LARGE-SCALE STRUCTURAL CHARACTERISTICS AND
PHOTOMETRY OF NGC 3031 DETERMINED FROM
EQUIDENSITY CURVES

W. Hoegner, Z. Kadla,
N. Richter, and A. Strugatskaya

The method of integral equidensity curves was applied for determining the large-scale structure of the galaxy NGC 3031. Altogether 49 equidensity curves were obtained from four UBVR plates taken with the 2-m telescope of the Tautenburg Observatory. The axial ratio and position angle of the major axis in dependence on the apparent distance to the center of the galaxy were derived. These dependences are the same in all the investigated wavelength regions. The relative surface brightness in UBV in dependence on the semi-major axis was determined by means of a photographic wedge printed on the original photographs. A comparison with photoelectric measurements in V and B enabled a determination of the zero-point and the apparent surface brightness.

The newly developed method for obtaining integral equidensity curves [1] provides a rapid and relatively simple means for studying the large-scale structure of extended celestial objects. The possibility of obtaining these curves from photographs taken in various wavelength regions enables the comparison of structural features of an object as defined by stars of different spectral types. It is proposed to apply this method to the investigation of globular clusters and elliptical and spiral galaxies.

The purpose of this article is to illustrate the possibilities of such investigations, the results of measurements of UBVR (λ_ref = 6800 Å) equidensity curves of the Sb type galaxy NGC 3031 (M 81) being used as an example (Fig. 1). Altogether 49 equidensity curves were obtained from plates taken with the 2-m Tautenburg telescope. Data on the plates used are given in Table 1. The equidensity curves in B are very similar to the isophotes of M 81 in blue light found from direct measurements by E. Dennison [2], using an automatic isophotometer.

The x and y coordinates of 72 points through 5° were measured on each equidensity curve. Each curve was then approximated by an ellipse and the parameters of the ellipse calculated with the Minsk-22 computer at Pulkovo. The derived results are given in Table 2, where R is the mean distance of the equidensity curve from the center of the galaxy, a is the the semi-major axis, b/a is the apparent axial ratio, φ is the position angle of the major axis, and σ_b/a and σ_φ are the corresponding mean errors. The dependence of b/a and φ on a are illustrated in Figs. 2 and 3, which show that the variations of these parameters are the same for all the studied wavelength regions. They also indicate that the values of these parameters derived in different studies will depend on the angular diameter of the galaxy on the photographs used for the investigation.

The true flattening 1 - b_φ/a_φ, where b_φ is the polar axis and a_φ the equatorial diameter, can be determined from the formula

The tilt angle $i$ for this galaxy was determined by Danver [3] by means of experimental photographic projection and found to be equal to 30°8, which corresponds to $b/a = 0.512$. Three of the measured equidensity curves, located at the first observational evidence of spiral arms, have a value of $b/a$ smaller than this. From the smallest value $b/a = 0.419$, we find $24\arcdeg 8$. The true axial ratio derived by using this value is given in the last column of Table 2.