NIR counterparts to ultraluminous X-ray sources

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Ultraluminous X-ray Sources

ULXs are pointlike, off-nuclear X-ray sources that emit above the Eddington luminosity of a 10 $M_\odot$ black hole.

- Super-Eddington accretion?
- Beaming?
- Massive black holes?

Artist impression of the most luminous ULX known to date: HLX-1 in ESO 243-49 (Farrell et al. 2009). It probably contains an intermediate mass black hole.
Reliable mass measurements
Dynamical mass measurements

\[
\frac{P_{\text{orb}} K_C^3}{2\pi G} = \frac{M_{\text{BH}} \sin^3 i}{(1 + q)^2}
\]

Marsh 1994
Dynamical mass measurements

Liu et al. 2013
To the near-infrared
Phase 1: imaging survey

62 ULXs

17 counterparts

11 candidate red supergiants

Heida et al. 2014, MNRAS
Phase II: NIR spectroscopy

![Graph showing normalized flux vs wavelength (Å). The graph includes two lines: one red line labeled "Template" and one blue line labeled "ULX counterpart." The x-axis represents wavelength (Å) ranging from 15400 to 16600 Å, and the y-axis represents normalized flux ranging from 0.6 to 1.2.]
Radial velocity offset

$V_{\text{sys, av}}$ [km/s]

$M_{\text{BH}}[M_\odot]$
Radial velocity offset

Velocity amplitude donor star (km/s)

Orbital period (years)

$M_{BH} = 10 \, M_\odot$

$M_{BH} = 100 \, M_\odot$

$M_{BH} = 1000 \, M_\odot$

150 km/s
Work in progress:
Phase-resolved spectroscopy
(of a M > 100 M☉ black hole?)