Optical observations of a black hole binary MAXI J1910—057 with the MITSuMe Telescope

Taketoshi Yoshii1, Yoshihiko Saito1, Yoichi Yatsu1, Tachibana Yutaro1, Nobuyuki Kawai1, Hidekazu Hanayama2, the MITSuMe Telescope team, and the MAXI team

1 Tokyo Tech, Tokyo 2-12-1, Japan
2 National Astronomical Observatory, Japan
E-mail(TY): yoshii.t.ac@m.titech.ac.jp

ABSTRACT

We report on optical observations of a black hole binary candidate MAXI J1910-057. It was discovered in outburst by Monitor of All-sky X-ray Image (MAXI). Soon after the optical counterpart was identified with Swift, we conducted observations by the MITSuME Akeno 50cm telescope in 3 bands (g′, Rc, Ic) for approximately 200 days from the day following the outburst. The soft X-ray light curve obtained by the MAXI observation shows that the source first brightened in ~10 days and then faded exponentially in ~90 days in X rays. During this time, a similar trend was observed in the optical light curves obtained by Akeno 50cm telescope. We made a broadband SED 18 days after the onset of the outburst using the data from Swift/X-ray Telescope (XRT), UV/optical Telescope (UVOT), and Akeno 50cm Telescope. This broadband SED is consistent with the model in which the outer part of the accretion disk is irradiated by the X-rays from the inner part. Furthermore, the source was observed 42-45 days later (July 12-15 2012) by the Murikabusi 105cm Telescope (g′, Rc, Ic) in Ishigakijima. With these observations, we detected a hint for 2hr periodicity in MAXI J1910—057.

Key words: X-ray binary — Black hole

1. Introduction

MAXI has discovered many black hole binary candidates e.g. XTE J1752–223, MAXI J1659–152 and GX339–4 and is monitoring these objects. This observation contributes to understanding black hole binaries.

The MITSuME Akeno 50cm telescope and “Murikabusi” 105cm Telescope can observe g′, Rc and Ic filters at the same time. Optical observation of black hole binaries helps X-ray observation.

1.1. MAXI J1910–057

MAXI J1910–057 was discovered by Monitor of All-sky X-ray Image (MAXI) on 2012 May 31 (MJD=56078) (Usui et al. 2012). Soon it made a soft-to-hard state transition (Nakahira et al. 2012), typical for a black hole binary. An optical counterpart was soon discovered, but there was no corresponding source in the DSS or 2MASS images (Rau et al. 2012), indicating that the mass-donating star has R magnitude >20.21, and low-mass. Its optical spectrum consists of mostly featureless continuum with some ionized He emission line, suggesting that it is emission from an accretion disk in a low-mass X-ray binary (Charles et al. 2012). Later the X-ray flux decayed exponentially followed by “soft-to-hard” state transition with a few re-flaring episodes. All these episodes are very similar to those found in knowing black hole binaries.

2. Observation

Optical observation of MAXI J1910–057 was performed for 53 days from 2012 June 1 (MJD=56079) to 2012 November 22. We used two telescopes. One is MITSuME Akeno 50cm telescope, the other is “Murikabushi” 105cm telescope at Ishigakijima observatory. These telescope can observe with g′, Rc and Ic filters at the same time. Our observing log is showed in Table 1. We decided target magnitude with aperture photometry using IRAF and calibrated using 3 reference stars.

3. Spectral Energy Distribution

The broad-band SED 18 days after the onset of the outburst (June 18, 2012) is produced using the Swift/X-ray Telescope(XRT), UV/optical Telescope (UVOT), and our MITSuME 50cm Akeno Telescope observation (g,Rc, Ic). Based on the spectral fitting in the X-ray domain we obtained a hydrogen column density with \( N_H = 0.31 \times 10^{22} \text{cm}^{-2} \). With a usual conversion factor, we derive \( A_V = 1.4 \) with which we correct the near-infrared-to-ultraviolet data (Cardelli et al. 1989).
Broadband SED (Av = 1.4) is consistent with the model in which an accretion disk outside part was irradiated by the X-rays from the vicinity of the black hole (Gierlinski et al. 2008).

4. Periodic analysis

We performed periodic analysis to the $R_c$ band data using “Murikabusi” 105cm Telescope 42 - 45 days later (2012 July 12-15) and found that MAXI J1910−057 was varied with a period in $\sim$ 2 hours. The origin of this optical variation is unclear, but it is likely to be associated with the orbital motion, such as the hot spot in the accretion disk, or the irradiated companion surface, or eclipse of the inner accretion disk by the outer disk bulge.

5. Summary

We observed black hole binary candidate MAXI J1910−057 by MITSuME Akeno Telescope for approximately 200 days from the day following the outburst. We made a broadband SED 18 days after the onset of the outburst. This SED is consistent with the model in which the outer part of accretion disk is irradiated by the X-rays from the inner part. Furthermore, the source was observed 42-45 days later (July 12-15 2012) by the $\|$ Murikabusi $\|$ 105cm Telescope($g$, $R_c$, $I_c$) in Ishigakijima. With these observations, we detected a hint for 2 hr periodicity in MAXI J1910−057. The origine of this optical variation is unclear, but it is likely to be associated with the orbital motion. Taking into account the binary period, we can strongly constrain the black hole mass.

References

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