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Spitzer constraints on pre-explosion variability of the SN 2023ixf progenitor

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Supernova (SN) 2023ixf was discovered by K. Itagaki in the very nearby galaxy (d=6.4 Mpc; Shappee & Stanek 2011, ApJ, 733, 124) Messier 101 (M101; NGC 5457) on 05/19/2023 and has been classified as a Type II SN by Perley et al. (AstroNote 2023-119). Since M101 was a target by several programs during the Spitzer Space Telescope mission, we analyzed publicly available data in order to follow the possible pre-explosion photometric evolution of the progenitor on the archival mid-infrared images. A single-epoch dataset exists obtained during the Spitzer Cryogenic Mission (03/08/2004, program 60 [GORDON_M101], PI: G. Rieke), while the SN field was serendipitously imaged many additional epochs between 2012 and 2019 during the Post-Cryogenic Mission (mostly part of the SPIRITS program; IDs 10136, 11063, 13053, 14089; PI M. Kasliwal). A point source is clearly detectable at 3.6 and 4.5 microns in Spitzer/IRAC images at the coordinates of the SN (RA=14:03:38.51, Dec=+54:18:42:10; Perley et al. 2023) at all epochs between 2004 and 2019, while there is no detection at 5.8 and 8.0 microns obtained in 2004. We determined the mid-IR fluxes of the source by applying simple aperture photometry on the 3.6 and 4.5 micron Spitzer/IRAC images. While there are some fluctuations, our preliminary dataset -- at least, to within the uncertainties -- does not exhibit significant flux changes in the preceding ~20 yrs before the explosion (which, if would be detected, could be an indication of pre-explosion eruptive mass-loss processes, if this object is the progenitor). Nevertheless, it is worth performing a more detailed analysis of this multi-wavelength, pre-explosion dataset of this object at a future time. It also remains for this object to be confirmed as the progenitor candidate via accurate astrometric registration with images showing the SN. If it is the progenitor candidate, based on weighted means of our preliminary photometry, the object had a brightness at 3.6 and 4.5 microns of 17.6 and 17.2 mag (+/- 0.2 mag in each), respectively. Assuming only Galactic foreground extinction (A[V]=0.024 mag; leading to negligible extinction in the IRAC bands), these correspond to absolute brightnesses of -11.4 and -11.8 mag (+/- 0.3 mag in each). These are both higher than what we would expect for a bare red supergiant (RSG) photosphere (approximately

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-9.6 and -9.3 mag, respectively), which implies that, if this is a RSG, circumstellar dust may be a factor. We note, for instance, that for SN 2017eaw, the progenitor had luminosities of -11.46 and -11.67 mag in the two Spitzer bands (Van Dyk et al. 2019, ApJ, 875, 136). If the SN 2023ixf progenitor were analogous to the SN 2017eaw progenitor, it may have had an initial mass of approximately 15 solar masses. A plot of our preliminary Spitzer photometry on the progenitor candidate for SN 2023ixf can be found at the link below.

http://titan.physx.u-szeged.hu/~szaszi/SN2023ixf_Spitzer_preexplosion_photometry.png

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