

Filter	Magnitude
B	12.84
V	12.46
R	12.26
I	11.73
B-V	0.38
B-I	1.11

Fig. 1 (top right) shows that there is a bar like structure oriented approximately at a position angle of 130 degrees, different from the overall position angle of the galaxy. An arm seems to emerge from the NW end of the bar going towards NE. Such a structure is not apparent on the opposite side. The isophotes are similar to the one given in Mazzarella and Boroson (1993) except that the arm structure is more pronounced in our contour map. The brightness gradient in the inner structure is more steep in the SW direction as compared to the opposite direction.

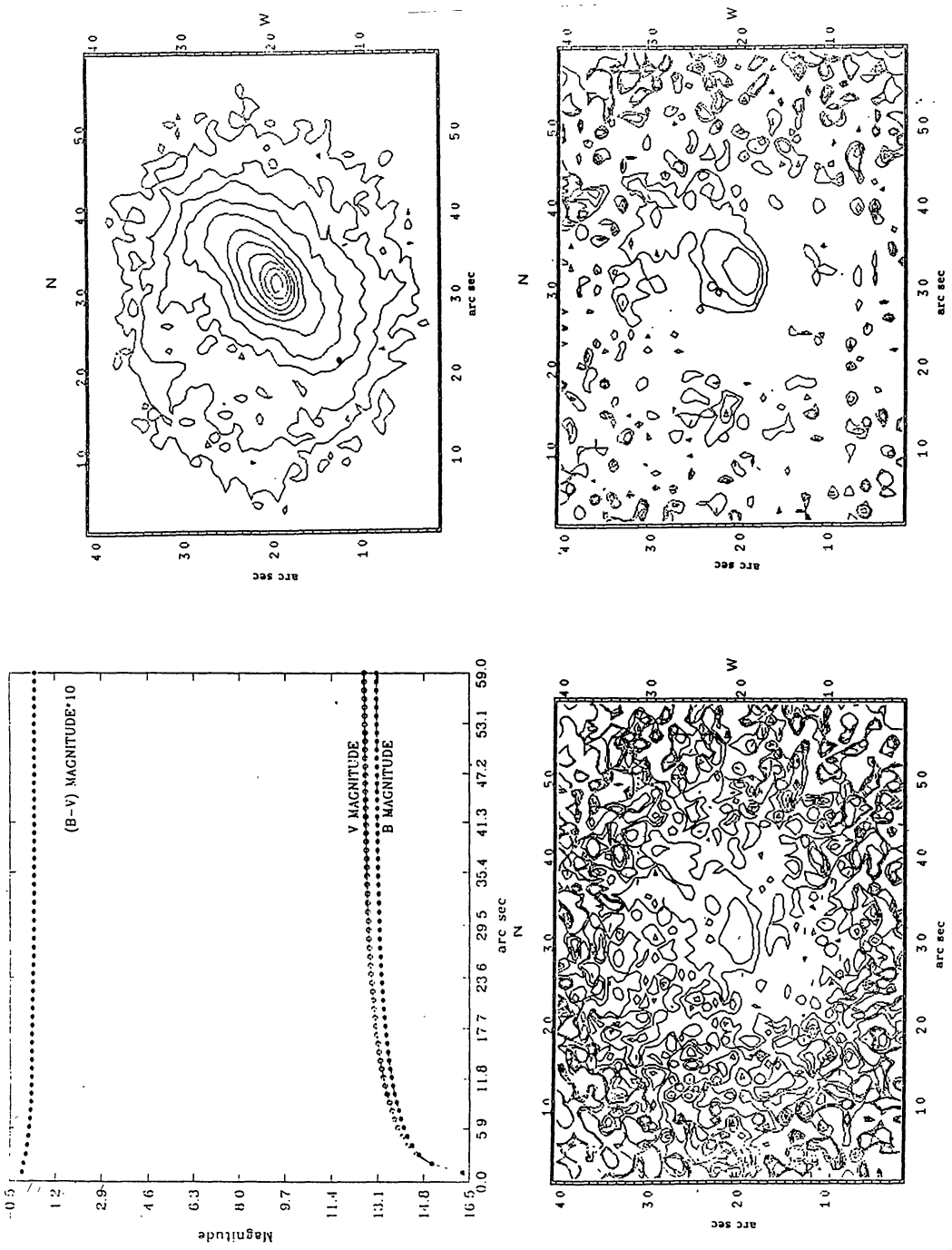

Figure 1. The growth curve of Mrk 1043 in B, V and B-V filters. X-axis represents distance from centre in arc second and Y-axis represents magnitude (top left). Contour map in B filter, the innermost contour is 17.5 mag and contour steps are 0.5 mag (top right). Contour map in B-V colour, the innermost contour is 0.2 mag and contour steps are 0.2 mag (bottom left). Contour map in B–I colour, the innermost contour is 0.9 mag and contour steps are 0.2 mag (bottom right).

Fig. 1 (bottom left) shows that the galaxy is bluest in the nuclear region, and in the NW direction it is bluer than the rest of the galaxy.

Fig. 1. (bottom right) shows clearly that the colour of the galaxy is bluest in the nuclear region and a feature extends from NW to NE with values of B-I = $1^m.1$ and $1^m.3$. The rest of the galaxy is redder.

3. Discussions

From the figure it is obvious that in the features towards NW and NE there is preponderance of early type stars with circumstellar gas and dust. The galaxy has strong Hα line in emission, (Mazzarella and Boroson 1993) showing presence of HII regions. The integrated energy distribution curve of the galaxy shows an excess of I radiation, which could be the near IR excess due to free-free and free bound continuum emission in the circumstellar envelope of the young hot stars. The steep gradient of brightness and colours in the SW direction may be due to the presence of thick dust with only Late type stars in the region. The Galaxy appear inclined about an axis in NE-SW direction, the NE side being nearer the observer. In this situation SW side is attenuated more compared to the NE side from the major axis of galaxy. The large gradient in brightness and in colour on SW side could also be due to the presence of large extinction.

The galaxy has significant amount of flux in the IRAS bands. On the basis of the 60 and 100μm band fluxes of the galaxy, the far infrared flux of the galaxy has been calculated with the help of the formula given by Zhenlong et al. (1991) as:

$$FIR(flux) = 1.75[2.55(S(60))+1.01(S(100))]\times10^{-14} \text{ Watt } m^{-2}$$

where S(60) and S(100) are the colour corrected flux densities of the galaxy in the 60 and 100μm bands. The flux between 40 and 120μm is taken into account. The factor 1.75 accounts for the gap between 60 and 100μm bands and also the flux missed beyond the 40-120μm range. The far infrared flux calculated above can be converted to the far infrared luminosity of the galaxy using the distance. This gives us $L(FIR)=4.06\times10^9 L_\odot$. The blue luminosity of the galaxy is greater than the far infrared luminosity by a factor of about 1.4. This indicates the presence of large number of stars.

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