Swift J1357.2-0933 as observed with Swift during its 2021 outburst

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*on **25 Apr 2021; 02:34 UT***
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Swift J1357.2-0933 (J1357) is a peculiar black hole candidate X-ray transient discovered in outburst during 2011 (ATel #3138) and peaked at an X-ray luminosity of ~1e36 erg/s (for an assumed distance of 6 kpc). This source underwent the second outburst in 2017 (ATel #10297), and the peak value of the X-ray luminosity measured was ~6e35 erg/s (e.g. Beri et al. 2019 MNRAS 485 3064). A third outburst was reported in 2019 (ATel #12816, ATel #12821, ATel #12867). Unlike the previous outbursts of J1357, it peaked at a significantly lower X-ray luminosity of about 3e34 erg/s (Beri et al. 2021 submitted).

On 2021 April 10, J1357 was detected with the Zwicky Transient Factory (Bellm et al 2019 PASP 131 018002, ATel #14539, http://ooruri.kusastro.kyoto-u.ac.jp/mailarchive/vsnet-alert/25703) detected that the source had brightened optically (g~18.7) compared to limiting magnitudes in quiescence until 2021 April 07 (g~19.5) and has continuously increased in brightness since then (https://lasair.roe.ac.uk/object/ZTF19aanxwrq/).

We report on follow-up observations of J1357 with the Neil Gehrels Swift Observatory (Gehrels et al. 2004 ApJ 611 1005). We observed this source 7 times between 2021-04-11 04:59 UT and 2021-04-23 08:42 UT. Except for the first observation, UVOT

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observations were taken in the image mode, using the six available filters (v, b, u, uvw1, uvw2, uvm2). For all XRT observations, photon counting mode was used. Our first observation made on 2021-04-11 04:59 UT detected the source with Swift/UVOT in the Vega system: UVW1 = 18.34 +/- 0.28, but did not detect the source in X-rays (95% confidence upper-level limit on the unabsorbed flux is ~ 7E-14 erg/s/cm^2). The increasing optical/UV brightness detected by Swift can be seen at https://sites.google.com/view/swift-j13572-0933/home. On 2021-04-16 01:26 UT, the source was first detected in X-rays and three later observations have been performed. We extracted the X-ray data using the online XRT pipeline (Evans et al. 2009 MNRAS 397 1177). The X-ray data were fitted with an absorbed power-law model using W-statistics (background subtracted Cash statistics; Wachter et al. 1979 ApJ 230 274), where we fix N_H to 1.2E20 cm^2 (Armas Padilla et al. 2013 MNRAS 428 3083). The values of the photon index varied between 2.7+/-0.5 and 1.8+/-0.2. These values are consistent with the previous reports on this source (e.g., Beri et al. 2019 MNRAS 485 3064). The observed 0.5-10 keV fluxes and luminosities assume a 6 kpc distance are as follows:

Date (MJD)	Photon Index	Flux (E-12 erg/s/cm2)	Luminosity (1E33 erg/s)
59320.06	2.7 +/- 1.4	0.14 +/- 0.06	0.6 +/- 0.3
59320.72	2.7 +/- 0.6	0.17 +/- 0.06	0.7 +/- 0.3
59325.37	1.8 +/- 0.2	2.8 +/- 0.3	12 +/- 1
59327.36	1.6 +/- 0.3	2.7 +/- 0.4	12 +/- 2

The 2019 outburst started on March 20 at 10:30 UT (ATel #12803) but was reported only on May 22 (ATel #12796), while for the other two outbursts in 2011 and 2017 the source was first detected when it was already at g'=15.99, r'=16.30 (ATel #3140), V_CSS=16.7+/-0.1 (ATel#10297). Comparing our results for the current outburst with previous outbursts suggest that for the first time the source has been caught in the early, rising phase of an outburst. We will continue to monitor this source with Swift. Further multiwavelength observations are encouraged to trace the early rise of the system.

Acknowledgment: We thank the Swift team members for scheduling the ToO observations.

URL: https://sites.google.com/view/swift-j13572-0933/home

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