CAPABILITIES OF THE OPTICAL MONITOR FOR THE RESEARCH IN X-RAY SOURCE AND STELLAR VARIABILITY

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1. Introduction

The project of an Optical Monitor (OM) for X-ray satellites, in particular the JET-X (Joint European Telescope for X-ray astronomy) experiment (Wells et al., 1991), derives from the scientific need of having complete data coverage at various wavelengths, UV and optical, of the observed X-ray sources, because these data are essential for a deeper understanding of the various classes of objects. When studying variable sources and/or transient astronomical phenomena, one needs that the multifrequency observations be performed essentially at the same time, because it is the knowledge of the simultaneous optical and X-ray behaviour of a source which contributes substantially to the clarification of its nature. In principle optical observations simultaneous with X-ray ones can be performed from ground based telescopes. However the complexity of satisfying the constraints typical of the optical telescopes (weather conditions, source observability) and of the X-ray instrumentation (e.g. orbital constraints) lead inevitably to a substantial loss of observing time. Therefore the only practical way of having an optimal utilization of the time available for X-ray observations, together with the wealth of scientific potential of simultaneous UV-optical observations, is to have a small telescope to be part of the same space mission.

2. JET-X Optical Monitor and Some Scientific Applications

JET-X is an experiment developed in the framework of a collaboration among United Kingdom, Italy, Germany and USSR, and is a part of the SPECTRUM X-GAMMA satellite, which will be launched by the beginning of 1995. The JET-X OM (Antonello et al., 1990) is a small Ritchey-Chretien optical reflector of 26 cm, equipped with two frame transfer CCD detectors,

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one designed to observe a small field (SF) of 8 arcmin with a resolution of 1.67 arcsec, the other to observe a wide field (WF) of 30 arcmin with lower angular resolution (6.2 arcsec). The WF of the OM coincides approximately with the total field of view covered by the X-ray detectors. In the main operating mode of the OM, the SF camera will observe the optical counterparts of X-ray sources, while the WF camera will observe the bright stars falling in the field of view. In the following, the expected performances of OM are briefly discussed in the context of some possible scientific applications.

X-ray Binaries. The basic criterion for reconstructing the geometry and the emission region(s) in these sources is the accurate study of the light curves at different frequencies. Irregular variability is observed in X-rays on timescales from seconds to weeks. With the JET-X telescope and OM the light curves of AM-Her or DQ-Her like systems (binaries containing a magnetic white dwarf) with $m_v \sim 15$ could be sampled with a resolution of 10 s in X-rays and few seconds in the UV and visual bands. Taking these values as typical for a distance of 100 pc, at a distance larger by a factor of three, X-ray, visual and UV light curves could still be measured with a resolution of minutes. In the low mass X-ray binaries, which consist of a collapsed object (neutron star or black hole) accreting matter through a disk from a low mass companion, besides rapid irregular variability, intensity dips with duration of minutes are observed in X-rays, while the orbital periods, difficult to detect due to the large intrinsic variability, are of several hours. A source such as Cyg-X2 can be monitored in the optical band with a time resolution of few seconds. Finally, the identification of the optical counterpart of the sources responsible for the so-called transients will be easily achieved with the OM if the source happens to be in the field of view.

AGNs. The study of variability of AGNs has long been recognized as one of the most powerful probes for understanding what occurs in the regions close to the massive black hole, thought to be at the nucleus, and in the gas surrounding it. The OM will be able to detect AGNs as faint as $m_v \sim 23$ in a reasonable exposure time (about 1000 s). Moreover, it will be able to yield the optical light curve of an AGN with $m_v \sim 15$ with a time resolution of about 10 s and an accuracy better than 10%, while for an AGN with $m_v \sim 18$ the same accuracy will be obtained with a resolution of about 100 s.

Stellar Variability. The study of all the variable celestial objects, from stars to AGNs, will take advantage of the observation from space over that from the ground, because the problems related to atmospheric phenomena such as transparency variations and scintillation are excluded, and it is possible to perform a continuous monitoring for some days. These advantages are vital for the development of stellar seismology. With the OM it will be possible to perform accurate differential photometry of bright stars and to detect short period variations with very small amplitude, less than 10^{-5} mag for $m_v \leq 7$. This kind of observations will be done in serendipity mode for the bright stars falling in the field of view of OM when JET-X will perform long surveys of X-ray source variability.

References

Antonello, E., Citterio, O., Mazzoleni, F., Mariani, A., Pili, P., and Lombardi, P.: 1990, in *Instrumentation in Astronomy VII*, SPIE **1235**, 867.

Wells, A., Stewart, G. C., Turner, M. J., Watson, D. J., Whitford, C. H., Antonello, E., Citterio, O., Cropper, M. S., Curtis, W. J., Peskett, S., Eyles, C. J., Goodall, C. V., Mineo, T., Sacco, B., and Terekhov, O.: 1991, in *Multi-layer and Grazing Incidence, X-ray/EUV Optics*, SPIE **1546**, in press.