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Research Note

A third quasar close to NGC 3842

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Summary. Radio and X-ray observations have identified quasar candidates in the area of Abell 1367, a cluster of galaxies in the Coma supercluster. NGC 3842 is one of the largest galaxies in A1367 and was previously reported as having two quasars within 73″ of the center of the galaxy. The present paper reports the confirmation of a third quasar at a distance of 73″ from NGC 3842. The new quasar has a redshift of $z=2.20$.

Key words: individual galaxies = NGC 3842 – quasars

1. Introduction

The nearby cluster of galaxies A1367 in the Coma supercluster was extensively observed with the Westerbork telescope in the course of a radio survey of clusters of galaxies (Gavazzi, 1979). In addition to some sources associated with cluster galaxies, two radio sources in the central region of the cluster were proposed for identification with stellar objects (Gavazzi, 1978). Recent X-ray observations with the Einstein Observatory (Bechtold et al., 1981; Gavazzi and Trinchieri, 1983) revealed the existence of 3 X-ray sources identified with star-like objects (one coincident with a radio-selected object). Two of the X-ray sources were closely spaced across NGC 3842, the large galaxy in A1367. Observations by Arp (1984) showed that these were both quasars. A radio source identified with a stellar object also fell about the same distance from NGC 3842. It has now been investigated spectroscopically and the results are reported in the present paper.

2. The observations

The three quasar candidates surrounding NGC 3842 are identified in Fig. 1 and their positions are given below:

QSO 1 $11^h41^m21^s.3$ $+20°13'32''$ X-ray source

QSO 2 $11^h41^m30^s.4$ $+20°14'16''$ X-ray source

QSO 3 $11^h41^m29^s.7$ $+20°12'42''$ radio source.

QSO 3 is associated with a 25.6 ± 2.3 mJy radio source found from a 1.4 GHz survey (Gavazzi, 1978). Measurements at 5.0 GHz with the Westerbork radio telescope ($S_{5.0}=21.8\pm0.5$ mJy) reveal a flat spectrum source ($\alpha_{1.4}^{5.0}=0.13\pm0.07$) often found associated with quasars.

The optical observations of QSO 3 reported here were made by H. Arp and J. W. Sulentic on the night of 6 Feb. 1984. The exposure was one hour in length with the cryogenic camera of the Cassegrain spectrograph of the 4-meter Mayall-telescope at Kitt Peak National Observatory. The CCD detectors were sensitive primarily in the red wavelengths from about $\lambda\lambda4000$ Å to 7000 Å at the dispersion used. The resulting spectrum is shown in Fig. 2 where two major, and several minor emission lines were recorded. The wavelengths of these lines were derived by comparison of their pixel numbers to the pixel numbers of Helium and Neon lines at the same position in a comparison spectrum taken directly after the quasar spectrum.

The spectrum is shown in Fig. 2 where the emission lines which were identified have been marked. He II may also be present in this spectrum to the red of C IV but it appears broad and may be confused with nearby lines. The redshift derived from these line identifications is $z=2.205\pm0.005$ for QSO 3 where the uncertainty is derived from the agreement in redshift for the four identified lines.

The redshifts and magnitudes of all three quasars are given below:

QSO 1 $z=0.335\pm0.002$ $m_{pg}\lesssim19$ mag

QSO 2 $z=0.946\pm0.005$ $m_{pg}\lesssim19$ mag

QSO 3 $z=2.200\pm0.005$ $m_{pg}\lesssim21$ mag.

3. Discussion

The exact probability of obtaining the observed association by accident depends on which of the properties of the quasars are considered as being significant. All three quasars are within 73″ of the center of NGC 3842. If we only ask what is the probability of finding two quasars $\leqq19$ mag this close to an arbitary point in the sky we obtain $p=7\ 10^{-6}$ (Arp, 1984). Finding three quasars within this distance is less probable but is difficult to calculate exactly because the average density of quasars near $m_{pg}\approx21$ mag is much less well-known (Woltjer and Setti, 1982; Arp, 1983). Of course, the percentage of quasars which are X-ray sources is less than the number of all quasars and the number of radio quasars is less than the number of all quasars. So, if we ask what the probability of finding quasars with these kinds of X-ray and radio properties is,

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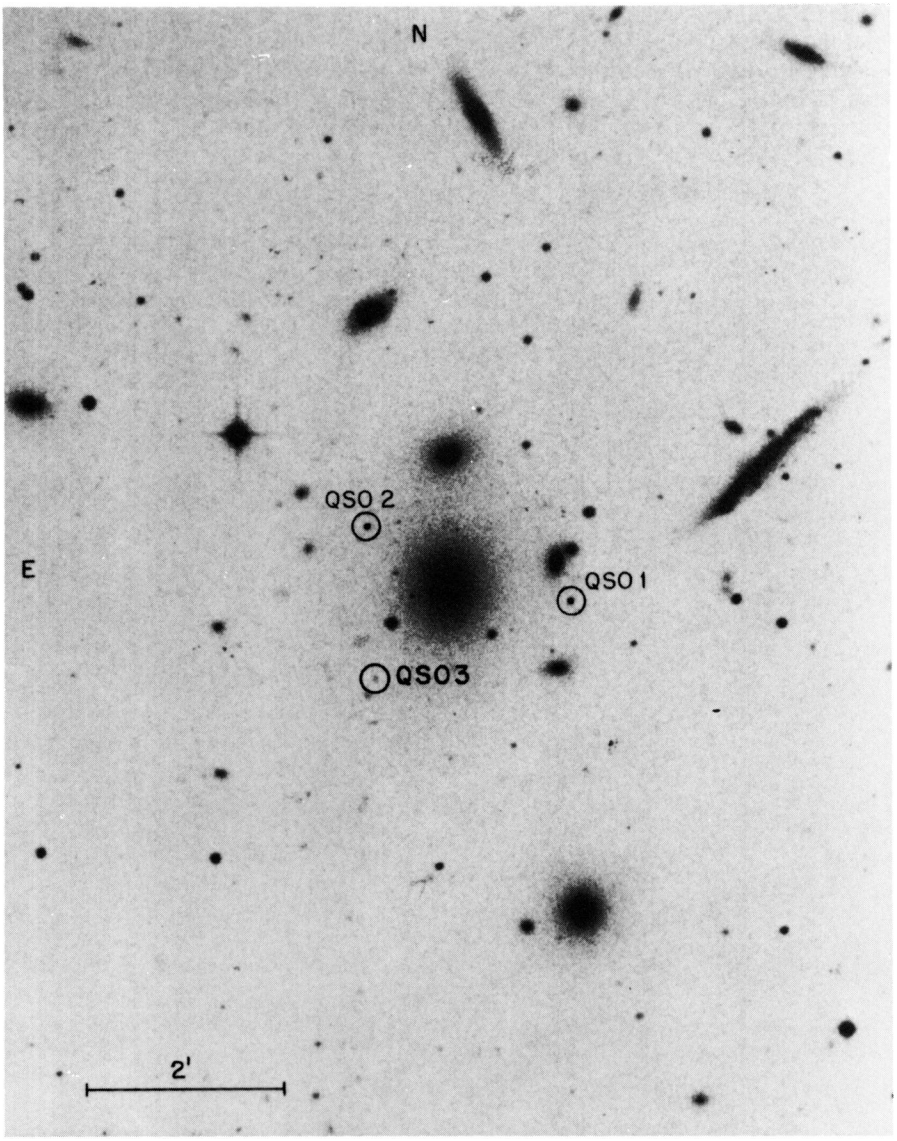

Fig. 1. Photograph on IIIa-J plate with the Palomar 48-inch Schmidt, courtesy Charles Kowal. The newly discovered quasar which is discussed in the text is labelled QSO 3. The central galaxy is NGC 3842

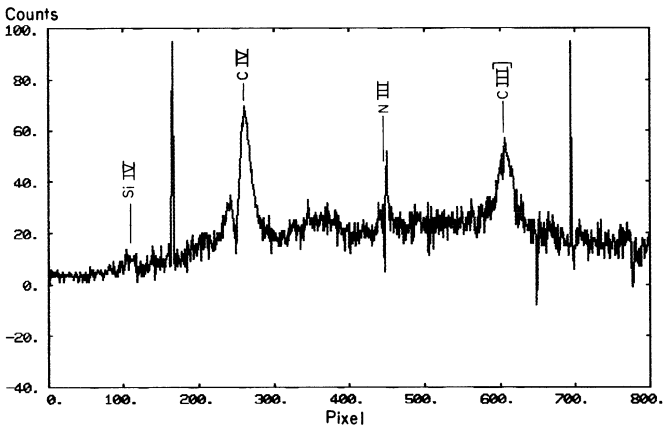

Fig. 2. Spectrum of QSO 3 as taken by Arp and Sulentic with the cryogenic camera on the spectrograph of the 4-meter Mayall-telescope at Kitt Peak National Observatory

the significance of the configuration becomes even much higher. [For the radio quasar if we use $N(S)=225\,s^{-2.5}$ radio sources/sterad Jy at 1.4 GHz we obtain $N(>25\,\text{mJy})\sim 1.5\,10^{-2}$ radio sources within 73″ of an arbitrary point on the sky. If we were to assume that all these radio sources were identified with quasars we would have about 10^{-2} as an upper limit of the probability of finding QSO 3 within its observed distance from NGC 3842.]

The hypothesis that quasars fall closer to low redshift galaxies than would be expected by chance has been enunciated extensively by a number of authors (Arp, 1966, 1983; Burbidge et al., 1972; Sulentic, 1981). The A1367 cluster discussed here was investigated by radio and X-ray surveys and one of the largest galaxies in the cluster was found to have three quasar candidates closely grouped around it. Spectroscopy has now confirmed all three of these as quasars. This represents confirmation of a very high order of significance for the previously reported associations of quasars with nearby galaxies. Systematic search for possible further ultraviolet excess objects in this cluster of active, X-ray and radio galaxies should now be carried out.

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