normal isotopic composition (Clayton, 1982). It seems then plausible that at least one supernova exploded in the vicinity of the proto-sun, some 10^6 years before its formation (Lee, Pappanasstassiou and Wasserburg, 1976).

7.3 The Open Questions

Although the appearance of SN 1987 A has led to new concepts as well as an extraordinary improvement in our understanding of type-II supernovae, some points remain obscure:

• The amount of dust condensed and its possible contribution to the total amount of dust in the galaxies. As pointed out by J. Wampler during this colloquium, the dust formed in the ejecta is expelled at great velocity and sooner or later will have to slow down, with a high probability of being destroyed.

• The enrichment of the circumstellar and interstellar matter in heavy elements (Danziger et al., 1990 were first to determine abundances and they show that there are large uncertainties in the quantitative estimates which are strongly model dependent).

• The stimulating role in star formation in dense interstellar clouds (Öpik, 1953; Herbst, 1977). Klein (1990) showed that the clouds could be destroyed in Rayleigh-Taylor time scales, and give rise to fragmented small clouds which could prevent star formation.

• The determination of H_o through a thermal interpretation at maximum visible light (Branch, 1977, found $H_o = 49 \pm 8$ kms^{-1} Mpc^{-1}). With the VLBI, Bartel (1990) estimated the distance to the LMC and deduced $H_o = 60 \pm 20$ kms^{-1} Mpc^{-1}, which in itself is not so new. However, Bartel stressed the point that he could get a far higher accuracy (~20%) by radio interferometry with Arecibo and VLBI.

On the other hand, some points traditionally related to the supernova phenomenon, or still speculative theories, have not received any input yet from SN 1987 A. Among them are the following ones:

• The relation between supernovae and phenomena observed in quasars;

• The acceleration of galactic cosmic rays in the shock wave fronts created by the explosion;

• The role of supernova induced star formation in producing and sustaining spiral structures in galaxies (Mueller and Arnett, 1976; Gerola and Seiden, 1978);

• The possibility that supernova explosions that took place during the first billion years or so after the big-bang (at a time when the galaxies we see today had not yet formed) impressed on the universe its large-scale structure (Ostriker and Cowie, 1981; Ikeuchi, 1981).

As one can see, future topics of interest are not missing! Much has still to be done to exhaust all the information collected during these first 1001 nights of observing SN 1987 A. These observations will be continued at La Silla, especially in the infrared and sub-millimetre ranges, where more than 80% of the energy is now concentrated. We will also witness the birth of the remnant, watching for any kind of surprise. New telescopes and new detectors will soon be in operation, and new exciting results will certainly be obtained.

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The Bolometric Light Curve of SN 1987 A

Continuing IR photometry in the J, H, K, L, M, N1, N2, N3, Q bands at ESO – La Silla combined with UBVRI photometry reported from CTIO (IAUC 4881, 4910) shows that the bolometric light curve on 10 November 1989 (day 991) lies 1×10^{38} ergs s^{-1} above a linear extrapolation from earlier epochs (Suntzeff and Bouchet, *A.J.* 1989, in press). This levelling off was already apparent for the previously observed day 14 August 1989 (day 903) though at a lower level of significance and is confirmed by observations in less than ideal conditions on 20 December 1989 (day 1030) when black body fitting gives T = 160 K and log L = 38.30 ± 0.05. Because more than 80 per cent of the flux is now emitted redward of the M band, the levelling off is almost completely due to the near constancy of the flux integrated over the M, N, Q bands for days 903, 991 and 1030. This implies that a hitherto undetected energy source is now contributing significantly to the total energy output. If it were due to ^{57}Co, the original amount would have to be 20–25 times the anticipated 0.0017 solar masses (Woosley and Pinto, Workshop on Gamma-ray Spectroscopy, 1988), but this is contradicted by the observed [Co II] 10.52 μ line strength on day 526 (Danziger et al., Proceedings of Santa Cruz Workshop, July 1989). A thermal echo from external dust seems unlikely since it would coincidentally need to have a colour temperature (150–180 K) similar to that of the SN's emission. Moreover, the corresponding scattering echo (cf. IAUC 4746) is not evident in the smooth UBVR light curves (IAUC 4881, 4910). Nevertheless, CCD frames should be inspected for new echoes within 5 arcsec of the SN.

Uncertainties in luminosities derived by fitting black body curves to the far-IR data have been checked using emission curves for isothermal dust clouds of astronomical silicate. With a dust mass 0.05 solar masses, inefficient dust emission at $\lambda > 30\ \mu$ lowers the luminosity by only 0.1 dex.

Pulsar emission, absorbed and reradiated by dust in the ejecta (IAUC 4746), seems the most likely explanation of our observations. Other spectroscopic signatures of such input should be sought.

Subsequent IR observations in January and February 1990 substantiate the flattening of the light curve.

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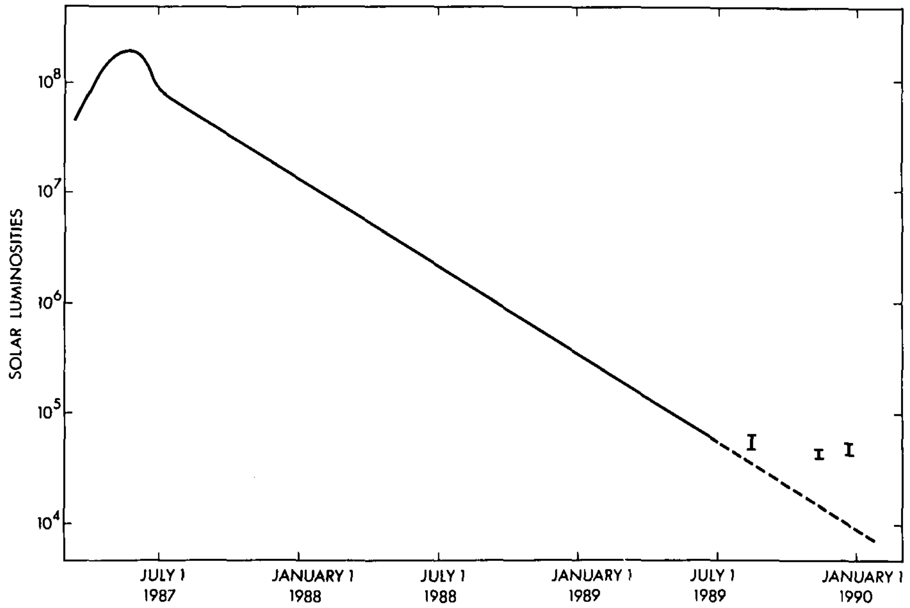

The bolometric light curve of Supernova 1987A ▶

A Photometric Study of the Bright Cloud B in Sagittarius

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1. Introduction

The study of the intrinsic properties of variable stars provides important information about stellar populations in the galactic bulge. The period of a variable star has the advantage of being independent of the distance, whereas the general distribution of stars in a colour-magnitude diagram is strongly influenced by the interstellar absorption.

It is this particular property of the variable stars which has led to numerous photographic studies since 1951 in the direction of the galactic centre, in order to detect such stars and to measure the distance between the Sun and the centre of our Galaxy. In the course of this work various objects have been studied, such as the areas around the globular cluster NGC 6522 and the sources SgrI and SgrII in which many variables of the RR Lyrae type have been detected (blue variables, giants of spectral type A-F with $0.2 < P < 0.5$ and A (amplitude) < 0.8, distance indicators used in particular for the determination of the extragalactic distance scale).

But the study of red variable stars in these regions is even more important and fruitful because we know that M-type giants are a major component of the stellar population in the central regions of galaxies of types E, S0 and Sb (our galaxy is of type Sb or more exactly SAB (rs) bc according to de Vaucouleur's classification scheme).

In 1958, Nassau and Blanco (1958) were the first to prove, with the help of objective prism plates, that there exists a large number of M giants in the field of the globular cluster NGC 6522. This work was later followed and enriched by V and I plates (Klube, 1966), on which the detection of M giants was facilitated by means of the large values of the colour index (V-I).

On the other hand, the accumulation of photographic data in J, H, K, L of the Johnson system for long-period variables (LPVs) detected in the Magellanic Clouds and in the solar neighbourhood (Wood and Bessel, 1983), as well as the refinement of the pulsation theory for Mira Ceti type variables (Fox and Wood, 1982) have permitted the deduction of certain fundamental physical properties of the LPVs. It was in this way that Wood and Bessel, in 1983, were able to show that the LPVs near the galactic centre differ considerably from those in the Magellanic Clouds and in the Local Group: While the J-K colours in these three regions are practically the same for $P < 250$ days, the LPVs near the centre of the Galaxy are particularly red when compared to other variable stars of the Mira Ceti type and they are all stars of spectral type M.

In 1965, working in particular in the red and near infrared photographical regions of the spectra ($\lambda_{eff} \sim 640$ and 830 nm), I detected 421 red variable stars (Terzan 1965, 1966, in the field of one square degree centred at the star 45 Oph ($\alpha = 17^h\ 24^m.1$; $\delta = -29°\ 49'$).

In the same year, Arp (1965) studied the particularly important question about the contamination of the population in the region of NGC 6522 by the projection in the same field of the images of the stars situated between the cluster and the Sun. He concluded that about 90 % of the stars which have a colour (B-V) = 1.0 are indeed stars at large distance which belong to the population in the central region of the Galaxy and resemble a stellar cluster and where the difference in magnitude from the centre to the exterior (in the direction from the galactic centre towards the Sun) is only 0.3 mag.

In 1966, Clube demonstrated that the stars which have $V > 15.5$ and $B\text{-}V > 1.6$ are mainly situated in the galactic bulge.

Then, in 1976, Lloyd Evans (1976) after a comparison of V and I plates taken in three selected fields towards the galactic centre (NGC 6522, SgrI, SgrII), confirmed the predominance of red stars in the galactic bulge. He detected, in particular, 121 red variable stars of the Mira Ceti type having periods significantly longer than those located in globular clusters.

This short historical overview in which only a few important steps in the study of the content of the galactic bulge have