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No. 44 June 1986

ESO Observations of Bright Supernova in Centaurus A

An extensive observing campaign is underway at the European Southern Observatory in an attempt to unravel some of the mysteries of massive stellar explosions, known as supernovae. It has been triggered by the sudden appearance of a comparatively bright supernova in the peculiar galaxy NGC 5128, located in the southern constellation Centaurus. This galaxy is one of the strongest radio emitters in the southern sky and is as such designated Centaurus A (Cen A).

The supernova, which has received the official designation 1986G by the International Astronomical Union, was discovered on May 3.5 UT by Reverend R. Evans, an amateur astronomer in Australia who has more than a dozen earlier discoveries to his credit. It appeared as a "new star", southeast of the centre of Cen A and almost in the middle of the broad dust band that girdles this unusual galaxy (see Figure 1). The magnitude was estimated as 12. No supernovae have been detected in this galaxy before. This event is of particular interest, because comparatively bright supernovae are rather rare and also because of the peculiar nature of the parent galaxy. The most recent supernova of a similar magnitude was in 1980, in the northern, spiral galaxy NGC 6946.

Supernovae are believed to represent a late evolutionary stage of massive stars in which the star runs out of atomic fuel. It can no longer support its own weight and collapses. Immediately thereafter follows a dramatic thermonuclear explosion during which the

outer layers are blown into the surrounding space. A small and very compact object may remain at the centre. The best known historical supernova was seen in the year 1054, giving birth to the Crab Nebula and an associated neutron star, which was detected as a radio pulsar in 1967. Most, if not all,

heavy elements in the Universe have been generated in the exceedingly hot interiors of stars in the supernova phase. Supernovae are very rarely discovered before they reach their maximal brightness and little is known about the early phases. Currently, about 20–25 supernovae are detected per year in ex-

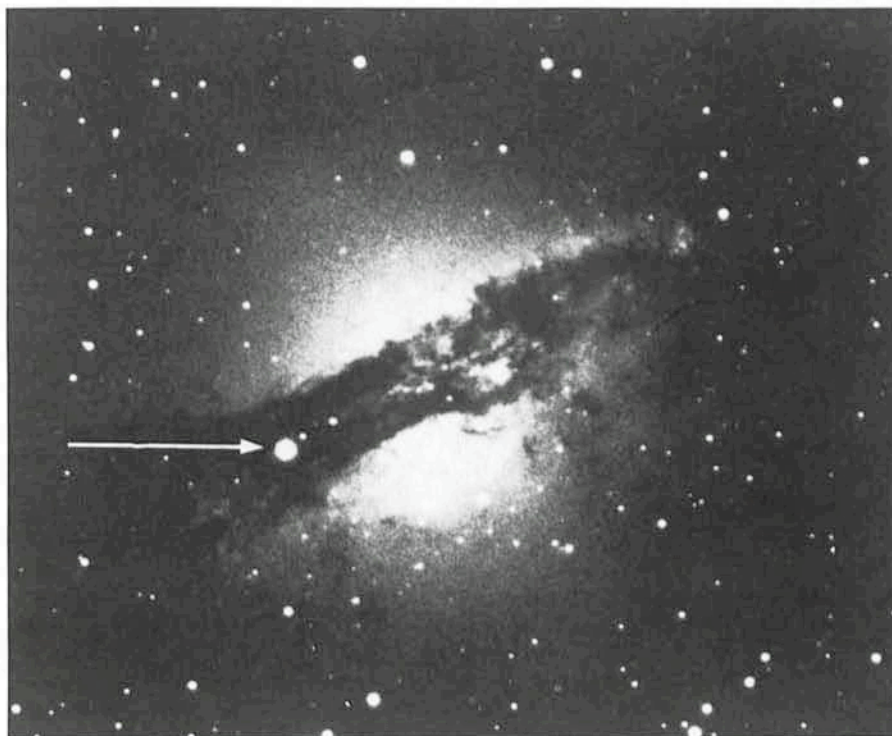


Figure 1: This picture of the newly discovered supernova 1986 G in the peculiar, southern galaxy Centaurus A (= NGC 5128) was obtained on 1986 May 8.0 UT with the ESO 40-cm double astrograph (GPO) on La Silla. Exposure: 90 minutes on blue-sensitive IIa-O emulsion. Observer: H. Duerbeck, visiting astronomer from Astronomisches Institut, Münster, FRG. The 11.5-mag supernova (indicated with an arrow) is situated in the extensive dust band that surrounds the galaxy.

terior galaxies; the last one in our own galaxy, the Milky Way, appears to be the one found by Kepler in the constellation Ophiocus in 1604.

Observations at ESO with the 1-m and 50-cm photometric telescopes have shown that supernova 1986G was still brightening at a rate of about 0.05 mag/day on May 11.2 UT. On this date, the V-magnitude was 11.4 and colour index (B-V) was 1.1 magnitude. CCD images in different colours were exposed at the Danish 1.5-m telescope (cf. the note by Galletta in this *Messenger*). Low-dispersion IDS and CCD spectra have been obtained with the ESO 1.5-m spectroscopic telescope and with the 2.2-m telescope (cf. the note by di Serego Alighieri). They show a typical Type I supernova spectrum before maximum, significantly reddened by absorption in Cen A. Of special interest are very high dispersion spectral observations, obtained with the CASPEC spectrograph at the ESO 3.6-m telescope. The Call H and K lines and the

Na I D lines show a complicated structure with no less than six very deep absorption components. From a preliminary analysis, it would appear that four of these are caused by absorption of the light from the supernova in four separate interstellar clouds in Cen A. One is due to matter in the Milky Way and one may belong to an intergalactic cloud between Cen A and the Milky Way, the existence of which was surmised in an earlier ESO study of this galaxy (D'Odorico et al., 1985, *Ap. J.* **299**, p. 852).

These observations, and the position near the middle of the dust band, indicate that the supernova is situated well inside the galaxy and that its light is dimmed by about 4 magnitudes due to obscuring dust. Had it been situated in an unobscured region, its magnitude would have been about 7.5, making it the brightest supernova in this century. Due to Cen A's peculiar structure (some astronomers consider it to be the result of a collision among two galaxies), it has

not yet been possible to measure an accurate distance to this galaxy. However, if the intrinsic brightness of 1986G is that of a normal Type I supernova, then the distance to Cen A would be around 2–3 Megaparsec (7–10 million light-years), or only 3–4 times farther away than the Andromeda Nebula. Cen A may therefore even be an outlying member of the Local Group of Galaxies. At a distance of 3 Megaparsec, the total radio energy would be around 10^{58} ergs, corresponding to 10^4 solar masses. Clearly, a most energetic event has taken place in Cen A rather recently; the velocity dispersion of the interstellar clouds may be a relict of it.

The ESO observations are continuing. The following ESO staff and visiting astronomers have participated so far: I. Bues, P.R. Christensen, S. di Serego Alighieri, H. Duerbeck, G. Galletta, L. Kohoutek, P. Magain, P.E. Nissen, D. Reimers, R. Schulte Ladbeck and J. Sommer-Larsen. *The editor*

CCD Observations of Supernova 1986G in Cen A

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A CCD image of the newly discovered supernova in NGC 5128 was obtained with the Danish 1.52-m telescope on May 8, 1986. By comparison with previous images of the same area it appears that the supernova is located in a luminous portion of the dust band, similar to a hole in the disk of gas surrounding the galaxy (Fig. 1).

This disk and the related dust lane is

probably the result of a recent collision with a gas cloud or a gas-rich system, whose age has been estimated to about 3×10^8 years (Tubbs, A.D., 1980, *Ap. J.* **241**, 969). A convincing proof of this is that the rotation axis of the gas coincides with the major axis of the underlying galaxy (Graham, J.A., 1979, *Ap. J.* **232**, 60; Marcellin, M. et al., 1982, *Nature*, **297**, 38) while the stars within the

galaxy share a cylindrical rotation around the minor axis (Bertola et al., 1985, *Ap. J.*, **292**, L 51), i.e. perpendicular to the gas rotation axis.

On the basis of these investigations, it appears that, in the region where the supernova is located, the mean gas motions relative to the sun are around 340–380 kms^{-1} , but that the stellar motions, extrapolated to the same point, would be around 500 kms^{-1} or more. Accordingly, the supernova in this peculiar galaxy (which is not oblate but triaxial) must belong to the old population of the underlying stellar system, if its velocity is higher than 450 kms^{-1} . However, the velocity of the central object of the supernova can only be measured at a later stage, when it is well past maximum. The interstellar absorption lines which were observed at ESO at high resolution then represent different layers (clouds) in the dust band. On the contrary, if the supernova belongs to the stars connected to the gas disk, its velocity must be lower, but in that case we shall be obliged to revise the age of the collision phenomenon (cf. the article by Tubbs). This hypothesis is also in contradiction with the Type I appearance of 1986G.

Clearly, it is of great importance to continue the observations of this interesting object.

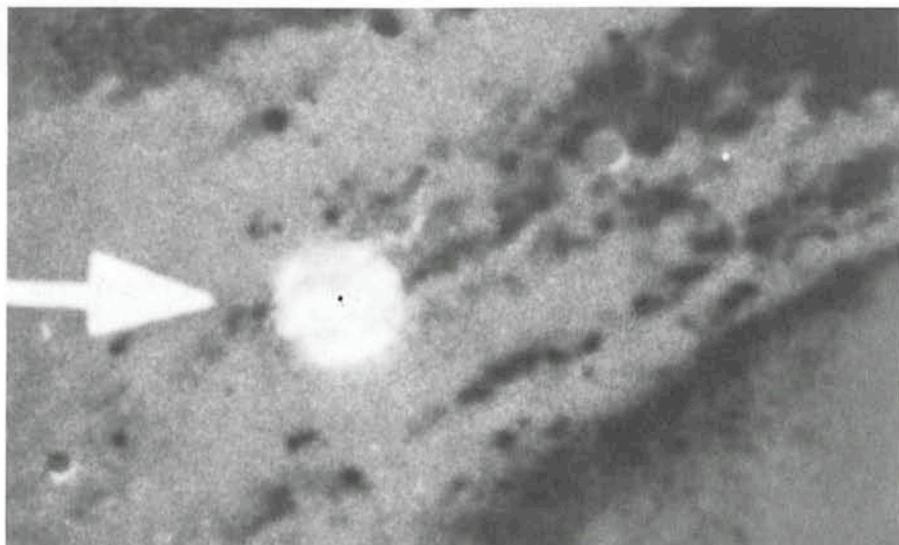


Figure 1: A sandwich of two photographs of Cen A, one taken before the explosion of the supernova and one after. The small point at the centre of the white circle is the position of 1986G, as measured on a CCD frame, obtained with the Danish 1.54-m telescope. The diameter of the white circle is about 18 arcseconds.