THE SUPERNOVA IN NGC 4564

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Supernova explosions are among the most violent events known to astronomy. Recently interest in supernovae has been stimulated by our increased understanding of stellar evolution and by the observation that supernova remnants are powerful sources of radio radiation. Observations of the spectra and light curves of supernovae suggest that at least two distinct types of supernovae exist. The most luminous supernovae are those of Type I which reach a mean photographic absolute magnitude of -18.4 at maximum light and during their later stages exhibit an exponential decline in luminosity. Supernovae of Type II are considerably fainter, attaining a mean photographic magnitude of -15.9 at maximum light, if a Hubble constant $H = 120$ km./sec./Mpc. is adopted. Supernovae of Type I have been observed to occur in E, Sb, Sc and Ir galaxies. Supernovae of Type II occur most frequently in Sc galaxies but have also been observed in galaxies of Type Sb. Type II supernovae are observed predominantly in the outer, spiral arm regions of spiral galaxies. This suggests that they are associated with a young stellar population. Possibly they are due to the explosion of very young, supermassive stars. This suggestion receives support from observations by Evans and Thackeray (1950) of the ring-shaped emission region N70 (Henize 1956) in the Large Magellanic Cloud. This nebula exhibits the same peculiar filamentary structure (van den Bergh 1960) that has been observed in a number of old galactic supernova remnants such as the Cygnus Loop. A star cluster, presumably containing young stars, is located at the exact centre of the ring-shaped nebula N70. It is, therefore, tempting to assume that the supernova which gave rise to the N70 nebulosity was a member of this cluster.

Our understanding of supernovae is greatly handicapped by the fact that supernovae occur so rarely and, because of their great distance, are usually extremely faint. The discovery of a relatively bright supernova by Romano of the Padua Observatory on May 9, 1961 (Liller 1961) in the elliptical galaxy NGC 4564 is, therefore, of considerable interest. On the night of May 19/20, 1961, the visual magnitude of the supernova was estimated to be approximately 11. According to Holmberg (1958) NGC 4564 has an integrated visual magnitude of 11.33 so that the supernova was probably slightly brighter than the galaxy in which it occurred. NGC 4564 is probably a member of the Virgo cluster, which

has a distance modulus of about 30, so that the absolute visual magnitude of the supernova was approximately −19. This high luminosity and the fact that NGC 4564 is an elliptical galaxy suggest that the supernova was of Type I. Bertola at the Asiago Observatory has obtained a spectrum of the object and reported it as probably of Type I.

Figure 1 shows a microphotometer tracing of a very weak spectrum

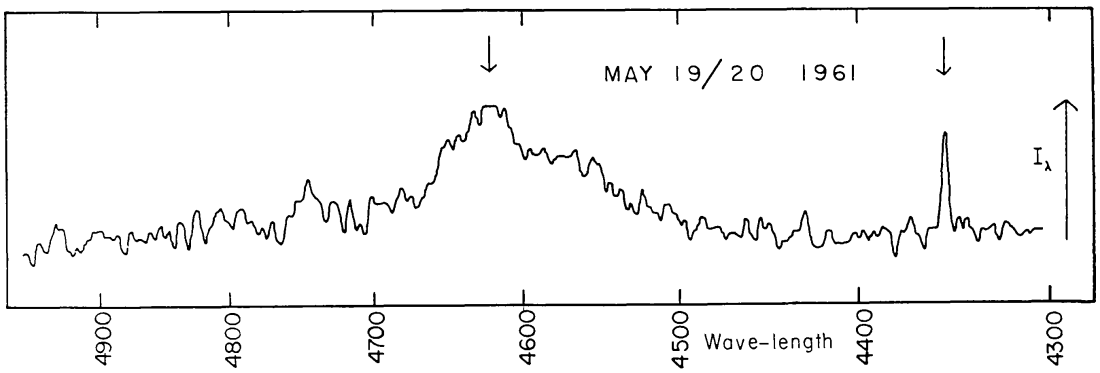

FIG. 1—Microphotometer tracing of the supernova in NGC 4564. The trace shows a broad emission feature centred at λ 4620 and a terrestrial mercury line at λ 4358. The ordinate, I_λ, is the intensity at that wave-length.

of the supernova in NGC 4564 which was obtained during a three hour exposure on 103aO emulsion during the night of May 19/20, 1961. The original spectrogram has a dispersion of 66 A./mm. at Hγ and was taken with the 12.5-inch spectrograph attached to the 74-inch telescope of the David Dunlap Observatory. A slit width corresponding to 3.3 A. at the plate was employed. In addition to a strong mercury line at λ 4358, which arises from commercial lighting, the tracing shows only a broad emission feature centred at λ 4620.

Observations by Minkowski (1939) of the Type I supernova in IC 4182 show that the emission band near λ 4600 does not become the dominant feature in the blue part of the supernova spectrum until more than ten days after maximum light. Assuming the development of the supernova in NGC 4564 to parallel that of the supernova in IC 4182 one may probably conclude that maximum light occurred at least ten days prior to May 19/20. In his 1939 paper, Minkowski notes that the most prominent features in supernovae spectra gradually shift to longer wave-lengths. Figure 2 shows the wave-lengths of the maximum of the λ 4600 feature in IC 4182, corrected for redshift on the assumption that this dwarf irregular galaxy is a member of the Canis Venatici Cluster, as a function of time after maximum light.

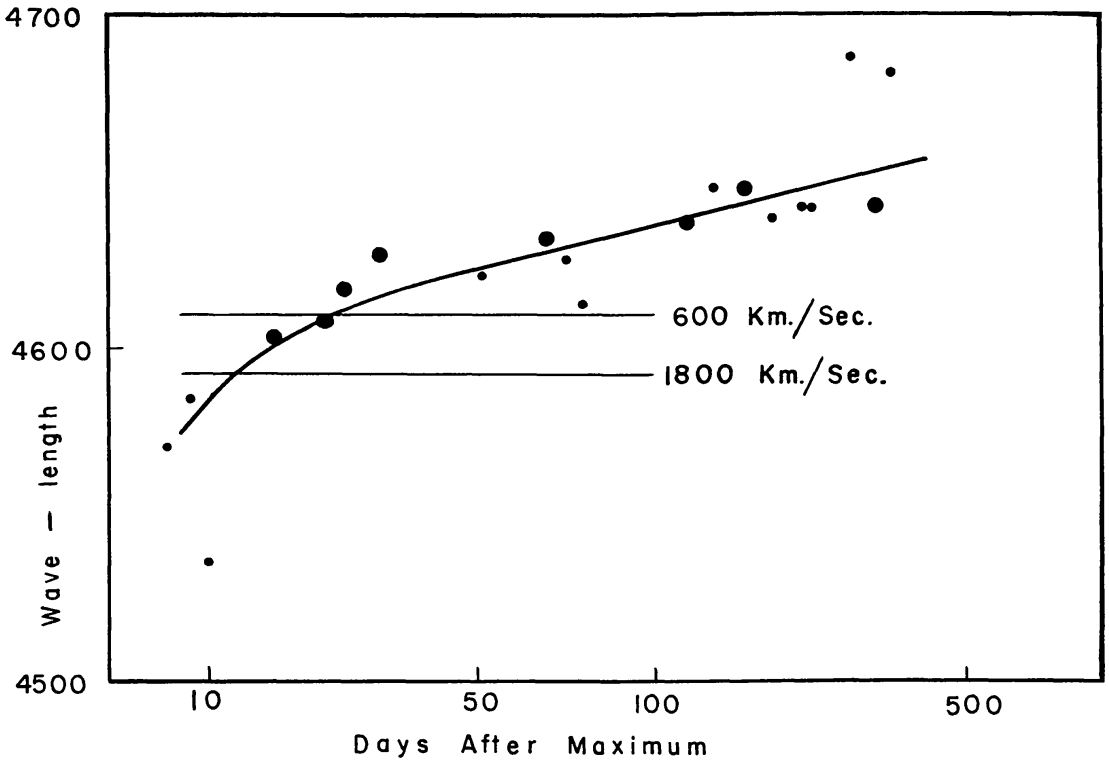

FIG. 2—Positions of the λ 4600 feature as a function of time after maximum light from Minkowski's observations of the supernova in IC 4182. Accurate observations are denoted by large dots. Horizontal lines indicate the position of the λ 4600 feature in NGC 4564 for assumed redshifts of 600 and 1800 km./sec. The figure indicates that the supernova in NGC 4564 was probably between 10 and 20 days past maximum on May 19/20.

The position of the λ 4600 feature in NGC 4564, corrected for redshift, on the assumption that this galaxy has a radial velocity between 600 and 1800 km./sec., is shown in figure 2 by two horizontal lines. (Most of the redshifts of members of the Virgo Cluster lie within this range.) The data in the figure suggest that maximum light occurred between 10 and 20 days prior to May 19/20. It should, of course, be emphasized that this conclusion is quite uncertain and depends critically on the assumption that the supernovae in NGC 4564 and IC 4182 were comparable in all respects.

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