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The neutron-star low-mass X-ray binary H 1658-298 back in quiescence

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The transient and eclipsing neutron-star low-mass X-ray binary H 1658-298 began its most recent outburst in August 2015 as determined using MAXI (ATel #7943) and we continued to monitor the outburst using Swift/XRT (e.g., ATel #7957, #8046). On 2017 February 15, the source was clearly detected at a luminosity of L_X ~1e36 erg/s (0.5 - 10 keV; assuming a distance of 10 kpc) but during the subsequent pointing on March 7 the source was not detected in a ~1.7 ksec observation. It indicated a count rate upper limit of 2.1e-3 c/s (0.5 - 10 keV; the exposure time was corrected by 900 seconds to account for the expected eclipse during the observation; determined using the linear ephemeris of Oosterbroek et al. 2001). This strong drop in flux suggested that the outburst had possibly ceased after ~1.5 yr.

To confirm that the source truly transitioned into quiescence, we requested 6 ksec of Swift/XRT data, with a 2 ksec observation every day between March 8 and March 10. During each observation the source was not or only marginally detected. We combined the 4 obtained observations (obs ID 00034002072 - 00034002075, March 7 - 10) and the stacked image shows that H 1658-298 was detected, showing the presence of 15 photons within a circular region having a radius 20 arcsec centred on the source. This shows a count rate of ~2.2e-3 c/s (0.5 - 10 keV) for the source (having corrected the exposure time for the several eclipses expected to have occurred during our observations). To understand what this implies for the temperature of the accretion-heated neutron star, we extracted a spectrum from the stacked data and fitted it with a neutron star atmosphere model (nstamos; Heinke et al. 2006), with a fixed value of Nh = 2.2e21 cm^(-2) implemented using tbabs. The obtained effective temperature as seen by an observer at infinity is 96 +/- 10 eV and we detected an unabsorbed 0.5 - 10 keV flux of ~1.1e-13 erg/cm^2/s resulting in an associated luminosity (for 10 kpc) of ~1.3e33 erg/s. The last outburst detection of the source was on February 15 and therefore our temperature estimate was obtained at a maximum of ~20 d after the end of the outburst. However, it is likely that this quiescent temperature was obtained closer to the end of the outburst since the source had to decay from ~1e36 erg/s to ~1e33 erg/s during that time span. This effective temperature is consistent with the initial temperature measurement of H 1658-298 ~40 d after the end of the 1999 - 2001 outburst (Wijnands et al. 2003).

We have triggered our XMM-Newton observation and will request additional Swift and Chandra observations to study the cooling of the accretion-heated neutron star in quiescence, similar to

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what has been done after its previous outburst (Wijnands et al. 2003, Cackett et al. 2013). Currently the first XMM-Newton observation is scheduled on March 23. More multi-wavelength coverage of the source, especially in optical would aid this study to determine if accretion has indeed ceased and settled into a cold, quiescent disk.

Bahramian, A, et al. 2015, ATel #7957
Bahramian, A, et al. 2015, ATel #8046
Cackett, E, et al. 2013, ApJ 774, 131
Heinke, C, et al. 2006, ApJ 644, 1090
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Oosterbroek, T, et al. 2001, A&A, 376, 532
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