X-RAY AND OPTICAL OBSERVATIONS OF THE X-RAY SOURCE EX0020528+1454.8

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ABSTRACT. We present preliminary results of the EXOSAT X-ray observations and quasisimultaneous and simultaneous optical photometry of the X-ray source EX0020528+1454.8 = 1E0205+149 found independently as an serendipitous source both with Einstein and EXOSAT satellites. The optical counterpart is a pair of dMe stars. Our results indicate that the object is variable both in X-rays and optical wavelenghts, and probably belongs to dMe flare stars.

1. INTRODUCTION

The soft X-ray source EX0020528+1454.8 was detected with the EXOSAT satellite on August 21/22, 1985, as a serendipitous source positioned only 21 arcmin apart from the observed target TT Ari. Previous 3 X-ray observations of the same field also with EXOSAT (Beuermann, 1985) revealed no source at this position suggesting that EX0020528+1454.8 is variable by a factor of at least 3.

Our X- ray observation of TT Ari (Hudec et al., 1986a) was supported by numerous optical measurements at 11 observatories (Wenzel et al., 1986). Partly based on photographic observations covering large fields of view, this program has resulted in obtaining quasi-simultaneous and partly simultaneous optical data also for the " new " source. This represents another fascinating possiblity to advantages of the use of photographic plates to study optical counterparts of X-ray sources already mentioned by Hudec (1985).

A reddish pair of stars exhibiting brightness variations between B = 15.3 and 16 was proposed as the probable optical counterpart (Hudec and Wenzel, 1986). Recently Cordova (1986) pointed out that the object is identical with the serendipitous Einstein source 1E0205+ +149 considering the errornous equinox for it position given by Reichert et al. (1982). The object is also identical with the Lowell proper motion object G035-027 (Giclas et al., 1986 and Cordova, 1986).

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Only preliminary results are presented here, the final and more detailed discussion will be published elsewhere (Hudec et al., 1986b).

2. X-RAY MEASUREMENTS

The source was detected by the EXOSAT LE experiment during the whole time of exposure, representing 11 hours and lasting from August 21.7 UT to 22.1 UT, 1985.

The low energy (0.05 - 2 kev) data were obtained using 3000 lexan filter (16:40 to 19:53 UT, Observation 1, and 23:19 to 02:59 UT, Observation 3) and Al-Parylene filter (19:57 to 23:19 UT, Observation 2). The combination of CMA detector with 3000 lexan filter represents the wavelenght range from 6.5 to 210 A, the Al-Parylene filter changes the working interval to 6.9 to 95 and 155 to 310 A.

The mean count rate corrected for sampling dead time, vignetting and point spread function, was found to be 0.013 ± 0.002, 0.009 ± 0.002 and 0.010 ± 0.002 for Observations 1, 2 and 3 respectively.

Although the object proved to be faint, there seems to be an indication for the X-ray flux variability by a factor of several tens of per cent over the time intervals of hours.

The corresponding average X-ray energy flux at earth was estimated to $(1.2 \pm 0.3) \times 10^{-12}$ erg $cm^{-2} s^{-1}$ in the 0.05 - 2 keV range assuming hot coronal source with $T = 10^6$ to 10^7 K and the column density $N_H = (1 - 5) \times 10^{18}$ cm^{-2}. The " softness " ratio between the count rates in both filters indicates the soft X-ray spectrum with a blackbody temperature of 10^6 K in line with no significant signal detection in the EXOSAT ME experiment ($\leq 1 \times 10^7$ K).

3. OPTICAL MEASUREMENTS

The photometric behaviour of G035-027 has been studied on 89 photographic plates taken at the Sonneberg, Ondřejov, Kleť and Skalnaté Pleso observatories at times close to the time of EXOSAT observation (Fig. 1).

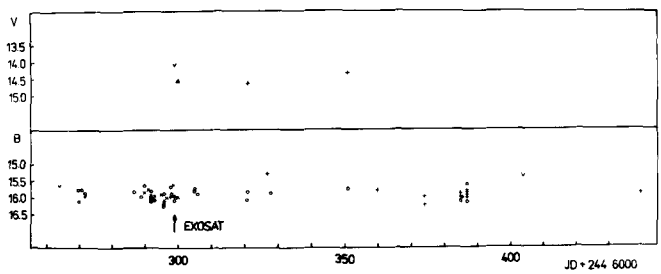

Figure 1. The long-term integral light curve of G035-027. The open circles represent measurements on Sonneberg astrograph plates, crosses Sonneberg Schmidt plates, diagonal crosses Kleť plates and triangles Ondřejov plates. Upper limits are indicated by " v " .

Although probably small amplitude light variations occur, on most plates the integral magnitude of the object amounts to B∼16 (B-V∼1.5). Only one plate, taken at the Sonneberg observatory on September 15, 1985, shows the object at B = 15.3, while the plates taken 6 day before and 1 day after shows the object in faint light. There are hints that similar brightenings occured also in the past : on the PSS print corresponding to August 13/14, 1950, the candidate star was B = 15.0 with B-V ∼ 1.5 and also the inspection of the Sonneberg sky archive supports the reality of the brightenings (Hudec et al., 1986b).

Comparison UBV sequences according to Goetz (1985) were used in our optical study.

4 . DISCUSSION

Our preliminary results confirm the proposed identification of the X-ray source 1E0205+149=EX0020528+1454.8 with Lowell proper motion object G035-027, consisting of a pair of dMe stars (dM4.5e + dM4.5e according to Reichert et al., 1982).

Considering our results as well as results obtained by previous authors for X-ray count rates (Reichert et al., 1982, Cordova, 1986, Beuermann, 1985), we conclude that the X-ray energy flux of the source vary by a factor of about 3 or even more on time scales of months to years and probably also by a factor of ∼ 30% on time scales of hours, a results not in disagreement with findings for some of the flare stars (Agrawal et al., 1985).

Recent EXOSAT observation of EX0020528+1454.8 was supported by 16 simultaneous photographic measurements (Fig. 2) indicating that the object was in faint light during the X-ray observation and, consequently, that the measured X-ray flux represent the quiscent state emission.

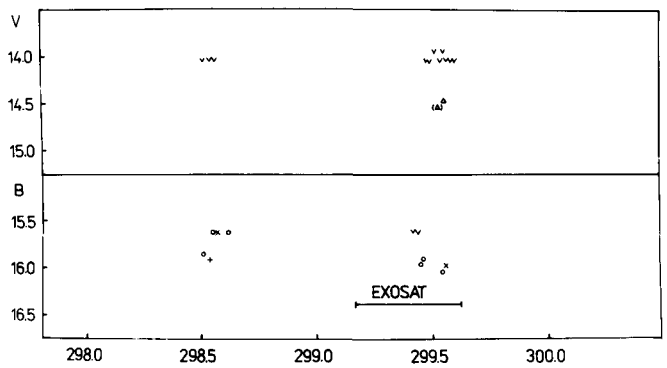

Figure 2. The detailed optical light curve of G035-027 around the times of X-ray observations. For meaning of individual symbols see Fig. 1.

We estimated the distance to the source d = (25 $\pm$ 15) pc, the mean V magnitude of the pair 14.5, the nearly equal brightnesses of both components and an average absolute magnitude for solar neighbourhood stars of dMe(4-5)e type $M_V \sim 13.2$ determined from data published by Pettersen (1976) taken into account. Another estimation based on the published value of the proper motion (Giclas et al., 1960) gives $d \sim 14$ pc. We assume d = 20 pc and arrive at the integral X-ray luminosity $L_x = 5.3 \times 10^{28}$ erg s^{-1} or $L_x = 2.6 \times 10^{28}$ erg s^{-1} for each component, in line with mean values for flare stars found by Agrawal et al. (1985) $L_x = 2 \times 10^{28}$ erg s^{-1} and thus confirming the proposed identification. The L_x/L_{bol} ratio we estimate to be $\sim 1.2 \times 10^{-3}$ agreeing again well with average L_x/L_{bol} ratios foud for flare stars but essentialy higher than the values reported for the non-flaring dMe stars ($\leq 7 \times 10^{-5}$ according to Agrawal et al., 1985).

5. CONCLUSION

We conclude that EXO020528+1454.8=1E0205+149=G035-027 is a pair of flare stars and that probably both flaring and small amplitude light variations (BY Draconis syndrome?) related to stellar activity occur in the object as a result of high level of it stellar activity.

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