DISCOVERY OF X-RAY ECLIPSES FROM THE TRANSIENT SOURCE LOCATED AT ONLY 0.1PC FROM SGR A*

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ABSTRACT

We present the discovery of X-ray eclipses with XMM-Newton from the transient source CXOGC J174540.0-290031 located at the Galactic Center at only 2.9$''$ (0.1 pc) South of the position of Sgr A*. In summer 2004, sharp and deep eclipses have been observed with a period of 27,961$\pm$5 s and a duration of 1,100$\pm$100 s, while no eclipses were present in Spring 2004. In the framework of semi-detached binary systems, we estimate the mass of secondary star to less than 1.0 $M_\odot$ and the mass of the compact object to less than 60 $M_\odot$.

Key words: X-rays; Galactic Center; Eclipses.

1. INTRODUCTION

The Galactic Center region is a very rich area of the sky that contains various astrophysical sources including many X-ray binaries. The current generation of X-ray satellites, Chandra and XMM-Newton, allow the discovery and the timing and spectral study of objects with X-ray luminosities between 10^{32} and 10^{35} erg/s.

2. CXOGC J174540.0-290031

During the large XMM-Newton multi-wavelength project to monitor SgrA*, in Spring and Summer 2004 (4 XMM-Newton revolutions), a brightening in the 2-10 keV energy band of a factor 2 within a radius of 10$''$ around SgrA* was detected (Bélanger et al., 2005). This X-ray excess was coincident with CXOGC J174540.0-290031, a moderately bright transient, discovered by Chandra in July 2004 (Muno et al., 2005). Figure 1 displays the EPIC light curves of this object (within a radius of 10$''$) during each XMM-Newton revolution (Porquet et al., 2005). Five sharp and deep X-ray periodic features are clearly detected during the revolution 866 with a period of 27,961$\pm$5 s, a duration of 1,100$\pm$100 s, a depth of about 79%, and an eclipse fraction of about 3.9% compared to the orbital period (Fig.2). Similar values were found for the next observation (rev. 867), while there was no detection of X-ray eclipses with depth larger than 19% in Spring 2004 (rev. 788 and 789). However the 2–10 keV luminosity was almost constant with about 2×10^{34} $(d_{8\mathrm{kpc}})^2$ erg/s over the four observations.

In the framework of eclipsing semidetached binary, we have constrained: the mass of the secondary star to be less than 1 $M_\odot$ (i.e. this binary is a low-mass X-ray binary); and the mass of the compact object to be less than 60 $M_\odot$ (Porquet et al., 2005).

We propose to explain the absence of the X-ray eclipse in Spring 2004 by the shift of the X-ray emitting region above the compact object (Porquet et al., 2005), possibly coincident with the base of the jet detected in radio at the same epoch (Bower et al., 2005).

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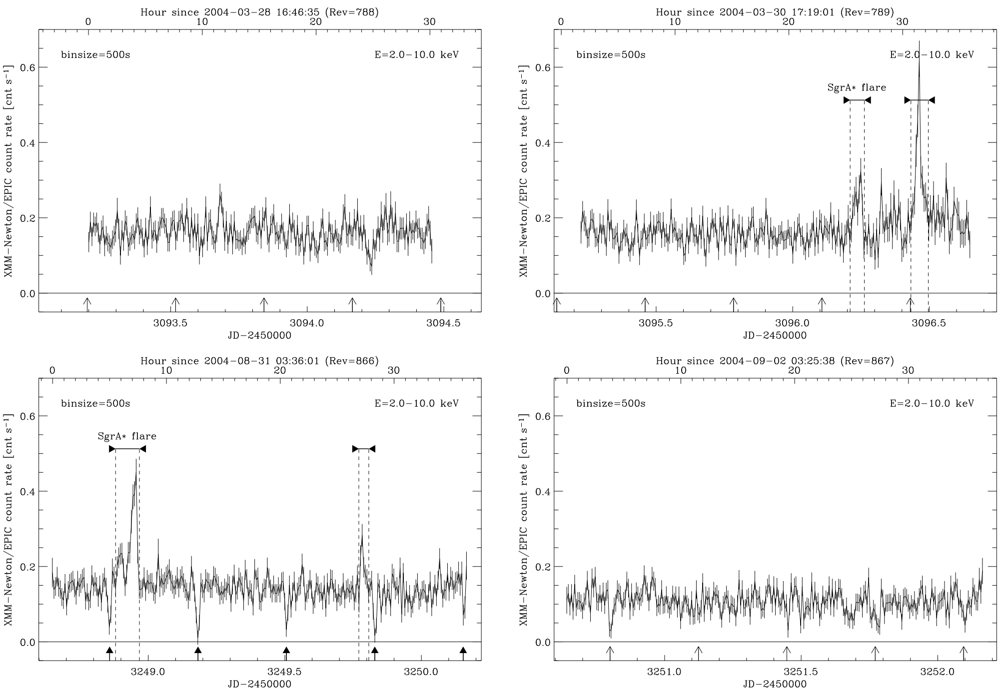

Figure 1. The 2-10keV EPIC light curve. The horizontal arrows indicate time intervals affected by X-ray flares from Sgr A. The quiescent X-ray emission of Sgr A* and the diffuse X-ray emission have been removed. Vertical arrows point to the five X-ray eclipses observed during the revolution 866 which were used to determined the eclipse ephemeris. Vertical thin arrows mark the predicted X-ray eclipses for the other revolutions (788, 789, and 867). While several X-ray eclipses are observed at the position of the eclipse ephemeris during the revolution 867, no obvious deep eclipses are observed during the revolutions 788 and 789 (Spring 2004 observations).*

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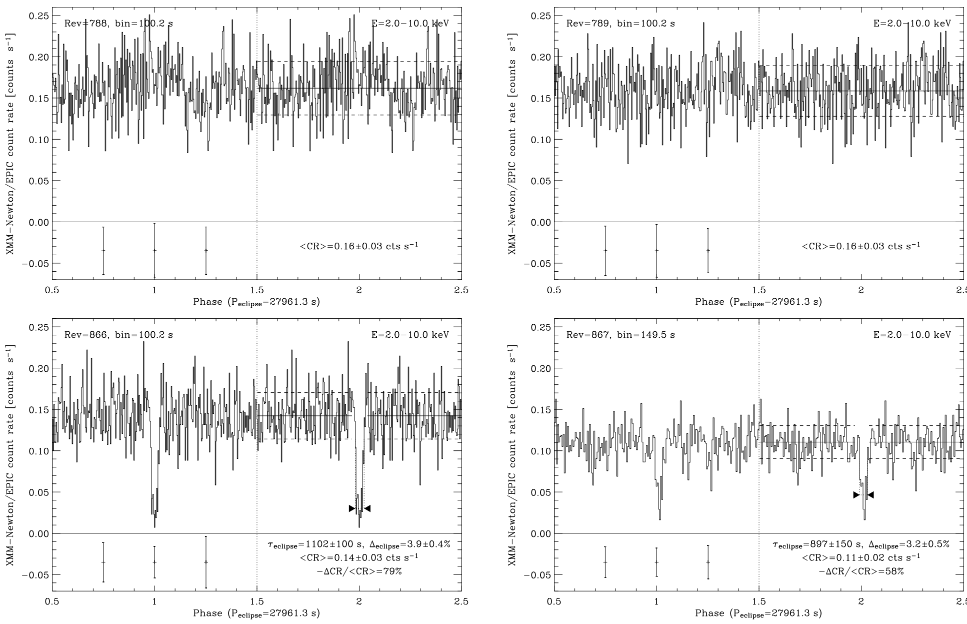

Figure 2. EPIC folded light curves for revolutions 788, 789, 866, and 867 in the 2-10 keV energy range. Two consecutive periods are plotted. The horizontal continuous and dashed lines in the second period indicate the average count rate level, <CR>, and one sigma dispersion, respectively . The duration of the eclipse $\tau_{\rm eclipse}$ is marked by arrows. The eclipse fraction $\Delta_{\rm eclipse}$ is defined as the ratio of the eclipse duration to the orbital period. The depth of the eclipse is defined by the relative count rate variation at the observed eclipse maximum. For clarity, only three 1σ error bars are indicated.