DISTANCE MODULUS OF NGC 3389*

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A re-discussion of the distance of NGC 3389 shows that it is not a dwarf member of the M 96 Leo group at $\Delta=8.3$ *Mpc*. The distance modulus derived from apparent diameter and magnitude, luminosity class and redshift is $\mu=31.3$ ($\Delta=16.6$ *Mpc* or A=0.2 mag.) and the total absolute magnitude is $M_T(B)=-19.1$.

NGC 3389, type SA(s)c, has a photographic major axis $D = 2.3 \pm \pm 0.1$ (m. e.) in the standard system of the *Reference Catalogue* [1] and an axis ratio $d/D = 0.59 \pm 0.05$; the standard face-on diameter is $D(0) = 1.85$. The maximum detectable diameter on the Sky Survey red print is $D(\text{max}) \simeq 2.8$. The galactic extinction in this direction is about $A_B = 0.2$ mag. [2].

(a) *Distance estimates from apparent diameter.* If we assume that NGC 3389 has the same linear diameter as M33 for which $D(0) = 50'$ and $\mu_0 = m_0 - M = 24.3$; ($A_B = 0.3$), the ratio of distances is 27 and the geometric distance modulus is $\mu_0 = 24.3 + 7.1 = 31.4$. More generally the modulus derived from a new analysis (unpublished) of the average face-on diameters of Sc galaxies in the *Reference Catalogue* is $\mu = 31.1$.

(b) *Distance estimates from apparent magnitude and surface brightness.* The standard B-system magnitude of NGC 3389 is about $B(0) = 12.5$ being an average of the *Reference Catalogue* values $m_c = 12.74 \pm 0.2$; (Harvard corrected) and $B(0) = 12.41 \pm 0.07$ (photoelectric). The corresponding total magnitude is $m_T = B(0) - 0.3 = = 12.2$. The observed color index $(B - V)(0) = 0.54 \pm 0.07$ corresponds to an intrinsic color $C_0(0) = 0.42$ (see the *Introduction* to the *Reference*

Catalogue for explanations of the corrections applied). The color matches closely that of M33 for which $(B-V)(0) = 0.55$, $C_0(0) = 0.42$ and $B(0) = 6.5$. If we could assume that the absolute magnitudes are the same, the apparent modulus of NGC 3389 would be $\mu = m - M = 24.6 + 6.0 = 30.6$. However, the *Reference Catalogue* shows that the average surface brightness of NGC 3389, $B'(0) = 13.5$ mag min^{-2}, is more than a magnitude brighter than the corresponding figure for M 33, $B'(0) = 14.7$, so that its absolute magnitude may also be brighter by about the same amount and, if so, the apparent modulus is $\mu = 30.6 + 1.2 = 31.8$. The general analysis (unpublished) of the apparent magnitudes $B(0)$ or m_c of Sc galaxies in the *Reference Catalogue* gives an apparent modulus $\mu = 30.8$. But, again, the average surface brightness of NGC 3388 is greater by 0.5 mag. than the average value $B'(0) = 14.0$ mag min^{-2} for its type and the adjusted modulus is $\mu = 31.3$.

(c) *Distance estimate from apparent magnitude and luminosity classification.* From a re-calibration [2] of van den Bergh's luminosity classification [3] and estimate Sc* III: for NGC 3389, corresponding to $M_G = -18.3$ in the $B(0)$ system, the apparent modulus is $\mu = 30.8 \pm 0.6$ (m. e.).

(d) *Distance estimates from the redshift.* NGC 3389 is projected among the members of the NGC 3379 group and it is often assumed to be a member of a Leo group or „cluster" [4—6]. However, in a recent detailed survey [2] of all nearby groups represented in the *Reference Catalogue*, NGC 3389 was not accepted as a member of the M 96 (NGD 3368) group (№ 11 in the survey) whose brighter members are NGC 3351, 3368, 3377, 3379, and 3384. The main reason is that the range of radial velocities of the members is from about 600 to 900 $km\ sec^{-1}$ with a mean value $\langle V_0 \rangle = 741\ km\ sec^{-1}$ and an average deviation of only 80 $km\ sec^{-1}$ for 9 members. The apparent radial velocity of NGC 3389 is $V = 1334 \pm 65$ according to the *Reference Catalogue*, after Mayall from one Crossley spectrogram, and $V = 1257$ according to Rubin and Ford [7] who used an image tube spectrograph with about 3 times the dispersion of the Crossley spectrograph. With relative weights 1 and 3 for the two estimates the weighted mean is $\langle V \rangle = 1276 \pm 32\ km\ sec^{-1}$ and the velocity corrected by $300 \cos A$ for the standard solar motion is $V_0 = 1145\ km\ sec^{-1}$. This is 404 $km\ sec^{-1}$ or 55 per cent larger than the adopted mean velocity of the M 96 group or again nearly 250 $km\ sec^{-1}$ above the largest velocity of the accepted members. This discrepancy is too large for a

small group and we conclude that NGC 3389 is only an optical member in the background of the M 96 group.

If it could be assumed that the ratio of the distances equals the ratio of the velocities the distance of NGC 3389 would be 1.55 times that of the M 96 group or 13 Mpc ($\mu_0 = 30.5$), but this procedure is incorrect because of the well-known nonlinearity of the velocity-distance relation in the northern galactic hemisphere [8, 9]. In the direction of NGC 3389 ($SGL = 94°$, $SGB = -26°$) the kinematic model of the Local Supercluster [7] predicts the velocity distance relation tabulated below

r/R_1	0.50	0.75	1.00	1.25	1.50
r (Mpc)*	6.2	9.4	12.5	15.6	18.8
V_0 ($kmsec^{-1}$)	620	840	1000	1120	1400

* For $R_1 = 12.5$ Mpc.

From it we derive for the M 96 group a distance $\Delta = 7.9$ Mpc in excellent agreement with the value $\Delta = 8.3$ derived in the survey of groups independently of velocities, and $\Delta = 16.0$ Mpc ($\mu_0 = 31.0$) for NGC 3389. The latter value is in better agreement with the estimates in sections (a), (b) and (c) than the value that would be derived on the erroneous assumption of a linear velocity-distance relation.

Table 1

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Method and comparison	μ	μ_0	ϖ
(a) Apparent diameter D (0) {M 33 / average Sc	(31.6) / 31.1	31.4 / —	1/2 / 1
(b) Apparent magnitude B (0) and surface brightness B' (0) {M 33 / average Sc	31.8 / 31.3	— / —	1/2 / 1
(c) Apparent magnitude B(0) and luminosity class L	30.8	—	1/2
(d) Red Shift and kinematical model	(31.2)	31.0	1/2
Mean	31.3	31.1	4

The various estimates are collected in Table 1 and the adopted weighted means are

$$\mu = 31.3 \pm 0.2, \quad \mu_0 = 31.1$$

and

$$\Delta = 16.6 \pm 1.7 \ Mpc.$$

This distance is 50 per cent greater than the indicative value $V/100$ calculated by Rubin and Ford [7]. It leads to more plausible values for the absolute magnitude and diameter of the galaxy as follows:

$$M_T(B) = 12.2 - 31.3 = -19.1$$

$$D(0) = 9.1 \; kpc, \quad D(\text{max}) = 14 \; kpc.$$

and also for the supernova (see previous paper [10]).

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МОДУЛЬ РАССТОЯНИЯ NGC 3389

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Пересмотр расстояния NGC 3389 показывает, что она не является карликовым членом группы Льва М 96 на расстоянии $\Delta = 8.3$ мпс Модуль расстояния, полученный по видимому диаметру и величине, классу светимости и красному смещению равен $\mu = 31.3$ ($\Delta = 16.6$ мпс при $A = 0^m 2$) и полная абсолютная величина равна $M_T(B) = -19.1$.

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