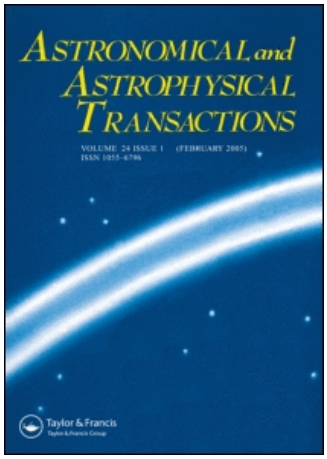

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BVR-photometry of the compact objects interacting with the nuclei of active galaxies

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BVR-PHOTOMETRY OF THE COMPACT OBJECTS INTERACTING WITH THE NUCLEI OF ACTIVE GALAXIES

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BVR-magnitudes of compact objects interacting with the nuclei of active galaxies NGC 1275, NGC 7469, Mrk 290, Mrk 298, 3C 120, and 3C 390.3 were obtained using a TV complex of the 0.5-m telescope. The positions of the objects on the two-colour diagram permit us to suppose that all of them except one contain nearly the same stellar populations as in the central regions of their host galaxies. Absolute magnitudes of 5 compact objects are equal to $M_v \sim -18^m.5$ but the object of 3C 390.3 (N-galaxy) is by one magnitude fainter.

KEY WORDS Active galactic nuclei, host galaxies of active galactic nuclei

The problem of the host galaxies containing Seyfert nuclei was considered by de Vaucouleurs (1968), Zasov and Lyutyi (1973, 1981), Pronik (1972), Adams (1977), Rees (1978), Balick and Heckman (1982), Neizvestnyi (1988), Fricke and Kollatshny (1989), Whittle *et al.* (1992, a, b, c) and other authors. All the authors mentioned many signs of disturbance of a regular structure of the host galaxies. It was suggested that they have tidal interactions with their satellites. Sometimes the satellites are absent but signs of the structure disturbances are present. Metik and Pronik (1976, 1977, 1979, 1981, 1990; Pronik and Metik, 1990) suggested that in latter cases the "perturbators" may be located inside the galaxies. For example, compact objects observed near the nuclei can be important in some cases.

We investigated 6 active galaxies, NGC 1275, NGC 7469, Mrk 290, Mrk 298, 3C 120, and 3C 390.3 which have a compact object interacting with the nucleus (see Figure 1). The evidences of the interaction of starlike objects with the nuclei of the host galaxies were published by different authors. For NGC 1275, it is shown by photometric maps obtained with the 6-m telescope in the spectral region 4800 Å and 6650 Å (Metik and Pronik, 1984) and in the photometric system B with a high angular resolution at Mount Maidanak (Dudinov *et al.*, 1990). Radioisophotes at 6 cm wavelength clearly show interaction in the case of NGC 7469 (Ulvestad *et al.*, 1981; Metik and Pronik, 1990). Multicolor photometry has allowed Metik and Pronik (1976) to reveal signs of the interaction in Markarian 290, and blue light images served for this purpose to Ambarzumyan and Shachbazyan in the case of

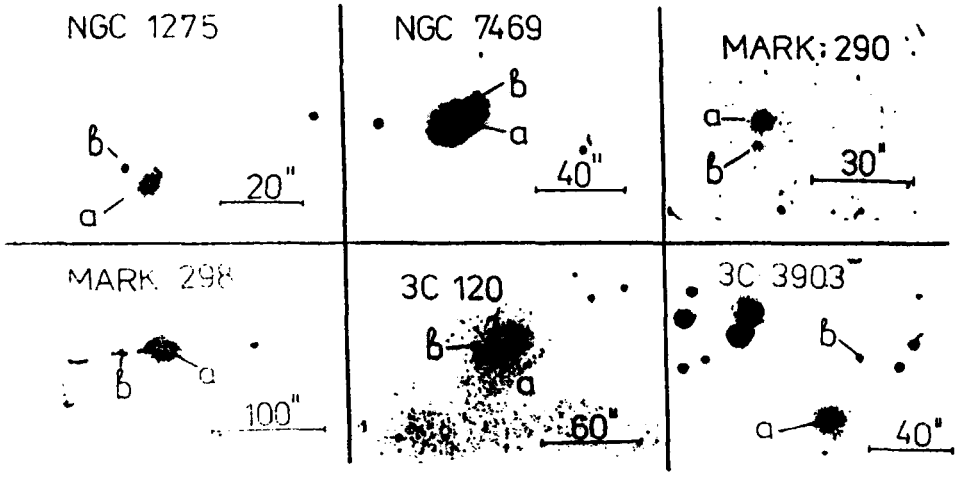

Figure 1 Two-color diagram of compact objects interacting with the active galactic nuclei and other well known by nature objects. The cross size is 2σ (see the text).

Markarian 298. The interaction in 3C 120 was revealed by Hua (1988) in the light of emission lines. The starlike object in 3C 390.3 is located inside a radio stream emanating from the nucleus of the host galaxy (Babadzanjanz *et al.*, 1981). The nature of the objects is unknown. As a first step toward the understanding, we have measured the BVR magnitudes of compact objects. In the discussion below, we adopt $H = 75$ km/s/Mpc.

OBSERVATIONAL DATA

BVR-observations were carried out at the Crimean Observatory during spring and autumn 1989 and spring 1990 with the 0.5-m meniscus telescope coupled with the TV devices using intensified isocon tubes. TV images were film-recorded and the method of stellar photographic photometry was used. This method and its accuracy were described by Abramenko *et al.* (1984, 1988). The color systems are close to those of Johnson. In each color band, 5–15 TV pictures were measured for each compact object. An estimate of the part of the light in the measuring diaphragm belonging to the host galaxies and the night sky allows us to conclude that for all the cases except NGC 1275 this can be neglected in comparison with that of the compact objects. In the case of NGC 1275, the host galaxy and the compact object lights were almost equal, but the contribution of the former was carefully taken into account. A comparison of our data for NGC 1275 and 3C 120 with other observations showed a good agreement.

Table 1. Stellar magnitudes of compact objects interacting with the active galaxies nuclei

Galaxy	*V*	*(B-V)*	*(V-R)*	M_v *compact objects*	*r, kpc*
NGC 1275	$15^m.67$	$0^m.39$	$0^m.88$	$-18^m.5$	2.5
NGC 7469	15.74	0.54	0.86	−18.5	5.0
Mrk 290	17.24	0.82	1.56	−18.2	4.0
Mrk 298	16.96	0.13	0.95	−18.6	23.0
3C 120	16.87	0.82	0.98	−18.6	14.0
3C 390.3	19.52	−0.37	1.40	−17.2	40.0

DISCUSSION

The problem under discussion is: are the compact objects stars of our Galaxy? The two-color diagram of the objects, $(B-V)(V-R)$, shows that, if it is so, all of them are influenced by very high interstellar extinction. It is well known that interstellar absorption in the region under consideration is not high: $A_v \leq 0^m.4$. The color indices obtained for the compact objects permit us to calculate the ratios $E(V-R)/E(B-V)$, they are 5.6–18.9. It is obvious that they are not real if $A_v \leq 0^m.4$. This fact allows us to suggest that the position of the objects on the two-color diagram is caused by their extragalactic nature.

Table 1 shows the V-magnitudes, color indices and absolute magnitudes of the compact objects considered, corrected for the redshift influence. The latter were supposed equal to the redshifts of host galaxies. Column 6 of the table contains the distances of the compact objects from the nuclei of host galaxies projected on the sky. The points inside the crosses in Figure 2 give the uncorrected color indices and their errors, the ends of arrows show the corrected ones. The data of Figure 2 evidence that the compact objects are different by their nature from globular clusters, elliptical and irregular galaxies and quasars (powerful sources). The color indices of the compact objects are close to those of Markarian and Seyfert galaxies, having both blue and infrared excesses in their emission. The positions of the starlike objects of Mrk 290 and 3C 390.3 do not coincide exactly with those of Markarian and Seyfert galaxy groups in the figure. But the red and blue color indices of the former can be obtained by shifting typical Markarian galaxies by intrinsic interstellar extinction. The nature of the second one will be considered later.

If the object in 3C 390.3 is omitted, the rest have equal absolute magnitudes $M_v = -18^m.5$. Their small distances from the host galaxy nuclei (2.5–23 kpc) suggest that they are located inside the galaxies. The published observational data show that the objects may have early A–F spectral types and are not connected with large gaseous complexes. All of them have signs of interaction with the nuclei of the host galaxies in optical continuum, or (and) in emission lines, or (and) in radio range.

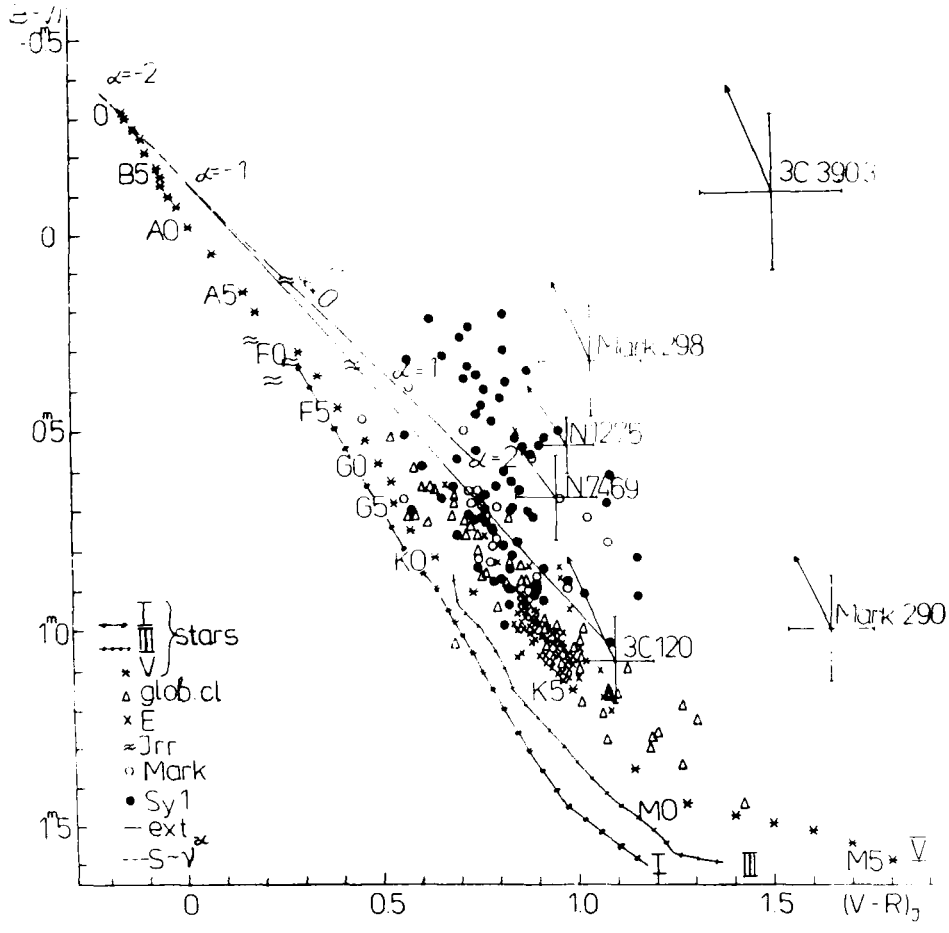

Figure 2 Identification maps of compact objects interacting with the active galactic nuclei according to Burbidge and Burbidge (1965), Burbidge *et al.* (1963, a, b), Metik and Pronik (1976), Arp (1968), Babadzanjanz *et al.* (unpublished); *a*, galaxy nuclei; *b*, compact objects.

The 3C 390.3 object is distinguished from the other ones by a very blue color index $(B-V) = -0^m.37$, very red color index $(V-R) = 1^m.40$ and its absolute magnitude by 1^m weaker than that of the other ones. Calculations show that the contribution of emission lines H_α+[NII], H_β and [OIII] 5007 Å in the spectral bands is too small to affect the color indices. The object is located in the northern part of the radio stream which emanates from the nucleus of the host galaxy. The distance of the object from the nucleus is not less than 40 kpc – it is located at the boundary of or outside the galaxy. All characteristics of the compact object in 3C 390.3 – the color indices, location in the galaxy, its absolute magnitude, resemble those of a peculiar galaxy in the 3C 120 system studied by Arp (1987) and the object of

Minkowsky, located in the optical bridge between the pair of galaxies NGC 547/545 and NGC 541 in the galaxy cluster A 194 (Simkin, 1976; van Breugel *et al.*, 1985). Both of them are typical extragalactic HII regions. Baryshev (1983, 1985) supposed that the object in 3C 390.3 is a result of the interaction of jets streaming from the nucleus with the interstellar and intergalaxies medium. Our data show that the object contains both young and late type stars. The degree of young and late type stars in the object may differ from that of normal galaxies because of its unusual nature caused by its position inside the jet streamers.

In conclusion one can ascertain that the above compact objects located in the systems of the host galaxies with active nuclei can have a common evolution with the host galaxies.

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