LETTER TO THE EDITOR

Based on a presentation made at the 89th Annual Meeting of the AAVSO, October 27th, 2000

"The Slow Death of Supernova 1999em"

The type IIP supernova 1999em in NGC 1637 appeared to this observer as dimming very slowly in brightness, less than a magnitude in 60 days. So I decided to search the AAVSO International Database online to see if this was unusual. From October 29, 1999 (discovery date of SN 1999em), to October 14, 2000, 12 supernovae made their way into the AAVSO program. 5 of these are type I, 5 are type II, and 2 are unrecorded as to type. All faded faster than SN 1999em. Searching 5 years back found SN 1998S as the slowest to fade, 3.5 magnitudes in 60 days. An immediate fact appeared: there are few faint data on the decay of supernovae. Only 13 observations of supernovae below 16th magnitude were reported to the AAVSO October 1999–October 2000. We all like to discover them, but not many like to help develop a light curve of their demise. I remembered that the type II supernova in the Large Magellanic Cloud (1987A) decayed very slowly. So I ran its light curve and found that it had decayed about 5 magnitudes in 334 days, the same amount of time since SN 1999em peaked. If SN 1999em were following a similar decay, as suggested by the light curve, then it should be between 17.5 and 18.0 magnitude and so easily imaged by CCD. This proved to be true. I imaged SN 1999em 334 days after peak magnitude and easily found it still there, shinning at about 18th magnitude, though it was difficult for me to get a precise measure due to lack of sequence and its location in a bright galaxy background. SN1993J in M81, type II, took a similar drop, but there are no AAVSO data below 16.0 magnitude. And this was the brightest supernova this decade! I don't know if there is much scientific value for AAVSO CCDers to follow supernovae into this Inner-inner Sanctum below 16th magnitude, but we can do it, so should we?

I contacted Dr. Peter Garnavich, University of Notre Dame, South Bend, Indiana, who responded:

"It is always useful to follow supernovae to as faint a level as possible. But if the quality of the data isn't good then it is not worth it. So if you can't get photometry to better than 0.1 mag accuracy in a standard filter then it is probably better to observe some brighter objects. Scientifically, the most useful thing about following supernovae at late time is that the decay rate is a clue to the mass of the exploded star. Once the supernova ejecta becomes transparent to light, it is powered only by the radioactive decay of elements produced in the explosion. These unstable elements make gamma-rays that are absorbed or escape the debris. The more massive the exploded star the more stuff around to absorb the gamma-rays so the light curve decays slowly. A low mass star allows more of the gammas to escape so the energy just flies away and the light curve drops quickly.

"Both SN 1999em and 93J were probably red supergiants. 87A was an oddball. Because it was in a blue SG [supergiant] phase when it exploded it was much fainter than a similar mass red supergiant would have been. Some models imply that the small amount of heavy elements in the Magellanic Cloud is the reason it was in a blue SG phase.

"93J was unusual too, but for different reasons. It had lost about 10 solar masses of gas to a companion star before it blew up and that is why it had a strange light curve.

"99em was the most normal of the three. It was a red supergiant with a large hydrogen envelope which is why it stayed on the "plateau" for so long.

"I'd love to get more people with CCDs following supernovae. They aren't popular with the visual observers because they tend to be too faint, but with CCDs new possibilities appear.

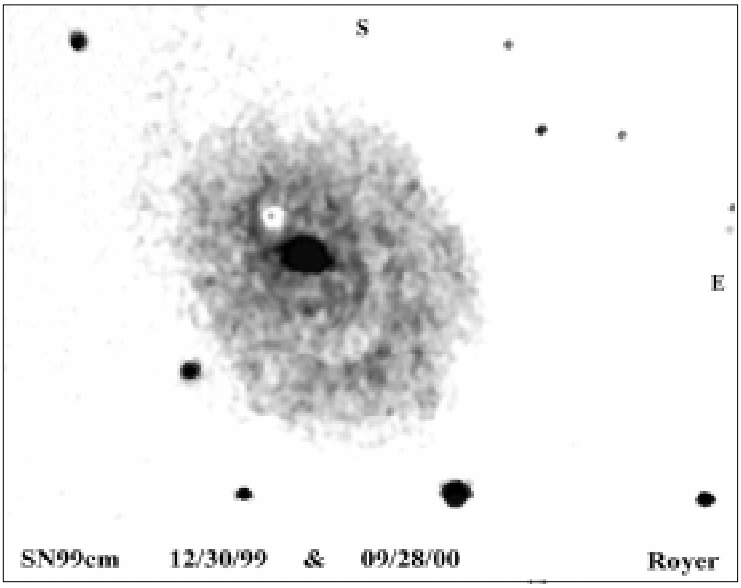

Figure 1. SN 1999em composite CCDV image, 18-inch f7 Newtonian telescope. Positive image of 12/30/99, magnitude 14.0 and negative image of 09/28/00, magnitude 18.0.

"Also with CCDs the need for a comparison sequence is relaxed. As long as there are stars in the field relative magnitudes can be determined. Usually some professional will make a standard sequence around some interesting supernova, it just takes a year to get published. The last thing needed is to figure the color terms for your filter/CCD combination, but that only takes looking at some standard fields on one photometric night. And the color terms won't change unless you get a new filter or CCD....

"What do you think about organizing more AAVSO observers with CCDs to be supernova observers? I think there is lots of potential, but it will take some work to get everyone taking the needed data so that the results can be combined.

—Peter."

So I think that before we read the Last Rites and pull the plug on these supernovae, we should put them in HOSPICE and attend to them in their demise.

I want to thank AAVSO Headquarters and staff for making their Website so useful and easy in researching this kind of data.

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