First Detection of Mid-Infrared Variability from an Ultraluminous X-Ray Source Holmberg II X-1

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We present mid-infrared (IR) light curves of the Ultraluminous X-ray Source (ULX) Holmberg II X-1 from observations taken between 2014 January 13 and 2017 January 5 with the Spitzer Space Telescope at 3.6 and 4.5 Î¼m in the Spitzer Infrared Intensive Transients Survey (SPIRITS). The mid-IR light curves, which reveal the first detection of mid-IR variability from a ULX, is determined to arise primarily from dust emission rather than from a jet or an accretion disk outflow. We derived the evolution of the dust temperature (Tdâˆ¼600âˆ'800 K), IR luminosity (LIRâˆ¼3Ã—10^4 LâŠ™), mass (Mdâˆ¼1âˆ'3Ã—10^{âˆ'6} MâŠ™), temperature radius (Reqâˆ¼10âˆ'20 AU). A comparison of X-1 with a sample spectroscopically identified massive stars in the Large Magellanic Cloud on a mid-IR color-magnitude diagram suggests that the mass donor in X-1 is a supergiant (sg) B[e]-star. The sgB[e]-interpretation is consistent with the derived dust properties and the presence of the [Fe II] (Î»=1.644 Î¼m) emission line revealed from previous near-IR studies of X-1. We attribute the mid-IR variability of X-1 to increased heating of dust located in a circumbinary torus. It is unclear what physical processes are responsible for the increased dust heating; however, it does not appear to be associated with the X-ray flux from the ULX given the constant X-ray luminosities provided by serendipitous, near-contemporaneous X-ray observations around the first mid-IR variability event in 2014. Our results highlight the importance of mid-IR observations of luminous X-ray sources traditionally studied at X-ray and radio wavelengths.

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