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ASTRONOMY AND ASTROPHYSICS

Is NGC 1023/1023A an interacting system?

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Summary. The controversial origin of the neutral hydrogen cloud in the vicinity of the S0 galaxy NGC 1023 (Sancisi et al., 1984) is re-discussed on the basis of new optical data. The stellar systemic velocity of the eastern companion galaxy NGC 1023A (peak surface brightness of about 23 B-mag arcsec^{-2}) has been measured on a spectrum taken with the *Photon Counting Multichannel Spectrophotometer* attached to the *Spectrograph SP-124* at the Nasmyth focus of the 6-m telescope of the USSR Academy of Sciences. The resulting value $V = 742 \pm 30\,\mathrm{km\,s^{-1}}$ is coincident with that of the H I condensation projecting onto NGC 1023A, thus proving the physical link of this object to NGC 1023. The morphological and photometric properties of NGC 1023A have been also derived by means of a high resolution plate of the 210-cm telescope of the University of Hawaii and by a long exposure plate of the 122-cm Asiago telescope. We were able to disentangle the image of NGC 1023A from that of the bright companion and show that it is a magellanic irregular or a low surface brightness late-type dwarf with an anomalously smooth texture. Its absolute magnitude $M_B = -15.7$ mag and its mean size $\bar{D}_{25} = 3.8$ kpc, computed assuming $\Delta = 10$ Mpc, are consistent with the above classification, while the asymptotic colours, $(B-V)_T = 0.7$ and $(U-B)_T = 0.0$ mag, are too red and the mass of the H I cloud projecting onto it is too low for the B-luminosity ($M_{\rm H\,I}/L_B = 0.29$). The global information is confronted with the model proposed by Sancisi et al., which assumes that NGC 1023A has experienced a tidal interaction with NGC 1023. The model may easily explain some of the peculiarities of NGC 1023A, but, as the above authors already pointed out, it is probably unable to account for all of the H I mass about NGC 1023 on the ground of accretion from just one passage of NGC 1023A.

Key words: galaxies – morphology – kinematics – H I – interactions

1. Introduction

The SB0 galaxy NGC 1023 (Fig. 1) is the brightest member of the homonymous group (Group 7; de Vaucouleurs, 1975) in Perseus, rich in late-type spirals and dwarf irregulars. It is characterized by the presence of a low luminosity condensation, denominated NGC 1023A by Hart et al. (1980), at the eastern end of the disk, 2′.6 from the center. This condensation, discovered by Pease (1917) and well visible on the PSS plates, has called the attention of Arp (1966) who included NGC 1023 among the family of early-types with "nearby fragments" in the *Atlas of Peculiar Galaxies.* Lately NGC 1023A has been interpreted as an asymmetric spiral arm by Derevjanko (1971), and as an individual galaxy, probably a companion of NGC 1023, by Barbon and Capaccioli (1975, hereafter BC).

NGC 1023 gained much interest when it was discovered to be one of the nearest members of the rare class of neutral-hydrogen rich lenticular galaxies (see van Woerden, 1977). Studies at increasing sensitivity and resolution led to the picture given by Sancisi et al. (1984, hereafter SVDH). NGC 1023 appears surrounded by 1.5 $10^9 M_\odot$ of neutral hydrogen with a rather complex density distribution and kinematics. Two clumpy ring-like clouds of H I with different mean systemic velocities are identified, carrying almost the same amount of material (5.5 $10^8 M_\odot$ each) and showing an overall rotation in the same sense as the stellar body, although in different planes. The "red cloud" has a strong condensation ($M_{\rm H\,I} = 8.8\ 10^7 M_\odot$) superposed on the optical image of NGC 1023A, and it seems morphologically and kinematically linked to a "tail" at higher redshift (see Fig. 3 of SVDH).

The interpretation of this picture is not straightforward and bears on the basic problem of the nature of H I surrounding early-type galaxies. This material is not evidently associated with regions of stellar formation, tends to be distributed mainly outside the optical boundaries and shows a fairly regular rotation with momenta not always aligned with those of the stellar bodies (van Woerden et al., 1983). The main question is: *accretion* at the expense of intergalactic H I clouds or dwarf companions (Silk and Norman, 1979), or *remnants of previous disks* mainly consumed by earlier star formation (Larson et al., 1980). In the case of NGC 1023 SVDH favour the first hypothesis, identifying the "donor" with NGC 1023A, but they leave the question open due to the lack of conclusive data. In this paper we re-discuss their arguments adding new pieces of information, a morphological and photometric study of NGC 1023A and its optical radial velocity.

The basic data about NGC 1023 are summarized in Table 1. The morphological type SB0$^-$ ($T = -3$) is taken from the Second Reference Catalogue of Bright Galaxies (= RC2; de Vaucouleurs et al., 1976). The size and the apparent total magnitude are by-products of our photometric study of NGC 1023A (Sect. 2.2). The diameter D_{25} at $\mu = 25$ B/ss (abbreviation for B-mag arcsec^{-2}), measured along the western part of the major axis, agrees with BC study (see their Fig. 3); we also re-confirm the sharp cut-off of the

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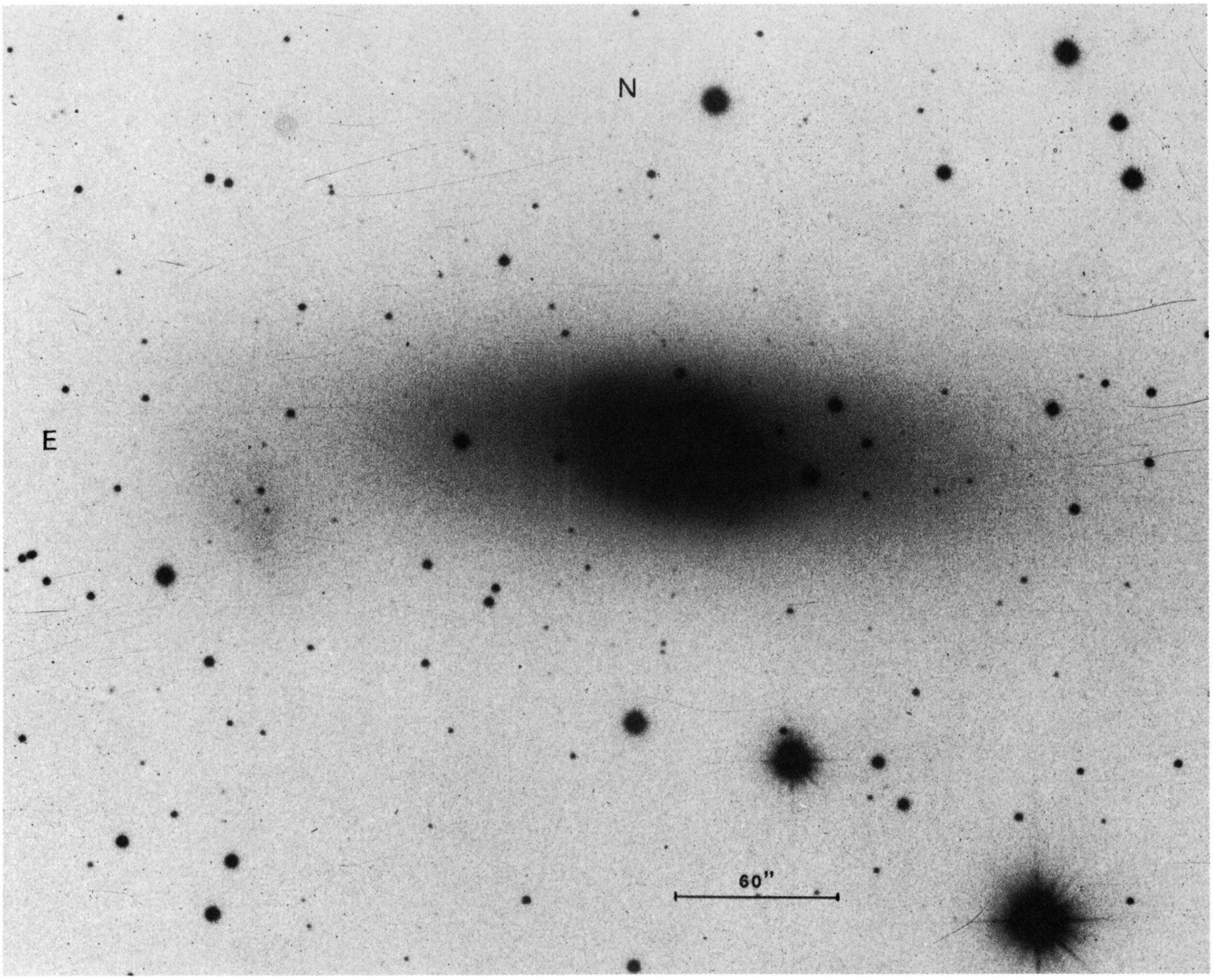

Fig. 1. Photograph of NGC 1023 and NGC 1023A from plate 2012 taken with the 210-cm telescope of the University of Hawaii

western edge of the disk and the presence of major departure of the outer light profile from a smooth trend. The apparent total magnitude $B_T = 10.20$ mag derived by us agrees perfectly with RC2 and is 0.2 mag brighter than in BC. The galactic extinction $A_{pg} = 0.24$ mag was taken from Kinman et al. (1982), and no internal extinction correction was applied to the total magnitude, since it is uncertain and likely not very large (Thuan and Martin, 1981). As in SVDH we adopted a distance of 10 Mpc; similar values were published by Hart et al. (1980), using the group velocity of $V_0 = 732\,\mathrm{km\,s^{-1}}$ with $H_0 = 75\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$, by de Vaucouleurs and Olson (1982) using the Faber-Jackson relation, by Aaronson and Mould (1983) using the Tully-Fisher relation, and by Davies and Kinman (1984) using the observed redshift and a Virgo-centric flow correction of $220\,\mathrm{km\,s^{-1}}$. On the contrary Sandage and Tammann (1982) give 17.9 Mpc. The asymptotic colours of NGC 1023 were calculated extrapolating the photoelectric data compiled by Longo and de Vaucouleurs (1983). Our results (Table 1) disagree slightly with the values $(B-V)_T = 1.00$ and $(U-B)_T = 0.55$ mag given in RC2 for NGC 1023, and fit the mean values extracted from RC2 for $T = -3$, with no allowance for galactic extinction: $(B-V)_T = 0.97 \pm 0.11$ (93 objects) and $(U-B)_T = 0.47 \pm 0.18$ mag (62 objects). We must add that the values $(B-V)_T^0 = 0.81$ and $(U-B)_T^0 = 0.35$ mag, computed following the precepts of RC2 with $A_B = 0.51$ mag, do not compare well with the average numbers for $T = -3$ published by de Vaucouleurs (1977).

2. Observations and reductions

2.1. Spectroscopic observations

Two medium dispersion spectra of the central region of NGC 1023 and NGC 1023A respectively were taken with the *Photon Counting Multichannel Spectrophotometer* attached to the *Spectrograph SP-124* (Ioannisiani et al., 1982) at the Nasmyth focus of the 6-m telescope of the USSR Academy of Sciences. In its 1024 channel mode this *SIT* TV-type scanner (Somova et al., 1982) has a typical resolution (FWHM) of 4 Å at a dispersion of 1.7 Å/channel. The rectangular slit was set to 2″.8 × 16″ with the long axis at P.A. = 120°. In both cases the night sky was monotored by a simultaneous exposure through an identical slit parallel

Table 1. Optical and radio parameters of NGC 1023

Morphological type: (RC2)	SB0$^-$ ($T = -3$)
Apparent total blue magnitude:	$B_T = 10.20$ mag
Adopted distance:	$\Delta = 10$ Mpc ($1' = 2.9$ kpc)
Adopted galactic extinction:	
Kinman et al. (1982)	$A_{pg} = 0.24$ mag
Asymptotic colours:	
from Longo and de Vaucouleurs (1983)	$(B-V)_T = 0.95$ mag
	$(U-B)_T = 0.48$ mag
Major axis diameter at $\mu = 25$ B/ss:	$D_{25} = 7'.7 = 22.3$ kpc
Absolute total magnitude:	$M_B = -20.05$ mag
Absolute blue luminosity ($\mathscr{L}_\odot = 1$):	$L_B = 1.63\ 10^{10}$
Heliocentric optical radial velocities:	
Tonry and Davies (1981)	$V = 617 \pm 19$ km s^{-1}
Schechter (1983)	$= 605 \pm 10$
Dressler and Sandage (1983)	$= 615 \pm 20$
This paper	$= 620 \pm 50$
Adopted mean value	$= 615 \pm 20$
Maximum stellar rotational velocity:	
Dressler and Sandage (1983)	$V_m = 251$ km s^{-1} at $r = 1'.5$
Velocity dispersion:	
Whitmore et al. (1985)	$\sigma_0 = 218$ km s^{-1}
Position angle of the major axis of the disk: (BC)	P.A. = 86°
Total H I mass in the vicinity: (SVDH)	$M_{\rm HI} = 1.5\ 10^9\ M_\odot$
Formal H I-mass-to-B-luminosity ratio:	$M_{\rm HI}/L_B = 0.09$

Table 2. Spectroscopic observations

Object	R.A. (1950.0)	Dec. (1950.0)	Exp. time	P.A.	Slit
NGC 1023	$2^h37^m20^s$	+38°50′54″	647^s	120°	2″.8 × 16″
NGC 1023A	$2^h37^m13^s$	+38°50′28″	4512^s	120°	2″.8 × 16″

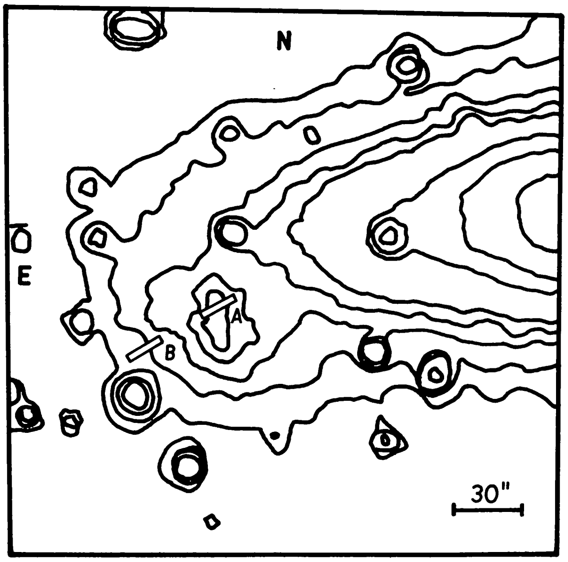

Fig. 2. Location of the spectrograph slits superposed to low resolution isophotes of NGC 1023A from the Asiago plate 9263, obtained with a Joyce-Loebl microdensitometer. The light of the object within slit B, used to monitor the sky, is 4 times less than within slit A

to the other and offset by 36″ along the direction of its long axis. In the first spectrum the main slit was centered visually onto the nucleus of NGC 1023, in the second it was positioned onto NGC 1023A by a blind offset ($\Delta\alpha\cos\delta = 154''$ and $\Delta\delta = -26''$). Details are summarized in Table 2, and the location of the slit for the second spectrum (NGC 1023A) is visualized against an isophotal map in Fig. 2. From the photometric study presented in Sect. 2.2 we calculated that the mean surface brightness of NGC 1023A within the two apertures is about 23.0 and 24.5 B/ss respectively, and that the contamination due to the light of NGC 1023 is negligible in both cases (see also Fig. 8).

Figure 3 plots the sky-subtracted count rates for the two spectra, corrected for instrumental response. In spite of the low surface brightness of the object, the spectrum of NGC 1023A exhibits the usual absorption features, the H and K lines, barely visible, and the G-band. On the contrary no emission lines could be found, in agreement with the negative results reported by BC.

The heliocentric systemic velocity of NGC 1023, estimated by the shift of the G-band and of the H and K lines between the galaxy spectrum and the night sky, resulted $V = 620 \pm 50$ km s^{-1}. This value is consistent with all the recent optical determinations (see Table 1).

The velocity difference ΔV of NGC 1023A with respect to NGC 1023 was evaluated by cross-correlating directly the spectra

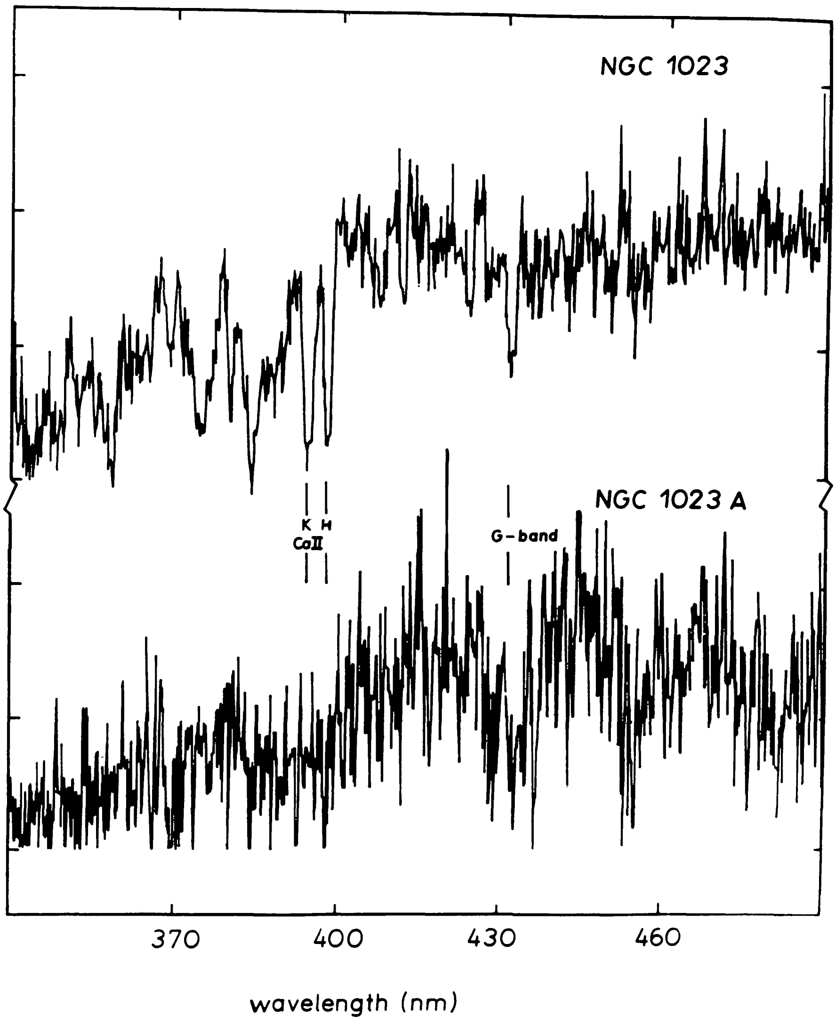

Fig. 3. Plots of the sky-subtracted count-rates of the spectra of NGC 1023 and NGC 1023A respectively, obtained with the *Photon Counting Multichannel Spectrophotometer* attached to the 6-m telescope of the USSR Academy of Sciences (see also Table 2)

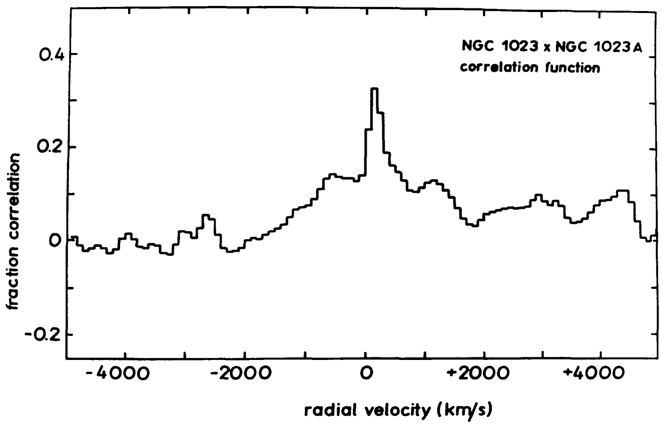

Fig. 4. Fractional correlation as a function of the differential radial velocity between NGC 1023 and NGC 1023A. The peak corresponds to $\Delta V = 127 \pm 30\,\mathrm{km\,s^{-1}}$

of the two objects. Our technique, similar to that described by Tonry and Davis (1979), was implemented by one of us (VA) at the Special Astrophysical Observatory. The fractional correlation as a function of the differential velocity, computed over a range of $\pm 25{,}000\,\mathrm{km\,s^{-1}}$ and plotted in Fig. 4 for the range of $\pm 4000\,\mathrm{km\,s^{-1}}$, has only one peak in excess of 0.3, corresponding to $\Delta V = +127 \pm 30\,\mathrm{km\,s^{-1}}$. Adopting $V(\mathrm{NGC\,1023}) = 615 \pm 20\,\mathrm{km\,s^{-1}}$ from the mean of the recent optical determinations given above (with a very conservative estimate of the errors), the radial velocity of the stellar component of NGC 1023A is $742 \pm 30\,\mathrm{km\,s^{-1}}$. This value is almost identical to that found by SVDH for the H I cloud projecting onto NGC 1023A.

2.2. *Photometric observations*

Some new information about the morphology of NGC 1023A was collected from a high resolution (FWHM = 1.″4) calibrated plate taken by J. Rose at the Cassegrain focus of the 210-cm telescope of the University of Hawaii (Table 3) In order to obtain a clear picture of NGC 1023A, we had to remove the contamination due to the outskirts of NGC 1023. For this purpose the plate was scanned with the PDS microdensitometer of the Institute of Astronomy of the Padova University (aperture size = scanning step = 50 μm), and the density frame was converted into relative intensity using the technique described by Barbon et al. (1982). The final frame was then cleaned of the stars on the side opposite to NGC 1023A by means of an interactive linear interpolation algorithm working on circular masks, rotated by 180° around the center of NGC 1023, smoothed with a gaussian filter and subtracted from the original. All these operations were performed

Table 3. Photographical material

No.	Emulsion	Filter	Exp. time	Scale	Telescope	Scanning par.	
						Apert.	Step
9263[a]	103a-O	GG13	90 min	34″.3/mm	Asiago 122-cm	50 μm	50 μm
2012[b]	IIa-O	GG385	60 min	9″.2/mm	UH 210-cm	50 μm	50 μm

[a] Calibrated with a spot sensitometer
[b] Calibrated with a rotating mask

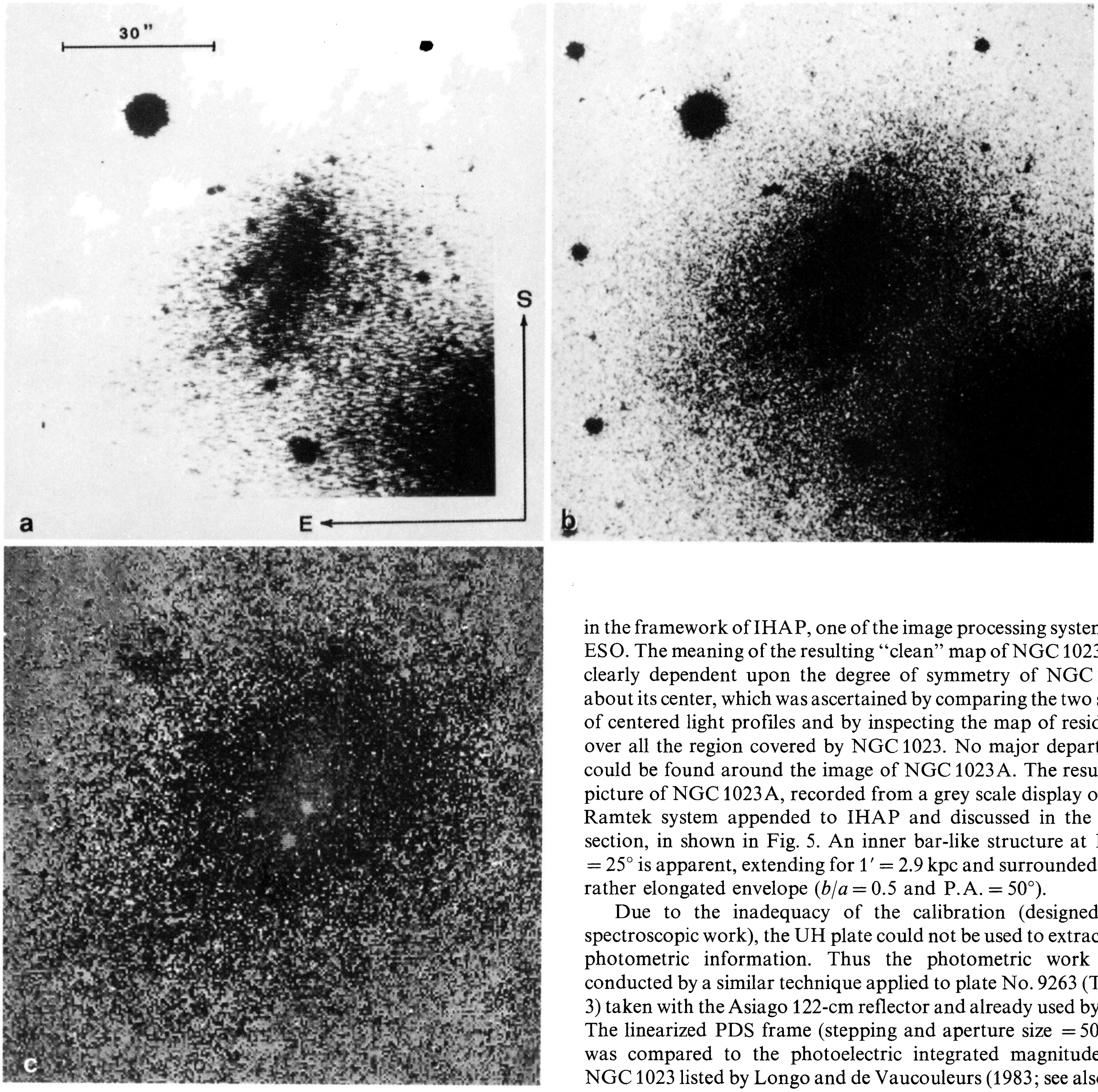

Fig. 5a–c. Computer pictures of NGC 1023A before (**a** and **b** same image displayed with a different clipping) and after (**c**) removal of NGC 1023. All frames, each of about 2′ × 2′, have the same scale and orientation

in the framework of IHAP, one of the image processing systems of ESO. The meaning of the resulting "clean" map of NGC 1023 A is clearly dependent upon the degree of symmetry of NGC 1023 about its center, which was ascertained by comparing the two sides of centered light profiles and by inspecting the map of residuals over all the region covered by NGC 1023. No major departures could be found around the image of NGC 1023A. The resulting picture of NGC 1023A, recorded from a grey scale display of the Ramtek system appended to IHAP and discussed in the next section, in shown in Fig. 5. An inner bar-like structure at P.A. = 25° is apparent, extending for 1′ = 2.9 kpc and surrounded by a rather elongated envelope ($b/a = 0.5$ and P.A. = 50°).

Due to the inadequacy of the calibration (designed for spectroscopic work), the UH plate could not be used to extract the photometric information. Thus the photometric work was conducted by a similar technique applied to plate No. 9263 (Table 3) taken with the Asiago 122-cm reflector and already used by BC. The linearized PDS frame (stepping and aperture size = 50 μm) was compared to the photoelectric integrated magnitudes of NGC 1023 listed by Longo and de Vaucouleurs (1983; see also the corrections). With the exception of an inner measure of Gallagher and Hudson (1976) and the two outermost values given by Bigay (1951), all clearly departing from the others, the residuals have no

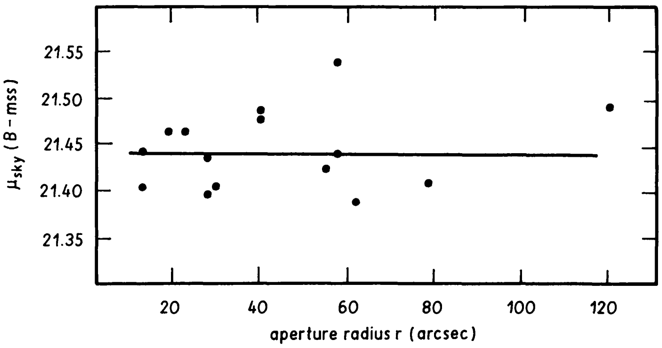

Fig. 6. Residuals from the comparison of the photoelectric integrated magnitudes of NGC 1023, listed by Longo and de Vaucouleurs (1983), with the intensity map of the galaxy derived from the Asiago plate 9263. No trend is apparent

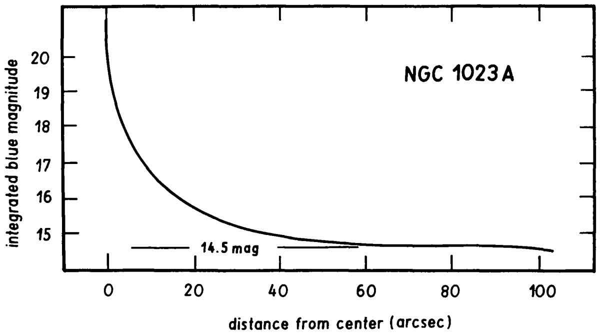

Fig. 7. Integrated blue magnitude as a function of the distance from the center of NGC 1023A. It was computed from the "clean" intensity map (NGC 1023 and foreground stars removed; see text) obtained from the Asiago plate 9263

trend in the range from 15″ to 122″ and set the zero point of the magnitude scale to 21.44 B/ss ± 0.04 rms (Fig. 6). Note that the formal error is of the same order as the scatter in the photoelectric magnitudes. The consistency of the zero point (i.e. of the linearization procedure) was also checked against NGC 1023A using one photoelectric integrated magnitude by Gallagher and Hudson (1976) and two pairs of values kindly provided to us by H. G. Corwin (private communication; see also Table 4), taken with different centering of the aperture. We obtained 21.6 ± 0.4 B/ss. Considering the observational uncertainty, this value is consistent with the previous estimate.

Figure 7 plots the integrated magnitude of NGC 1023A as a function of the distance from the center (set visually). It was computed from a clean map of the object obtained by the same procedure described above for the UH plate. All foreground stars were removed by linear interpolation with the adjacent pixels. The asymptotic trend is not perfectly flat due to some residual signal of NGC 1023 increasing toward its center. From the graph we estimate a total magnitude B_T (NGC 1023A) = 14.5 ± 0.4 mag; the error incorporates the zero point uncertainty. This value is 1.3 mag fainter than that given by BC, who did not account properly for the contamination caused by NGC 1023. The derivative of the integrated light curve of Fig. 7, i.e. the "mean" light profile of NGC 1023A, is a well defined exponential law with $\mu(0) = 22.9$ B/ss and a scale length $\alpha^{-1} = 19\farcs2 = 0.93$ kpc. From the same curve we estimate a mean diameter $D_{25} = 1\farcm3 = 3.8$ kpc.

The contamination of the integrated light of NGC 1023A by NGC 1023 is shown by the curve of Fig. 8 which represents the ratio of the integrated light $L_1(r)$ of NGC 1023A alone to the integrated light $L_T(r)$ of the combined image of the two galaxies as a function of the distance r from the center of NGC 1023A. This curve was used to correct the observed photoelectric colours (Table 4) assuming the constant values $(U-B) = 0.95$ and $(B-V) = 0.48$ mag for NGC 1023 at large distances, deduced from the aperture photometry. For instance, since $L_1/L_T = 0.47$ at $r = 37''$, then the observed colours of NGC 1023A, $(U-B)_T = 0.83$ and $(B-V)_T = 0.26$ mag within $r = 37''$, correct to 0.72 and 0.04 mag respectively. A summary of the basic information about NGC 1023A is given in Table 5.

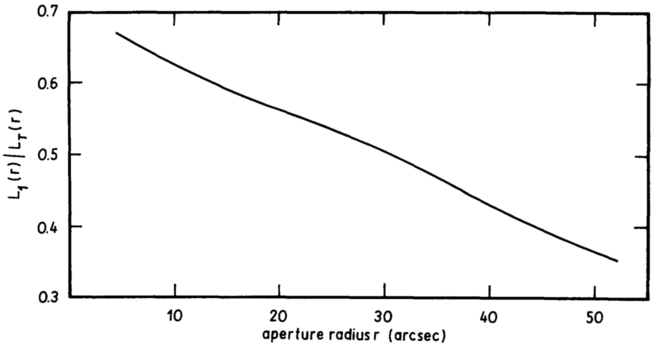

Fig. 8. Ratio of the integrated light L_1 of NGC 1023A alone to the total light L_T contributed by both galaxies (NGC 1023 + NGC 1023A) within the same circular aperture as a function of the aperture radius

Table 4. Photoelectric colours of NGC 1023A

Source	Aperture radius	V (mag)	$(B-V)_0$	$(U-B)_0$	$(B-V)_c$	$(U-B)_c$
			(Observed)		(Corrected)[a]	
Gallagher and Hudson (1976)	14″0	15.27	0.71	–	0.58	–
Corwin (private communication)[b]	18″9	15.00	0.79	0.07	0.69	−0.12
	18″9	14.60	0.81	0.31	0.71	0.12
Gallagher and Hudson (1976)	22″5	14.22	–	–	–	–
Corwin (private communication)[b]	37″7	13.11	0.84	0.30	0.72	0.08
	37″7	13.43	0.83	0.22	0.71	0.00

[a] No correction for differential extinction
[b] Two values relative to different centering

Table 5. Optical and radio parameters of NGC 1023 A

Morphological type:	Im or late-type dwarf ($T=10$)
Apparent total blue magnitude:	
Observed: ($r_{\rm lim} \sim 50''$)	$B_T = 13.6 \pm 0.2$ mag
Corrected for overlapping	$= 14.5 \pm 0.4$
Peak surface brightness:	$\mu_B = 23.0$ B/ss
Corrected integrated colours: (see also Table 4)	$(B-V)_T = 0.7$ mag
	$(U-B)_T = 0.0$ mag
Adopted distance:	$\Delta = 10$ Mpc
Adopted galactic extinction:	$A_{pg} = 0.24$ mag
Peak brightness of exponential disk:	$\mu(0) = 22.9$ B/ss
Scale length of exponential disk:	$\alpha^{-1} = 19''.2 = 0.93$ kpc
Mean diameter at $\mu = 25$ B/ss:	$D_{25} = 1'.3 = 3.8$ kpc
Absolute total magnitude:	$M_B = -15.7$ mag
Absolute blue luminosity ($\mathscr{L}_\odot = 1$):	$L_B = 3\ 10^8$
Heliocentric radial velocity:	
Optical (this paper)	$V = 742 \pm 30$ km s^{-1}
H I (SVDH)	$= 743 \pm 3$
Position angle of the bar:	P.A. = 25°
Position angle at $\mu = 25$ B/ss:	P.A. = 50°
H I mass: (SVDH)	$M_{\rm H\,I} = 8.8\ 10^7 M_\odot$
Observed H I-mass-to-B-luminosity ratio:	$M_{\rm H\,I}/L_B = 0.29$

3. Results

In Sect. 2.1 we have shown that the optical systemic velocity of NGC 1023 A coincides with that of the H I condensation projecting onto it. In turn the H I condensation is part of the "red cloud" linked to NGC 1023 (SVDH). Thus we have to conclude that NGC 1023 A and NGC 1023 are close objects. The projected distance between their centers is $d_a = 2'.6 = 7.6$ kpc and possibly the actual distance d_t is not much larger. In fact NGC 1023 A projects at one end of the "red cloud" which, according to SVDH, seems to be a ring-like structure rotating in the same sense as the stars of NGC 1023 (although more slowly and about a systemic velocity which is 90 km s^{-1} larger than that of NGC 1023). If the "red cloud" encircles NGC 1023, then d_t is indeed not much larger than d_a.

A close inspection to Figs. 1 and 5 gives the impression that NGC 1023 A is a magellanic type irregular (see the examples given by Feitzinger, 1980). As mentioned before, it possesses a barlike structure extending for $1' = 2.9$ kpc along a direction at P.A. = 25°, which is embedded in a fainter envelope with $D_{25} = 3.8$ kpc. Not much of the structure is apparent, in agreement with BC and Davies and Kinman (1984). However we see clumps of light, mainly in the southern ridge. The general texture of NGC 1023 A, as judged from the high resolution UH plate, is slightly more grainy than the regions of NGC 1023 with comparable surface brightness. The "bridge" connecting the two stellar bodies, which is visible in Fig. 5a, b, is likely a result of the superimposition of the two images since it disappears in the "clean" image of Fig. 5c.

The absolute magnitude, the size and the mean surface brightness of NGC 1023 A are consistent with the smallest T9 galaxies in RC2[1] and also with the DDO sample ($T=10$) investigated by Thuan and Seitzer (1979a, b; see also Sandage et al., 1985)[2]. On the contrary the corrected colours (Table 4) are about 0.22 mag redder in $(B-V)$ and 0.25 mag redder in $(U-B)$ than expected from the mean colours extracted from RC2 for $T=9$: $(B-V)_T = 0.48 \pm 0.08$ mag (for 24 objects) and $(U-B)_T = -0.25 \pm 0.12$ mag (for 14 objects). This conclusion remains unchanged if the colours of NGC 1023 A, corrected as in RC2, are compared with the average values for $T=9$ and 10 (de Vaucouleurs, 1977). Taking the mass $M_{\rm H\,I} = 8.8\ 10^7 M_\odot$ of the neutral hydrogen cloud superposed on the optical image of NGC 1023 A, we obtain $M_{\rm H\,I}/L_B = 0.29$ (solar units). This number is a factor of 3 less than the expected mean value for $M_B = -15.7$ mag according to the data compiled by Davies and Kinman (1984, see their Fig. 4) for low surface brightness dwarfs, and places NGC 1023 A at the lower boundary of the $M_{\rm H\,I}/L_B$ vs. L_B distribution.

4. Discussion

In the previous section we have seen that NGC 1023 A resembles a magellanic irregular or a low surface brightness late-type dwarf. This classification, consistent with the absolute magnitude and with the linear size of the object, is in contrast with the quite smooth texture of the galaxy image, with the colours (which are by far too red), with the lack of emission lines and with the low content of H I. The proximity of NGC 1023 A to NGC 1023, as well as the provocative morphology of the neutral hydrogen in the area of NGC 1023 (particularly the "tail"), suggest a possible way to remove the above discrepancies. Following SDVH we assume

[1] For the comparison we used redshift distances with $H_0 = 75$ km s^{-1} Mpc^{-1} for RC2 and A_e (NGC 1023 A) = 50″

[2] The mean surface brightness of NGC 1023 A was computed from formula (4) of Thuan and Seitzer (1979a) adopting a Holmberg major diameter $a_{\rm H} = 1'.5$ and an axis ratio $r_{\rm H} = 0.5$

that, not too long ago, NGC 1023A has experienced a tidal interaction with the more massive companion. Although insufficiently strong to disrupt the galaxy, the fly-by encounter may have caused the removal of a large fraction of the interstellar material of NGC 1023A. The obvious consequences of that must be a cut of the value of $M_{\rm H\,I}/L_B$ and a sudden reduction of the stellar formation activity, which may account for the observed lack of structures and of emission lines and for the red colours. Let us try to quantify this picture.

First of all we estimate the time required by a magellanic irregular or late-type dwarf galaxy [$(B-V)_T=0.4$ and $(U-B)_T=-0.3$ mag] to change its colours by about $+0.25$ mag if the star formation rate is suddenly cut to zero. The calculations, kindly provided by F. Olivi, were made assuming a late-type galaxy model with a constant rate of star formation up to 10^{10} yr and a Salpeter IMF with $\alpha=2.35$; main sequence, subgiant, giant and horizontal branch stars are taken into account (see Barbaro and Olivi, 1986). The evolution of the colours after the complete stop of the star formation requires 1.5 10^8 yr to produce a $\Delta(B-V)$ of 0.22 mag and only 0.3 10^8 yr for the variation of 0.25 mag in $(U-B)$. Since the latter colour is more sensitive to our drastic modification of the star formation rate, we consider 10^8 yr a reasonable estimate of the time interval required to produce the colour changes attributed to NGC 1023A. This number is in perfect agreement with the crossing time $t_c=1.1$ 10^8 yr evaluated according to the model of tidal interaction of dwarf objects with gaseous haloes of massive galaxies (Silk and Norman, 1979). For the calculations we used M(NGC 1023) $=1.3$ 10^{11} $M_\odot$ after Dressler and Sandage (1983) and a velocity difference $\Delta V=250$ km s^{-1} between NGC 1023A and NGC 1023; the latter value is 2 times larger than the observed radial velocity difference and 4 times larger than the mean velocity dispersion of Group 7 as estimated by Hart et al. (1980) under the assumption of the existence of two subgroups. Such a coincidence, coupled with our improved photometric data, encouraged us to proceed testing if all of the H I mass in the area of NGC 1023 may have been stripped from the dwarf companion.

If we take the ratio of all the H I mass around NGC 1023 to the present luminosity of NGC 1023A, we obtain $M_{\rm H\,I}/L_B=5$, a large value at the upper boundary of the distribution of dwarf galaxies in the L_B vs. $M_{\rm H\,I}/L_B$ plane (Davies and Kinman, 1984). Since such a distribution has a mostest slope and a large dispersion around the mean trend, the agreement improves but not significantly if we increase the B-luminosity of NGC 1023A to a plausible value possessed before the encounter. We may estimate a correction of 0.5 B-mag due to the stopping of the star formation (Olivi, private communication), but we have also to consider the effect of the fragmentation of the stellar body. This is difficult to quantify, but the lack of major optical debris indicates that the correction to the luminosity is likely to be small (with our material it is not possible to estimate the amount of the faint debris, if any). Thus, although not totally inconsistent with the data, it does not seem likely that all of the H I around NGC 1023 has been supplied by the dwarf galaxy. Again, as in SVDH, NGC 1023A is probably the *donor* of just the H I tail and the "red cloud".

However the question is far from solved. In fact, up to now we have no detailed kinematical model accounting for the velocity field of the H I clouds. In an attempt reported by Appleton (1983) the parameters required to reproduce the kinematical picture are implausible; particularly the mass and the size of the accreting galaxy. Further kinematical observations of both galaxies are needed as well as detailed computer simulations. Nevertheless it appears difficult to reject the hypothesis of a tidal interaction between the two objects, since otherwise the peculiarities of NGC 1023A would remain unexplained.

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