INTEGRAL/OMC: OPTICAL COUNTERPARTS OF ROSAT SOURCES

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ABSTRACT

Five sources monitored by OMC, located close to five targets from the ROSAT catalogues (RASS BSC and RASS FSC), present a high degree of variability in the optical band, with variations typical of binary systems and active stars. We found periods around half a day for three of them and one day for the two others. The estimated spectral types range from late F to early K. The combined optical and X-ray properties of these objects fit very well with the average properties of binary systems and active stars, respectively, supporting the identification of these OMC stars as the previously unknown optical counterparts of the ROSAT sources.

Key words: binary systems; active stars; variable stars; optical photometry; X-rays.

1. INTRODUCTION

The Optical Monitoring Camera (OMC) is a small telescope with a CCD camera onboard the INTEGRAL satellite (Mas-Hesse et al., 2003). It has been designed to monitor simultaneously, in the optical band (V-Johnson filter), the high-energy sources observed by the main INTEGRAL instruments. The simultaneity of the observations is critical in this case due to the fast and unpredictable variability of the high-energy emitting objects. The field of view (FOV) of the camera is $5{\times}5$ degrees, covering the central area of the large FOV of the high energy instruments (SPI and IBIS) and coincident with the Fully Coded FOV of JEM-X.

OMC monitors routinely around 100 stars in each field. The targets of interest are extracted from the *OMC Input Catalog* (Domingo et al., 2003), which contains, among other sources, all those compiled in the ROSAT catalogues: RASS BSC (Voges et al., 1999) and RASS FSC (Voges et al., 2000). Five targets which were selected from the ROSAT catalogues, have been found to show a large degree of variability in the optical. Their

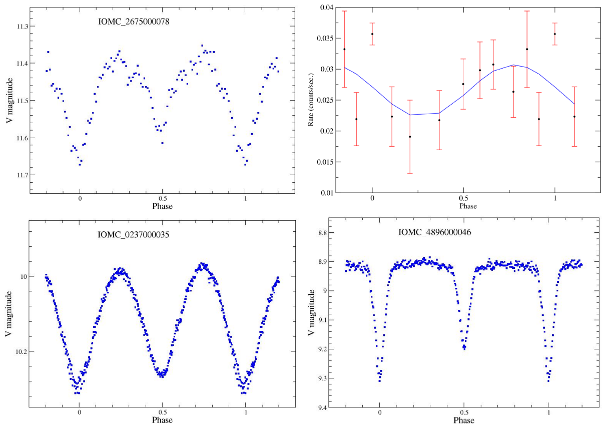

Figure 1. Light curves obtained by OMC (upper-left) and ROSAT (upper-right) of the binary IOMC 2675000078 and light curves obtained by OMC of the binaries IOMC 0237000035 (lower-left) and IOMC 4896000046 (lower-right).

lightcurves are shown in Figs. 1 and 2. Table 1 summarizes their OMC and ROSAT identifications, as well as the optical periods derived from OMC data, and X-ray luminosities derived from the ROSAT fluxes.

Analysis of the ROSAT data with XSAS SW (Zimmermann et al., 2000) shows little absorption in soft X-rays. We have therefore assumed that the optical extinction towards these objects is negligible. We have estimated their distances deriving the corresponding spectral types from their color excesses, as compiled in the Tycho (ESA, 1997) and Tycho-2 (Høg et al., 2000) catalogues, and comparing the apparent with the corresponding absolute magnitudes.

2. ECLIPSING BINARIES

The optical lightcurves of the sources IOMC 2675000078, IOMC 0237000035 and IOMC 4896000046 correspond to contact, contact-W UMa and detached eclipsing binary systems, respectively.

Table 1. Identification, optical periods and ROSAT luminosities of the sample.

Identifier	Period (days)	L_X (erg/s)
IOMC 0237000035	0.46515	2.25×10^{30}
1RXS J095156.0+004722	$\pm$0.00018	
IOMC 1306000026	0.419	1.09×10^{30}
1RXS J054101.8+203624	$\pm$0.002	
IOMC 2674000067	0.967	2.11×10^{30}
1RXS J200219.0+333912	$\pm$0.005	
IOMC 2675000078	0.42233	1.41×10^{31}
1RXS J200912.0+323344	$\pm$0.00003	
IOMC 4896000046	0.9871	1.07×10^{30}
1RXS J095706.3-012019	$\pm$0.0008	

While the variations of their optical emission is due to some type of activity in the photosphere and the geometry of the system during the orbital motion, the X-ray emission observed in all these systems is probably due to emission of the hot corona of (one of) their components (paper in preparation). In the case of the prototype Algol system the procedence of the X-ray emission is clearly coronal but which component causes it is actually not completely understood (Ness et al., 2002; White et al., 1986; Ottmann & Schmitt , 1996).

As listed in Table 1 the rotation periods of these binaries is rather short, between 0.4 and 1 day. The lightcurve of the two systems with the shortest rotation periods shows that they are in contact, which might induce a high degree of activity in their components, giving rise to the observed X-ray flux.

2.1. IOMC 2675000078

1RXS J200912.0+323344 (the likely X-ray counterpart of IOMC 2675000078) was observed as a 34 831 s pointed observation by F. Haberl with HRI instrument onboard ROSAT satellite in 1997 as part of a program to search for cataclysmic variables. We observe a weak modulation with a period of 0.11 ± 0.04 days (i.e., approximately $1/4$ of the orbital period). In Fig. 1 we show the ROSAT lightcurve folded with this period. We will discussed in a future paper the possible implications of this shorter X-ray period.

3. ACTIVE STARS

It is known that late type stars of F-M spectral types with high rotation velocities have strong magnetic fields, being active and showing significant brightness variations originated from the photosphere, chromosphere, transition region and corona (in the optical, UV and X-ray ranges, respectively). These activity manifestations are correlated with the axial rotational period. Messina et al. (2003) have determined a correlation between L_X/L_{bol} and the amplitude of the optical variations, A_{max}, confirming the dependence of coronal activity on photospheric magnetic fields.

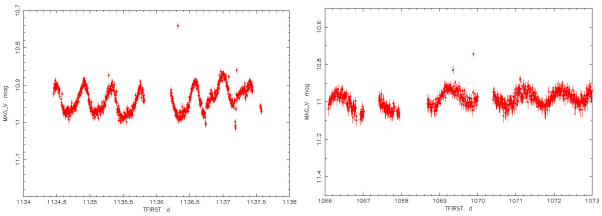

Figure 2. Light curves obtained by OMC of the two active type stars IOMC 1306000026 (left) and IOMC 2674000067 (right).

Both IOMC 1306000026 and IOMC 2674000067 fit very well on these correlations, both considering their optical periods, L_X/L_{bol} and A_{max} values. This supports the identification of the OMC targets as the optical counterparts of the ROSAT sources.

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