The brightest ULXs, the hyper luminous X-ray sources

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Abstract

Intermediate mass black holes (IMBHs) are thought to be the building blocks of supermassive black holes that are found in the centres of the more massive galaxies. However, until recently, the observational evidence for IMBHs has been weak,which poses problems for understanding the origin of supermassive black holes. Two promising environments to search for IMBHs include the centres of low mass galaxies and in the most luminous of the ultra lumimnous X-ray sources, the hyper-luminous X-ray sources (HLXs). Here I present recent results on the temporal evolution of the best studied IMBH candidate, HLX-1, which has a mass of ~1x10^4 M⊙, as well as discussing a recent study of the environment around this extreme ULX. I also present preliminary studies of other newly discovered HLXs.

Outbursts of HLX-1

The 8th outburst of HLX-1 (since 2008) started on or just before the 19th April 2017. This is 2.3 yr after the previous outburst that started in January 2015. The first 5 outbursts recorded since 2008 were fairly evenly spaced by ~1 yr. The 6th was delayed, showing 1 yr and 6 weeks between outbursts (Godet et al. 2014). The 7th outburst was also delayed showing ~15 months between outbursts (Godet et al. 2015), see Fig. 1. The lengthening of the orbit is consistent with SPH modelling of an elliptical system with an IMBH and a compact companion. Such a system will slowly become unbound due to tidal effects (see Fig. 3 and Godet et al. 2014). The 2017 outburst may therefore be the last outburst observed from this unusual system.

Origin of HLX-1

Webb et al. (2010) proposed that HLX-1 may have been created in a minor collision between a dwarf galaxy and ESO 243-49, which stripped the dwarf galaxy and caused stars to be thrown off their orbits, allowing a star to be captured by the central dwarf-galaxy BH. Earlier work looking for evidence for such a collision found no HI tidal tails that could be expected in such a merger (Musaeva et al. 2015). More recent MUSE integral field observations also showed no evidence for a recent minor merger, although evidence for mergers in the history of ESO 243-49 were seen through a rapidly rotating central disc in ESO 243-49, see Figs 2, 4 and 5 and Webb et al. (2017). In addition, the previously detected Hα line varied by a factor >6 between the high soft state and the MUSE observations in the low hard state, confirming the association of the Hα line with HLX-1 and thus the distance of 95 Mpc (Webb et al. 2017).

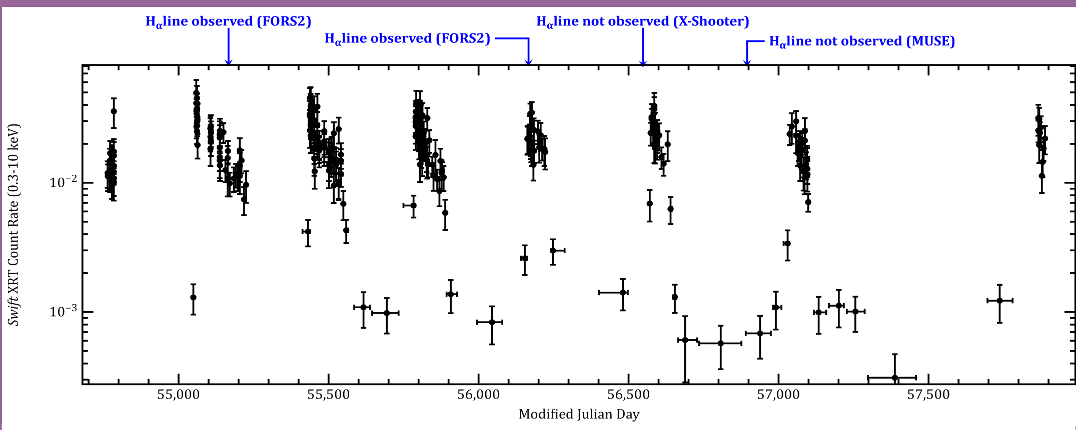

Figure 1 : Swift X-ray lightcurve of the IMBH HLX-1(2008-2017)

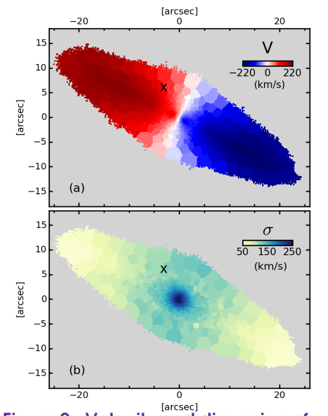

Figure 2 : Velocity and dispersion of ESO 243-49 measured from MUSE data

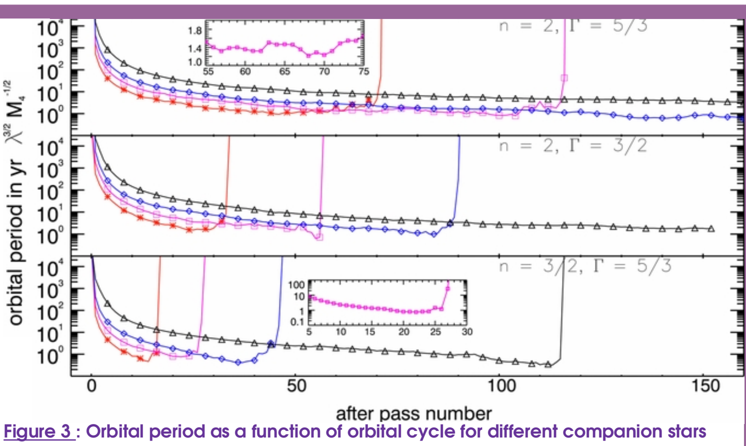

Figure 3 : Orbital period as a function of orbital cycle for different companion stars (with different polytropes) to the IMBH HLX-1 (from Godet et al. 2014)

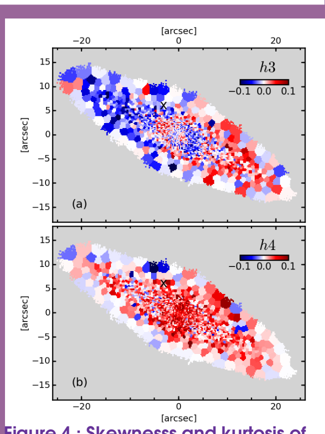

Figure 4 : Skewnesss and kurtosis of ESO 243-49 measured with MUSE data

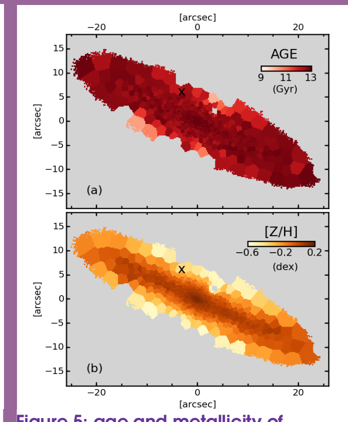

Figure 5: age and metallicity of ESO 243-49 measured with MUSE data

Searching the 3XMM catalogue (Rosen et al. 2016) for IMBHs akin to HLX-1, has revealed several excellent candidates that are currently being followed up at all wavelengths. Searching for IMBH in the centres of dwarf galaxies (low luminosity AGN, LLAGN) e.g. Koliopanos et al. (2017) is another way to search for these progenitors of supermassive black holes. Whilst no bonified IMBH has yet been found in LLAGN, new methods i.e. those outlined in Koliopanos et al. (2017 & poster J014) should allow us to find such objects in the near future. Many IMBH could remain in galaxies (e.g. Madau & Rees 2001), but they are still only detectable when they accrete. Given the apparent short lifetime of HLX-1, it is natural that few IMBH are known.

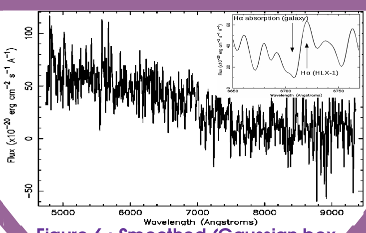

Figure 6 : Smoothed (Gaussian boxcar=3) galaxy subtracted MUSE spectrum of HLX-1 (low state, see Fig.1.) Insert shows region around the Hα line.

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