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Chinese astronomers investigate black hole X-ray binary MAXI J1820+070

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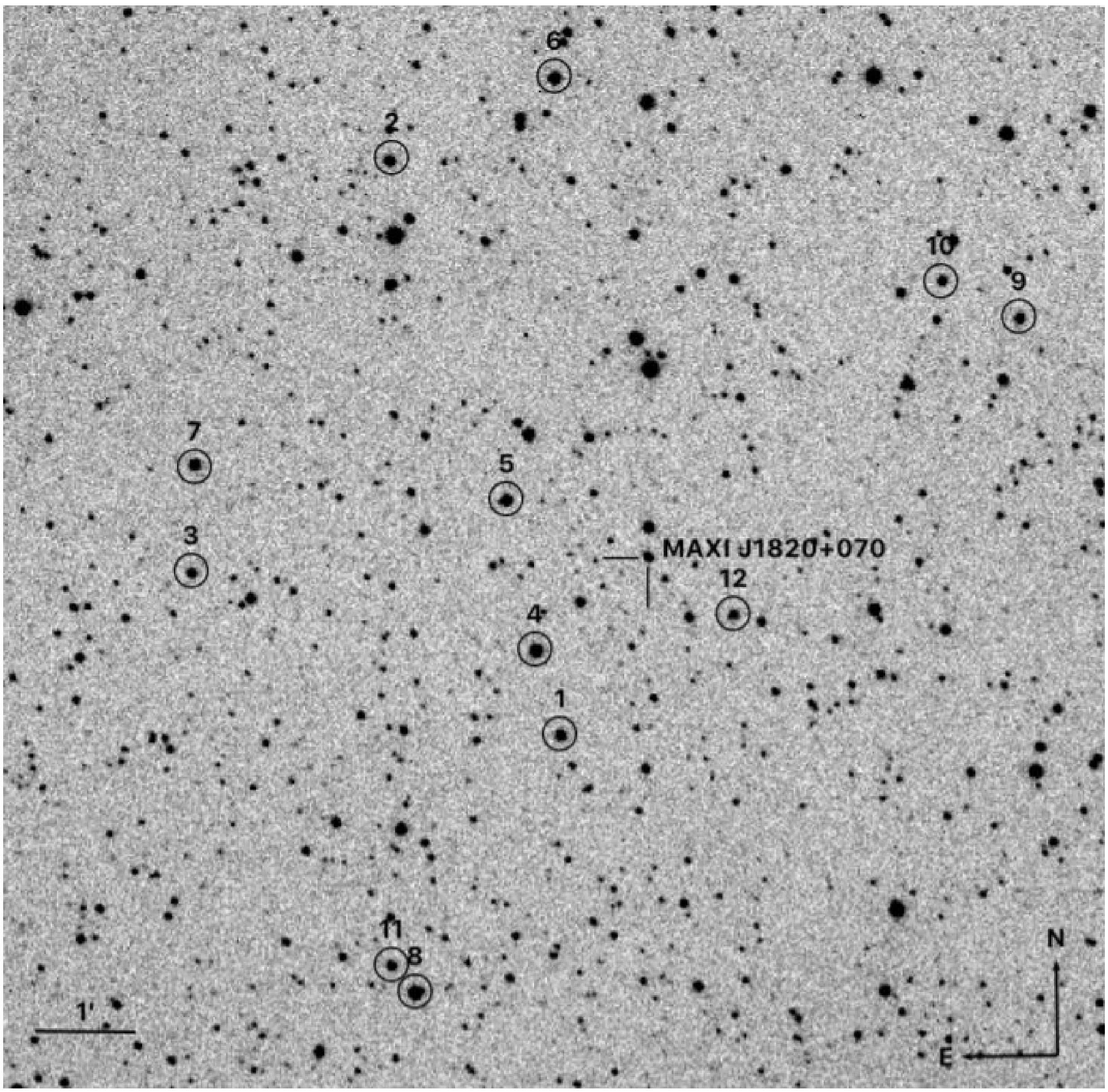

Image of MAXI J1820+070/ASASSN-18ey, taken with the Tsinghua-NAOC 0.8-m Telescope (TNT). Credit: Sai et al., 2021.

Astronomers from China have performed a comprehensive multiwavelength monitoring of a low-mass black hole X-ray binary system known as MAXI J1820+070. Results of this study, published April 21 on the arXiv pre-print repository, shed more light on the properties of this source.

In general, X-ray binaries are composed of a normal star or a white dwarf transferring mass onto a compact neutron star or a black hole. Based on the mass of the companion star, astronomers divide them into low-mass X-ray binaries (LMXB) and high-mass X-ray binaries (HMXB).

MAXI J1820+070 is an LMXB that was first detected during its outburst (which received designation ASASSN-18ey) in March 2018 by the All Sky Automated Survey for SuperNovae (ASAS-SN). Follow-up observations of this source confirmed its LMXB status and estimated that it is located some 9,640 light years away from the Earth.

After the discovery of MAXI J1820+070, a team of astronomers led by Hanna Sai of the Tsinghua University in Beijing, China, has commenced a monitoring campaign of this source in X-ray, ultraviolet, and optical bands, lasting over 18 months. For this purpose, the researchers employed ground-based facilities, including the 0.8-m Tsinghua-NAOC Telescope (TNT), the Yaoan High Precision Telescope, as well as the AZT-22 1.5-m telescope.

"We present extensive photometry in X-ray, ultraviolet, and optical bands, as well as densely cadenced optical spectra, covering the phase from the beginning of optical outburst to ~ 550 days," the astronomers wrote in the paper.

The observational campaign captured several outbursts and rebrightenings of MAXI J1820+070. The spectra of this source showcases an evolution trend similar to other black hole LMXBs, which is most likely a result of the temperature change of the outer disc during outbursts. The optical emission was found to precede the X-ray by nearly 21 days during the rebrightening process.

Furthermore, the pseudo equivalent width (pEW) of emission lines in MAXI J1820+070 exhibit anticorrelations with the X-ray flux, which could be due to the increased suppression by the optical continuum. At around the X-ray peak, the full width at half maximums (FWHMs) of Hβ and He ii λ4686 lines appear to stabilize at 19.4 Angstrom and 21.8 Angstrom. According to the paper, this corresponds to the line forming region at a radius of 1.7 and 1.3 solar radii within the disk.

Starting from about 200 days after the outburst commenced, the X-ray flux shows a sudden drop, while the flux variation in optical/ultraviolet flux is much less significant.

"This discrepancy suggests that the viscous energy of the accretion disk can contribute significantly to the optical/ultraviolet flux when irradiation diminished," the astronomers explained.

The study also detected an intensity jump in optical and ultraviolet bands about 210 days after the start of the outburst, what could be an instantaneous response of the companion to the heating of X-rays and a response of the disk to the extra mass flow.

More information: Optical and Ultraviolet Monitoring of the Black Hole X-ray Binary MAXI J1820+070/ASASSN-18ey for 18 Months, arXiv:2104.10370 [astro-ph.HE] arxiv.org/abs/2104.10370