SNE STUDIED BY M-1 GROUP IN 2000

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Needs work
1) language
2) tables vs text
2a) Table 4 has a note "(1)" which doesnt seem to belong—probably meant to be a text footnote, but I could not find location.
3) refereces: I emailed asking him to send me a revised reference list, formatted according to JAAVSO instructions.

Abstract

In this report we present the most important Sne studied by M-1 Group in year 2000. M-1 Group was founded in 1989, since then we have been monitoring the most important supernovae appeared in our skies. In this report we include data and light curves of SN 1991gi in NGC 3184, SN 2000db in NGC 3949, and SN 2000dk in NGC 382. We also attach some pictures of some weak Sne. In the last part we compare the absolute magnitude of the brightest SNe studied this year, versus the expected values established theoretically nowadays. We also try to explain some of the oddities of SN 2000cx appeared in NGC 524.

1. Introduction

2000 has been another rich year in supernova discoveries. Automatic patrol teams built by both professional observatories and individual amateurs, compete sweeping every clear night the rich fields of galaxies, and finding SNe down to magnitude 19. Visual discoveries disappeared from I.A.U. circulars

Although a big number of SNe were discovered, nearly all of them before maximum, the year 2000 features a total lack of bright events. Actually, none of them attained m = 13.

If we review the objects under surveillance in year 2000, it is worthwhile to remark some very unique things. Like the two SNe appeared in just three months in one galaxy. This happened in the face on spiral NGC 6951, located in Cepheus. Another unusual event was the second SN appeared in NGC 3810. This galaxy gave another one in 1997, dubbed as SN 1997 dq. Finally to mention that several SNe were found in interactive galaxies belonging to ARP catalogue.

2. Observation Techniques

All observations included in this report were made by M-1 members (Table 1). Apparent magnitudes were determined by the method of differential photometry. This requires the use of photometric charts with accurate values for the magnitudes of nearby stars used for comparison. The following material was available: charts from the AAVSO, GSC, and USNO A1.O (this last provided by Dr. Taichi Kato) We

have noticed some discrepancies from one set of charts to another. But we have compared our measurements with those furnished by other observers (especially Mr. Gianluca Masi, from Italy) and we have found that there is a good agreement among the data.

Visual photometry, based on the estimate of a fraction of magnitude by comparison with two reference stars, can give a margin of error of + 0.3 mag. as proven by our work on M 35. Differential photometry using CCD cameras is much more precise than visual estimates. From published work (CCD Astronomy, Fall, 1994) we are confident that a margin of error of + 0.05 magnitude is obtainable for a 13th mag. star with exposure times of 300 seconds.

When no filter is used with the CCD camera, a correction is required to compensate for the response of the electronic chip. A study of 28 stars in the M35 cluster leads to a correction of + 0.4 for stars with color index (B-V) = + 0.55.

Taking all this into account, we feel that our final margin of error is of the order of + 0.2 mag. The programs applied to CCD photometry are those already incorporated into each camera. We haven't used any extinction parameter for possible absorption between the galaxies we studied and our location.

Let us cover in more detail the objects under study in year 2000.

3. SN 1999gi in NGC 3184

One of the most important SN of this year monitored by us during nearly 5 months, was found in December 9th of 1999 in the Ursa Major galaxy NGC 3184. It was discovered by the Japanese amateur R. Kushida, at m = 14.5. It was classified as type II. It did not attained the level of brightness expected in a galaxy located 30 m.l.y. far from us. It was probably obscured by dust and gas of our own galaxy. Later it raised up to m = 14, staying several weeks at this maximum level. In January, faded slowly, losing one magnitude in one month. Afterwards the fall remained slower, and by mid april the SN was still visible at m = 16. One more time we can see the nearly flat slope, and the plateau stage, typical in type II SN. All those details can be found in the attached curve.

4. SN 2000db in NGC 3949

This SN was found on August 6th by M. Aoki, Japanese astronomer, working with a 43 cm aperture telescope equipped with a CCD camera. His first estimation was m = 14.3, and he reconfirmed the value next day. Spectrum of the new star found in Ursa Major galaxy NGC 3949, showed the typical features of type II SN. The number of observations performed by M-1 members, was rather poor, only 14. This was due to the very low position of this galaxy in August. SN 2000 db peaked at nearly at m = 14, and we were able to monitor it one month, till m = 15.3. In the attached curve a moderate dispersion can be found. This is due to the lack of a good and reliable chart.

5. SN 2000cx in NGC 524

The brightest SN of the year was discovered by the automatic KAIT telescope. This occurred on July 18th. Initial estimation was m = 14.5, and it was confirmed next day at m = 14.3. This type Ia SN, is located, as can be seen in the image, clearly out of the galaxy structure. Considering this is a SO galaxy, we can deduct that the size and mass of galaxies are clearly larger than we can suppose based on normal images.

SN 2000 cx became the brightest SN of the year. It attained m = 13, staying in this brightness till beginning of August. Later it faded very fast, losing a couple of magnitudes in 30 days. Another important issue of this SN is the high level of brightness achieved considering it exploded in a galaxy 130 light year far away from us. The absolute magnitude overcomes a little bit the value of -20, what represents one magnitude higher than normal type Ia SNe. The light curve attached shows a small dispersion, typical in SNe found out of the bright part of the galaxy.

6. SN 2000dk in NGC 382

The KAIT telescope discovered another supernova the 18th of September in the galaxy NGC 382, neighbor of NGC 383. Initial brightness was m = 16. This pair of galaxies belong to ARP catalogue with an entry of 331. SN spectrum confirmed to be a type Ia SN. This SN did not overcome m = 15, and in spite of the difficult position close to a pair of galaxies with concentrated brightness, we got 10 observations in a period of one month and a half. Perhaps the most amazing of this event is its appearance in a very special group of galaxies. Based on the apparent brightness and the high radial velocity, these galaxies are considered very massive objects, able to provide many SNe per century. We attach below the light curve.

7. SN 2000E in NGC 6951

The galaxy NGC 6951 gave a couple of SNe in three months. The first one was SN 1999 el appeared in November, while the second was SN 2000e discovered in January. The first attained only m = 14.5, and the one appeared in 2000 overcame a little bit m = 14. Rome Observatory was credited with the discovery made on January 26th, The spectrum confirmed a type Ia SN.

It is interesting to remark that both SNe found in just three months, exploded in very distant places. Therefore we believe both events are fully independent. The conclusion is that this fact is still more unusual.

8. Absolute magnitude of some type Ia SNe of year 2000

Type Ia SNe are currently considered as standard candles, able to repeat the same level of brightness in each event. Nowadays, this parameter attains Mabs:-19.

This year we were able to study the level of fulfillment of this value in three type Ia SN discovered and monitored well before getting the maximum. In the attached table the results show some clear discrepancies compared to the forecasted behavior. In the case of SN 2000 cx in NGC 524, we find a hyperluminous SN, overcoming the value of -20. We also estimate higher brightness in the SN appeared in NGC 382. On the other hand, the one discovered in NGC 6951, remained quite dim, although in this case one reason to explain this low value may be the fact that this part of the sky is covered by layers of interstellar dust of our own galaxy.

9. Some investigations regarding the unusual SN 2000cx

As it was mentioned in the presentation of SN 2000 cx curve, found in NGC 524, the new star appears quite far from the galaxy nucleus. Actually, observing carefully the images taken by several telescopes, we measure a distance of 1.9 minutes from the galaxy center. This means a real distance of 78.000 light years. Therefore the star is far away from the outer part of the galaxy, since according to catalogues, galaxy diameter attains 3.2 minutes. In order to justify this anomaly, we have been trying to find a logical explanation. We summarize below two possible justifications:

1) The galaxy might cover a larger area than the one measured in the catalogues. However, NGC 524 is classified as lenticular or elliptical, E1 type. This is near circular. Therefore it does not seem too logical to find such a huge size in a galaxy without arms.
2) The supernova found might be located in a dwarf galaxy directly associated to NGC 524, but so small that is not visible from here even using the largest telescopes. This is quite possible. First of all we know that NGC 524 is not isolated. Actually, it is the most important member of a cluster of galaxies. NGC 505, 509, 532, 516, 525, 518. are all members of this group, orbiting around the center of gravity of the cluster mass. Furthermore, there are other galaxies in this part of the sky. They are also probably members of NGC 524 group although we have no confirmation because their radial velocities are not known. SN 2000 cx might be located in a dwarf galaxy too weak to be visible. Actually, many large galaxies own small galaxies in the surroundings. Our local Group, include in addition to Andromeda, Milky Way and Triangle galaxies, some other smaller. These would not be visible at NGC 524 distance. (If we take Hubble parameter, H0 = 60 Km/s/Mpc, we deduct a distance of 141 m.l.y). The smallest galaxies of our Local Group have only a population of 100,000 suns, and they attain a diameter of 3000 light years. The total brightness is so small and sparse, that are nearly not visible from us even using the largest telescopes.

If we assume that SN 2000cx appeared in a dwarf galaxy associated to NGC 524, and located somewhere in advance, a little bit closer to us, we would be able to explain

a couple of things. First the tremendous distance of the SN from NGC 524 center, estimated to be 78,000 l.y far away. Second. If SN 2000 cx belongs to a galaxy closer to us than NGC 524, the absolute magnitude calculated would be a little bit closer to the normal value of m = -19.

10. Acknowledgements

We would like to thank all the observers who have sent us their observations and images of the supernovae. We would finally like to thank Mr. Taichi Kato and Mr. Hitoshi Yamaoka for their comments on theoretical magnitude and the recessional speed involved in the calculations when a supernova is discovered.

References

Riess, Press, Kirshner et al 1996, ApJ, 473.
Hamuy, M., et al. 1996a, AJ, 112, 2408
Hamuy, M., et al. 1991, AJ, 102, 208
Phillips, M.M. 1993,ApJ,L105,413
Saha, A., et al., 1999, ApJ, in press
B.Leibundgut, G. Contardo, P. Woudt, J. Spyromilio. E.S.Observatory. Astrophysics,2 Dec 1998.
Shaefer Bradley E. -1996AJ .111.1668S
Sandage Allan, Saha A., Tammann G. A. , Panagia Nino, Macchetto D., 1992 Apj. 401L...7S.
Manuel Lopez Alvarez. Photographic Atlas for Supernovae Search.Vol II.
CCD Astronomy, Fall 1994.
Hodge, Paul, Sky & Telescope, Oct. 1993
Investigaci=n y Ciencia ,Marzo 1999
Dr. E. M. Carreira (private communication, 1999)
IAU circular.
Hitoshi Yamaoka. VSNET . yamaoka@ rc.Kyushu-u.ac.jp
Sky-Catalogue, Guide 6.0

Table 1. All the observations included in this report were made by the following M-1 members, using the instruments listed.

Observer	*Telescopes*	*Features*
Rodrigo Losada	Refractor	15-cm/f10+CCD
Diego Rodríguez	Newton	20-cm/f4+CCD
Aldolfo Darriba	Schmidt-Cassegrain	20-cmf/10
Miguel Rodríguez	Newton	21-cm/f4
Carlos Segarra	Newton	25-cm/f4.7
Juan M Sanjuán	Newton	31-cm/f5
Josep M° Bosch	Newton	31-cm/f5+CCD
José Ripero	Newton	33.5cm/f4.5
Francisco Pujol	Newton	40-cm/f4.5
José Carvajal	Newton	45-cm/f4.5
Esteban Reina	Schmidt-Cassegrain	20-cm/f6.3+CCD
Peret Horts	Schmidt-Cassegrain	20-cm/f6.3+CCD
Julio Castellano	Schmidt-Cassegrain	20-cm/f10+CCD
Rafael Ferrando	Schmidt-Cassegrain	25-cm/f10+CCD
Pepe Manteca	Schmidt-Cassegrain	25-cm/f10+CCD

Table 2. Wave widths of filters used.

Filter	*Width*
V	500–620
R	560–900
I	720–1080

Table 3. CCD cameras. With Texas Instrument, Kodak 400 and Sony ICX027BLA chips.

Type
CCD 245
CCD ST237-Sbig
CCD ST5-Sbig
CCD Starlight-Xpress
CCD ST7-Sbig
CCD ST9-Sbig

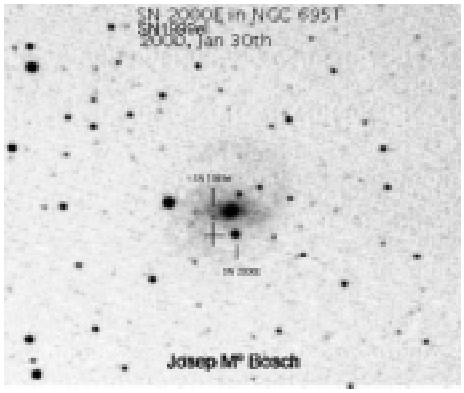
Table 4.

Supernova	*Maximum Brightness*	*Radial Velocity*	*Absolute Magnitude*	*Deviation*
SN 2000cx in NGC 524	13.1	2595	-20.08	-1.08
SN 2000dk in NGC 382	15.2	5393*	-19.5	-0.5
SN 2000e in NGC 6951	13.9	1627	-18.26	+0.74

**We take as radial speed the average of 7 members of ARP 331.: Vr = 5293.*

Note: We consider as parameter of Hubble: Ho = 60 Km/s/Mpc. With a value of 70, M abs becomes 19.74, 19.2 y 17.9 respectively. Basically, our above conclusion remains the same.

(1) This is the first time that a hyperluminous SN (Type SN 1991 T), is found in a SO type galaxy (IAU Circular 7463)




2000cx Sep-22
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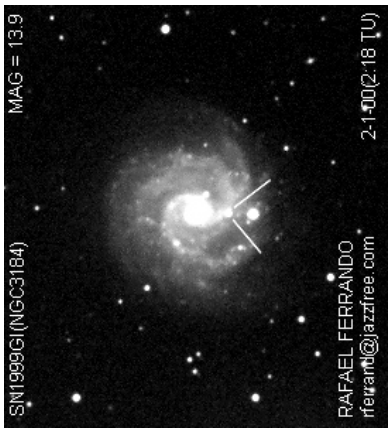
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RAFAEL FERRANDO
rferrand@jazzfree.com
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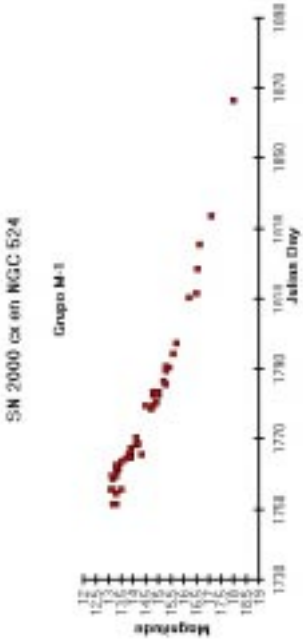
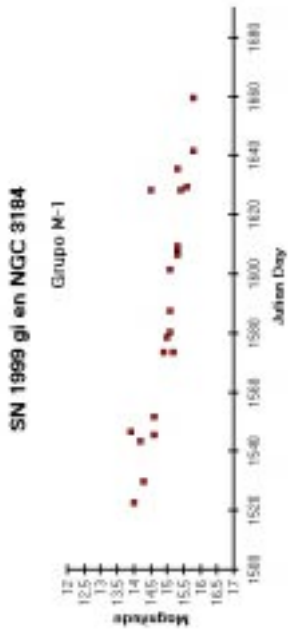

SN 2000 cx en NGC 524
Grupo M-1
Julian Day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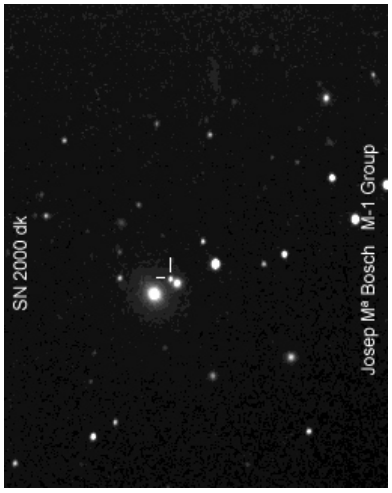
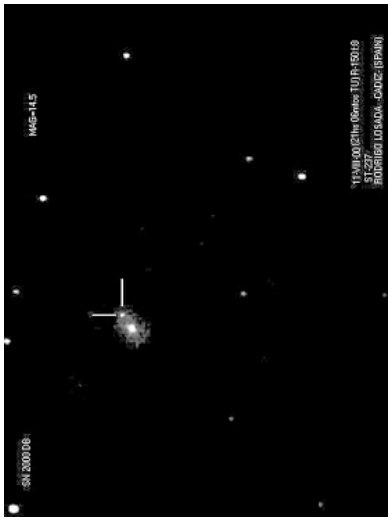
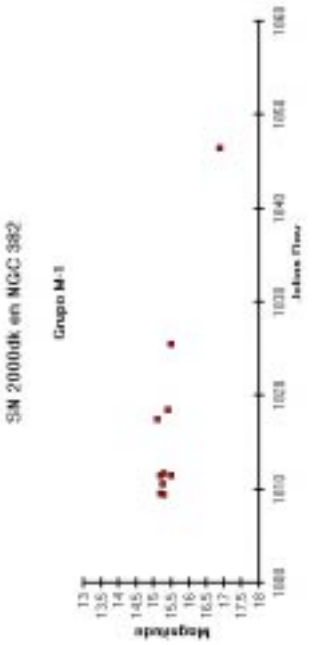

SN 2000 dk
Josep Mª Bosch M-1 Group


SN 2000 db
MAG-14.5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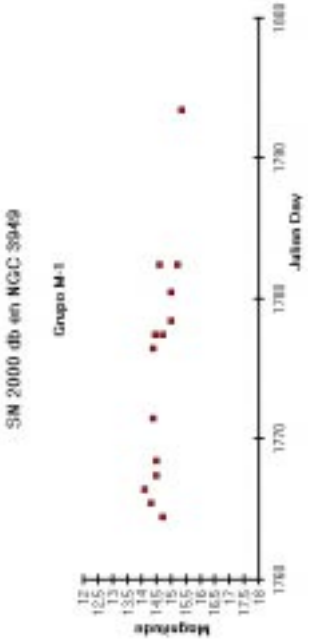
Grupo M-1
Magnitude
Julian Day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Julian Day