Astron. Astrophys. 341, 487–490 (1999)

ASTRONOMY
AND
ASTROPHYSICS

A first glance at SGR 0526-66 only 2.6 days after 5 March 1979

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Received 9 June 1998 / Accepted 21 September 1998

Abstract. By chance, a Schmidt plate (+ H_α filter) was taken on 6 March 1979, 2.6 days after the famous soft gamma-ray burst that took place on 5 March. Another four plates were exposed through UVBR filters four to six days after the event. N49 – the plerionic supernova remnant presumably related to the soft gamma ray repeater – and the surrounding area have been examined, on the basis comparison with another plates taken at different epochs. No optical transient has been found within the SGR error box, nor at the position of the point X-ray source observed by *ROSAT*. Any variability was smaller than 0.5 mag for objects brighter than U = 18, B = 18, V = 18 and R = 20. This negative result could favour the existence of a beamed outflow that it is not aligned with the line of sight.

Key words: gamma rays: bursts

1. Introduction

Soft Gamma-ray Repeaters (SGRs) emit inttermitent bursts of soft gamma-rays. Only four SGRs have been observed so far. The Soft Gamma-ray Repeater 0525-66 (hereafter SGR 0526-66) was first detected by the *Konus* experiment on VENERA 11 and 12 at 15:50 UT on 5 March 1979, when it produced an extraordinary outburst reaching a peak intensity of several times $10^{-3}\ \mathrm{erg\,cm^{-2}s^{-1}}$ in 0.2 ms rise time (Mazets et al. 1982, Cline et al. 1982, Golenetskii et al. 1988), at least one order of magnitude greater than any other soft gamma-ray event ever observed. The 0.2 ms risetime implied an emitting region with a diameter $\leq$ 60 km. Successive bursts took place on 6 March (06:14 UT), 4 April (00:43 UT) and 24 April (18:28 UT).

The main event on March 5 was observed by several experiments, allowing to determine a precise error box (0.05 arcmin^2) which was positionally coincident with the 2 arcmin^2 plerionic supernova remnant N49 in the Large Magellanic Cloud, at a distance of 55 kpc. Therefore it was thought that the observed bursts were pressumably associated with the neutron star within the SN remnant, as it has been proven for another soft gamma-ray repeater, SGR 1806-20 that lies in a plerion (Murakami et al. 1994, Kulkarni et al. 1994).

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The SGR 0526-66 error box has been widely studied over the years. Since the work of Fishman, Duthie and Dufour (1981), a possible detection of optical bursts were reported (Pedersen et al. 1984), and a limit of m_V = 19.4 was set for any periodic component on the basis of a search for an optical 8 s periodicity (Boër et al. 1989), similar to the periodicity observed in the 5 March gamma-ray event (Barat et al. 1979, Terrell et al. 1989).

N49 has been observed four times by *ROSAT*, and a point X-ray source has been detected within the SGR error box (Rothschild et al. 1994). The same point source was already seen by *EINSTEIN* 45 days after the 5 March event. The overall countrate from the point source has been found to be constant during the $\sim$2-yr duration of the *ROSAT* observations (Marsden et al. 1996), similarly to another soft gamma-ray repeater, SGR 1806-20 (Sonobe et al. 1994).

It has been proposed that SGRs are produced in "magnetars", neutron stars with magnetic fields B $\sim 10^{14}$ G, when the magnetic field drifts through the neutron star crust, causing a starquake during which the starquake energy is released as an intense SGR burst (Thompson & Duncan 1996, Cheng et al. 1996, Duncan et al. 1998). This seems to have been confirmed in the case of SGR 1806-20 (Kouveliotou et al. 1998). The thermal radiation is enhanced by a factor of 10 or more due to the strong magnetic field, producing the observed persistent X-ray emission (Usov 1997).

2. Observations and results

We found several high quality Schmidt plates taken very close in time to the 5 March event. The first plate (ESO 3188) was taken on 8 March 1979 at the European Southern Observatory (ESO) Schmidt Telescope at La Silla (Chile). The plate was exposed through a H_α filter on 8 March 1979 (from 06:43 to 09:13 UT), 2.6 days after the extraordinary event of 5 March, and only two days after the second burst that took place on 6 March. See Fig. 1. Another five plates were obtained from four to six days after, at the United Kingdom Schmidt Telescope Unit (UKSTU) at Siding Springs Observatory, New South Wales, Australia (in the UBVR broad bands). Table 1 reports the plate material we have examined.

A visual inspection using a microscope performed for a $\sim$ 100 square arcmin region around N49 did not revealed any vari-

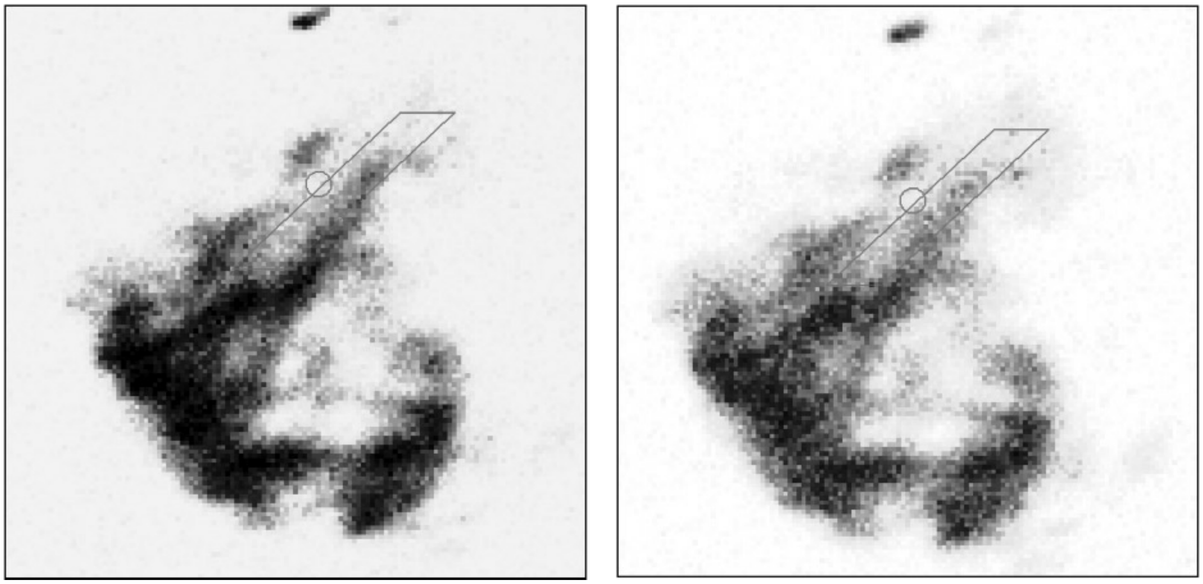

Fig. 1. *Left:* N49 on 8 March 1979. The circle marks the position of the *ROSAT* source, near the error box of SGR 0526-66 (from Rothschild et al. 1994). *Right:* The same region, showing the N49 area on 17 February 1976. Both plates were exposed through an H_α filter.

Table 1. Schmidt plates fortuitously taken the week following the 5 March 1979 event

Date	Time after 5 Mar 79	Telescope	Filter	Plate Number
8 Mar 1979	2.6 d	1.0 ESO	H_α	ESO 3188
9 Mar 1979	4.1 d	1.2 UKS	B	UKS 4852
9 Mar 1979	4.1 d	1.2 UKS	U	UKS 4853
9 Mar 1979	4.2 d	1.2 UKS	V	UKS 4854
9 Mar 1979	4.2 d	1.2 UKS	R	UKS 4855
11 Mar 1979	6.2 d	1.2 UKS	V	UKS 4857

able object on the images. Any variability was smaller than 0.5 mag, for objects brighter than U = 18, B = 18, V = 18 and R = 20.

In any case, the region including N49 on the ESO plate 3188 was digitised by means of the PDS machine at ESO headquaters, Garching, with a resolution of 5 μm. An identical region on a second plate taken on 17 Feb 1976 was also scanned. All the UKSTU plates were scanned via the fast, high precision micro-densitometer SuperCOSMOS at the Royal Observatory, Edimburgh (Hambly et al. 1998, McGillivray 1998). The sampling interval was 10 μm, achieving a resolution of 15 μm.

All the images were reduced by using the standard MIDAS and IRAF routines. The two regions on ESO plates (see Fig. 1) were shifted in order to align the centroids, and one image was divided by the other, in order to search for variability. Fig. 2 shows the UBVR images of the N49 region on the UKSTU plates.

Thus, the main result of our search is that no variable object or variable patch in the nebula was detected either within the SGR 0526-66 error box given by Mazets et al. (1982) or at the position of the point X-ray source observed by *ROSAT* (Rothschild et al. 1994). We also examined the surrounding area with an identical negative result, as we discussed elsewhere (Castro-Tirado 1994).

3. Discussion

Postburst nebular emission has been predicted as a result of the impulsive release of relativistic particles in the nebulae surrounding SGRs (Tavani 1994).

The time delay ΔT between the soft gamma-ray bursts and the nebular emission depends on the geometry of the relativistic outflow. If we assume that the inner shock radio in N49 is 0.1” (Rothschild et al. 1994), at the distance of the LMC, this is $R_S \sim 8$ x10^{16} cm. According to Tavani (1994), and in case of a beamed outflow not aligned with the line of sight, ΔT is comparable to the propagation time $\Delta t \sim R_S/c \sim 30$ d, and the nebular emission is comparable with the synchrotron timescale of the schock emission. However, if the flow is considered to be isotropic, the onset of nebular emission follows the burst (ΔT $\sim$ 0) with a duration comparable to Δt ($\sim$ 30 d).

The negative result presented in this paper might favour the existence of a beamed outflow in SGR 0525-66 that it is not aligned with the line of sight, although we do not know which is the fraction of the nebular high-energy emission that will be reprocessed into optical wavelenghts.

4. Conclusions

No optical transient has been found within the SGR 0526-66 error box, nor at the position of the point X-ray source observed by *ROSAT*. This negative result could favour the existence of a beamed outflow that it is not aligned with the line of sight. The fact that we have not found transient optical emission associated to SGR 0526-66 from 2.6 to 6 days after the 5 March 1979 event

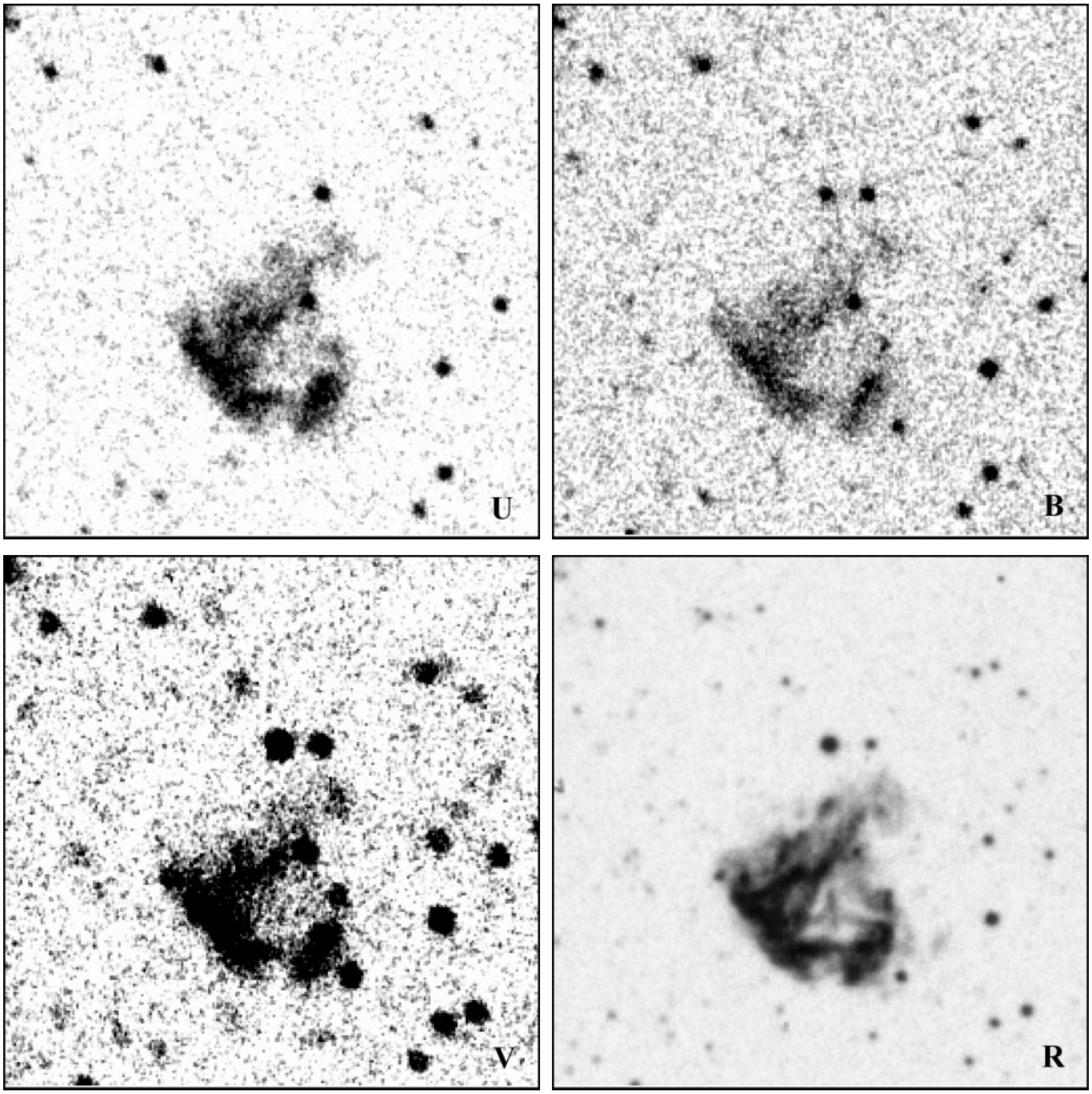

Fig. 2. UBVR images of the N49 region taken by the 1.2-m UKSTU, four to six days after the 5 March event. Limiting magnitudes are U = 18, B = 18, V = 18 and R = 20. North is at the top and east to the left.

is not surprising: no transient infrared emission was found either during a high activity period in the another SGR in a plerion, SGR 1806-20 (Castro-Tirado et al. 1998).

Acknowledgements. We thank the referee, M. Boër, for his useful suggestions on this paper. AJCT is grateful to E. Hopp for the hospitality at the ESO hearquaters in Garching. JG also thanks to S. Tritton for the facilities given at the Royal Observatory of Edimburgh. We are also indebted to H. MacGillivray for scanning the UKSTU plates on SuperCOSMOS.

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