# Optical Identification of the Transient X-ray Source 4U1543–47

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Since the decay of the highly successful X-ray observatory on board the "Einstein" satellite, things have been relatively quiet concerning discoveries on the X-ray sky. For some time, the scene was dominated by the tiny Japanese satellite Hakucho. This spacecraft carried no imaging detectors, but turned out to be very useful for the study of already known, relatively bright sources. At ESO, we used much observing time simultaneously with Hakucho in an attempt to learn more about the so-called X-ray burst sources (1). Recently, two more X-ray satellites have been launched: the second Japanese satellite, TENMA, and the European EXOSAT.

Most of the observations with these satellites are planned in advance, but, as is the case with ground-based observations, the temporary appearance of a new celestial object may justify a change of schedule. This is what happened on August 18, 1983, when the transient source monitor on board TENMA detected a bright, new X-ray source near the border between the southern constellations Lupus and Norma. Three days later the source had reached half the brightness of Sco X–1, which may be called the "Sirius" of the X-ray sky. At La Silla, we were immediately alerted by telex in order that we could try to identify the source optically, but during just those days, odds were against any optical work. Full moon was approaching, and the Schmidt telescope was out of operation because of technical work. Dr. Tanaka, from the TENMA team, had, however, remarked that the new source appeared very close to the position of a bright X-ray transient which had been seen from July 1971 till September 1972 by the Uhuru satellite. This source, called 4U1543–47 (2), had never been identified optically. We immediately checked our CCD data bank for pictures of the former transient position. Indeed, CCD pictures had been taken in July 1981 during the installation period of the CCD camera at the 1.5 m Danish telescope. Prior analysis of these images (which were taken in three colours) had shown no object of conspicuous colours. The images were checked once more, but with the same result. The location of the old transient was, however, not known to great accuracy, and it could, indeed, be outside the area covered by the CCD.

The operation team of the EXOSAT satellite had, of course, also been alerted by the Japanese discovery. The first, crude analysis of observations from August 28 resulted in a position which was well outside the old error box, although still, in itself, quite large, 30″ maximum error radius (3). This readily gave a good reason why our old CCD pictures had not shown anything interesting. Still, the two positions are so close that the two transients must be identical.

Finally, on the last night of the month we obtained a Schmidt plate of the area. The photograph was taken in red light in order to compare it with a similar plate from the ESO Survey of the Southern Sky. The classical method would now be to "blink" both exposures, but we chose first to put them on top of each other. Shifting one slightly with respect to the other, we did, in fact, see what we had hoped for: a star which had increased in brightness. The change was only modest, at most a factor of 2.5, but still interesting as the star was located near the middle of the error circle quoted by the EXOSAT team (Fig. 1 is a finding chart of this star).

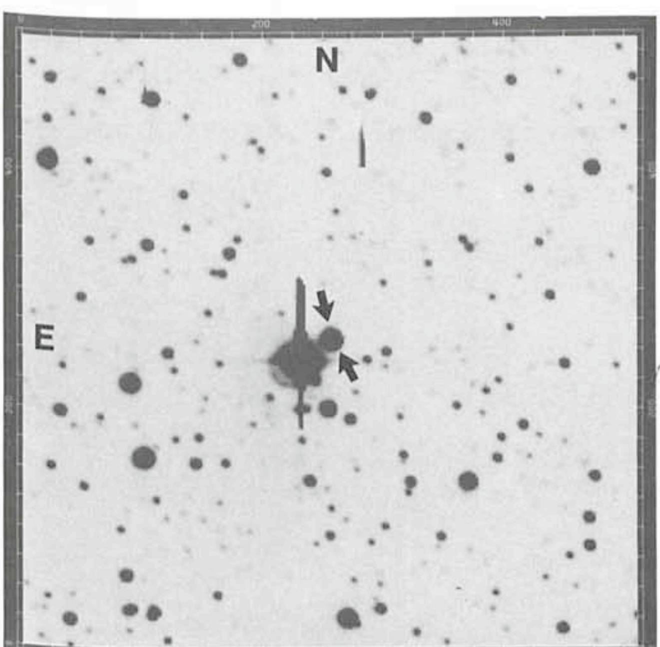


Fig. 1: *Finding chart of the optical counterpart of 4U1543–47 from a CCD frame obtained with the 1.5 m Danish telescope. The field is apparently 2 arc minutes square.*

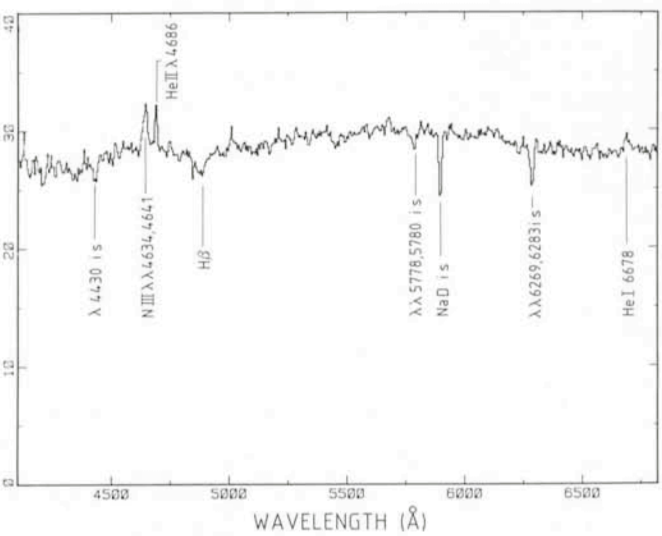


Fig. 2: *Spectrum of the optical counterpart of 4U1543–47 obtained on the evening of September 2, 1983 with the Image Dissector Scanner and the Boller and Chivens spectrograph attached to the Cassegrain focus of the 3.6 m telescope. The dispersion was 171 Å/mm$^{-1}$. Exposure time: 60 min. The emission line He II λ 4686 and the blend N III λλ 4634, 4631 are clearly visible, leaving no doubt as to the identification with the X-ray source. Several interstellar absorption features are present with a relatively large equivalent width, showing that this star is relatively distant. This spectrum is very similar to the one of other transient X-ray sources, e.g. A0620–00 (5).*

The same night was the first in a new CCD run at the 1.5 m Danish telescope and we managed to squeeze the object in. Although low in the west at the start of the night, the pictures allowed a crude measurement of the brightness and colour of the candidate from the Schmidt plate. Observations from this night and from the two following are consistent with a constant V = 14.9, B–V =0.6. The object is thus not a very conspicuous one with respect to either brightness or colour. The final confirmation would have to come from spectroscopy. Luckily, the 3.6 m telescope was assigned for low-dispersion spectroscopy during the same nights. Mira and Philippe Véron were equipped with a finding chart and were able, shortly after the start of the night of September 1/2, to confirm the discovery. The candidate showed a spectrum rather typical for X-ray transients, the most characteristic feature being emission lines due to nitrogen and helium. Later spectra, by the Vérons, by Joergensen, and by Pakull, have added much weight to the observations, and may even be used for studying the variability of certain features. The strength of some interstellar absorption lines is indicative of the distance of the object, probably more than 1 kpc (~ 3000 light-years) (Fig. 2).

By the middle of October, Dr. Blissett, of the EXOSAT team, reported that the X-ray position had been refined so that the maximum error now is 10″. The new position is, in fact, only 4″ from that of the optical counterpart as measured with the pointing facility of the 1.5 m Danish telescope (4).

### References

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# Colour Pictures with a CCD Camera

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The 1.5 m Danish telescope at La Silla has been used to photograph a number of galaxies with a CCD camera (1) through three different filters: blue (Johnson B), red and infrared (Gunn r (L) and z). The images have been reduced with the ESO image processing system IHAP and then transferred to the VAX computer to use DICOMED, the high quality hard copy device which produces colour slides. These photographs are in real but not natural colours in the sense that instead of using blue, green and red images, we have used blue, red and infrared. The colour balance is arbitrary but the same for all pictures, except #2. The seeing was 1.2 to 1.5 arcsec. In all cases, north is at the top, east to the left.

*Fig. 1: NGC 1068. This is the prototype of Seyfert 2 galaxies. The picture shows an overexposed nuclear region, the red nuclear bulge and a ring of blue knots, hot stars and H II regions. To the NE and SW of the nucleus, some kinds of reddish filamentary structures emerge in the general direction of the radio structure (3). (Field size 47 × 47 arcsec).*

*Fig. 2: NGC 1068. In contrast to all other pictures taken here, this was produced using an image taken with a 250 Å bandwidth filter centred on 5500 Å, avoiding all emission lines, the z image which also avoids emission lines, and a narrow band ($\Delta\lambda$ = 20 Å) filter centred on the very strong [OIII] $\lambda$ 5007 Å emission line. The nuclear region is again overexposed. The emission line region appears green, extending towards the NE. Narrow band pictures (4), (5) have previously revealed this emission cloud. The scale is the same as for the preceding image.*

*Fig. 3: NGC 1808. This is one of the rare galaxies with nuclear hot spots (6). Three primary hot spots connected by high surface brightness filaments have been reported (7). Our picture indeed shows a star-like nucleus and two blue "hot spots" to the SE and NW of the nucleus with reddish filaments which may not connect the nucleus to the hot spots. Spectra obtained with the IDS and the Boller and Chivens spectrograph at the ESO 3.6 m telescope with a 4 × 4 arcsec aperture show that the strong H$\alpha$ and [NII] emission lines have a complex profile, suggesting the superposition of a normal H II region and a Seyfert-like nebulosity similar to that observed in the nucleus of the SBb galaxy NGC 7496 (8). It is therefore very likely that NGC 1808 has a Seyfert 2 nucleus; this galaxy is associated with the radio source PKS 0505–375 which has received very little attention. The red filamentary structure could be associated with the Seyfert phenomenon rather than with the hot spots. This galaxy clearly deserves more observations (field size: 47 × 47 arcsec).*

*Fig. 4: NGC 7177. Sab galaxy. The bright red bulge is partly obscured on the SE quadrant by dust. Faint blue arms can be seen (field size: 47 × 47 arcsec).*

*Fig. 5: NGC 289. This late type (SBbc) galaxy has quite a conspicuous nucleus (with very faint emission lines) in a red bulge, partly obscured by dust lanes, and surrounded by blue spiral arms (field size: 104 × 104 arcsec).*

*Fig. 6: NGC 7496. SBc galaxy. The picture shows well the blue regions of star formation in the arms. The bulge is almost non-existent. A spectrum of the bright nuclear region shows complex emission lines (8) (field size: 47 × 85 arcsec).*

Colour pictures are not only attractive, they may also be useful as is best shown by the photograph of the central region of NGC 1808 which makes it possible to sort out the different components.

### References

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