Rev. Mexicana Astron. Astrof., **21**, 329-330 (1990)

SEARCH FOR PHOTOMETRIC PULSATIONS FROM SN1987A

Francisco J. Jablonski

Departamento de Astrofísica
Instituto de Pesquisas Espaciais, Brazil

RESUMEN. Reportamos los resultados de una investigación fotométrica de pulsaciones ópticas de SN1987A. Mostramos que 768 días después de la explosión, el límite superior de la amplitud de cualquier señal pulsante en el intervalo 5-5000 Hz corresponde a la magnitud V ∿ 20.

ABSTRACT. We report the results of a photometric search for optical pulsations from SN1987A. We show that 768 days after the explosion, the upper limit to the amplitude of any pulsed signal in the range 5-5000 Hz corresponds to magnitude V~20.

Key words: STARS-NEUTRON — STARS-SUPERNOVAE — PHOTOMETRY

I. INTRODUCTION

One of the possible results of the collapse of the progenitor star in SN198 A is the formation of a neutron star. The detection of neutrinos (Hirata et al. 1987; Bionte et al. 1987) is a strong evidence for that. As in other supernova events, the formation of a pulsar is likely. The aim of this work is to test that possibility by means of a search for optical pulsations.

II. THE OBSERVATIONS

The observations were carried out in four occasions, during the period 1989 February 28 to 1989 April 1. The data were acquired using the 1.6 m telescope of the CNPq/Laboratório Nacional de Astrofísica, in Brazil. Red sensitive GaAs photomultipliers without filters defined the photometric passband. A special hardware was built at the Department of Astrophysics of INPE by Mr. Clemens Gneiding to allow 10 KHz sampling rate. Data blocks of 2^{19} integrations were stored in the core memory of a IBM PC microcomputer and sequentially stored in magnetic tape. Time gaps of 80 s between the data blocks were produced in the acquisition process and were precisely controlled to maintain the synchronicity of the whole time series. Test runs in constant flux stars showed that the data are free from instrumental effects. Table I shows the number of integrations as well as the V magnitude of SN1987A in each occasion.

III. DATA REDUCTION AND ANALYSIS

The search for a coherent signal in the optical light of SN1987A was carried out by calculating the power spectrum of each of the data blocks of 2^{19} integrations. The

Table I. Log of the observations

Date	No. of integrations	Magnitude (V)
28/02/89	17×10^6	11.9
05/03/89	16×10^6	12.1
31/03/89	32×10^6	12.5
01/04/89	19×10^6	12.5

calculations were done in an efficient way by using an adapted version of the mass storage FFT code of Fraser (1979). The sum of the power spectra of all blocks collected during each night allows us to reach fainter limits of sensitivity in the search. The statistical properties of the procedure of adding up several power spectra when searching for pulsations is described in detail in van der Klis (1988) and we followed its prescriptions in our analysis. Prior to the calculation of the power spectrum, a high-pass filter was applied to each data block. The filtering procedure consisted of calculating the average of 2048 consecutive integrations and subtracting the corresponding value from the individual points. This is convenient to suppress the DC component and also to cut off the low frequencies in the power spectrum that arise from scintillation noise and from variations in the transparency of the atmosphere. This filter also defines the range of frequencies covered by our search: ~5 to 5000 Hz. Notice that the step in the frequency grid of the search, ~0.02 Hz, is large enough to allow frequency shifts, as those due to Doppler shifts in a monochromatic signal, without substantial loss of sensitivity.

IV. RESULTS

Table II summarizes the results of the search. The second column shows the number of days since the explosion. The third column shows the upper limit (at 90% confidence level) to the r.m.s. variation of any signal in the range of frequencies 5-5000 Hz. Column four lists the same limit in apparent magnitudes scaled from the DC values of Table I. Column five shows the corresponding absolute magnitude limits, assuming a distance of 55 kpc to the LMC. We have also calculated the combined limit obtained from days 767 and 768.

Table II. Upper limits to the amplitude of coherent pulsations in the optical light of SN1987A

Date	day	Ampl. (%)	V	M_V
28/02/89	736	< 0.25	> 18.5	> -0.2
05/03/89	741	< 0.16	> 19.2	> +0.5
31/03/89	767	< 0.13	> 19.8	> +1.1
01/04/89	768	< 0.12	> 19.8	> +1.1
Combined		< 0.10	> 20.0	> +1.3

V. CONCLUSION

We have shown that after 768 days from the explosion of SN1987A, no coherent pulsed signal in the range 5-5000 Hz is present in the optical flux to the limit of apparent magnitude V~20. This corresponds to absolute magnitude M_V~+1.3 in the LMC, just a factor of two brighter than the intrinsic luminosity of the Crab Pulsar. We are continuing the observations, since as the supernova fades, fainter limits can be set to the presence of pulsations.

REFERENCES

Bionte, R.M., et al. 1987, Phys. Rev. Letters, 58, 1494.
Fraser, D. 1979, ACM Trans. Math. Soft., 5, 500.
Hirata, K., et al. 1987, Phys. Rev. Letters, 58, 1490.
van der Klis, M. 1988, EXOSAT preprint, no. 81.

Francisco J. Jablonski: Departamento de Astrofísica, Instituto de Pesquisas Espaciais, C.P. 515, 12201 São José dos Campos (SP), Brazil.