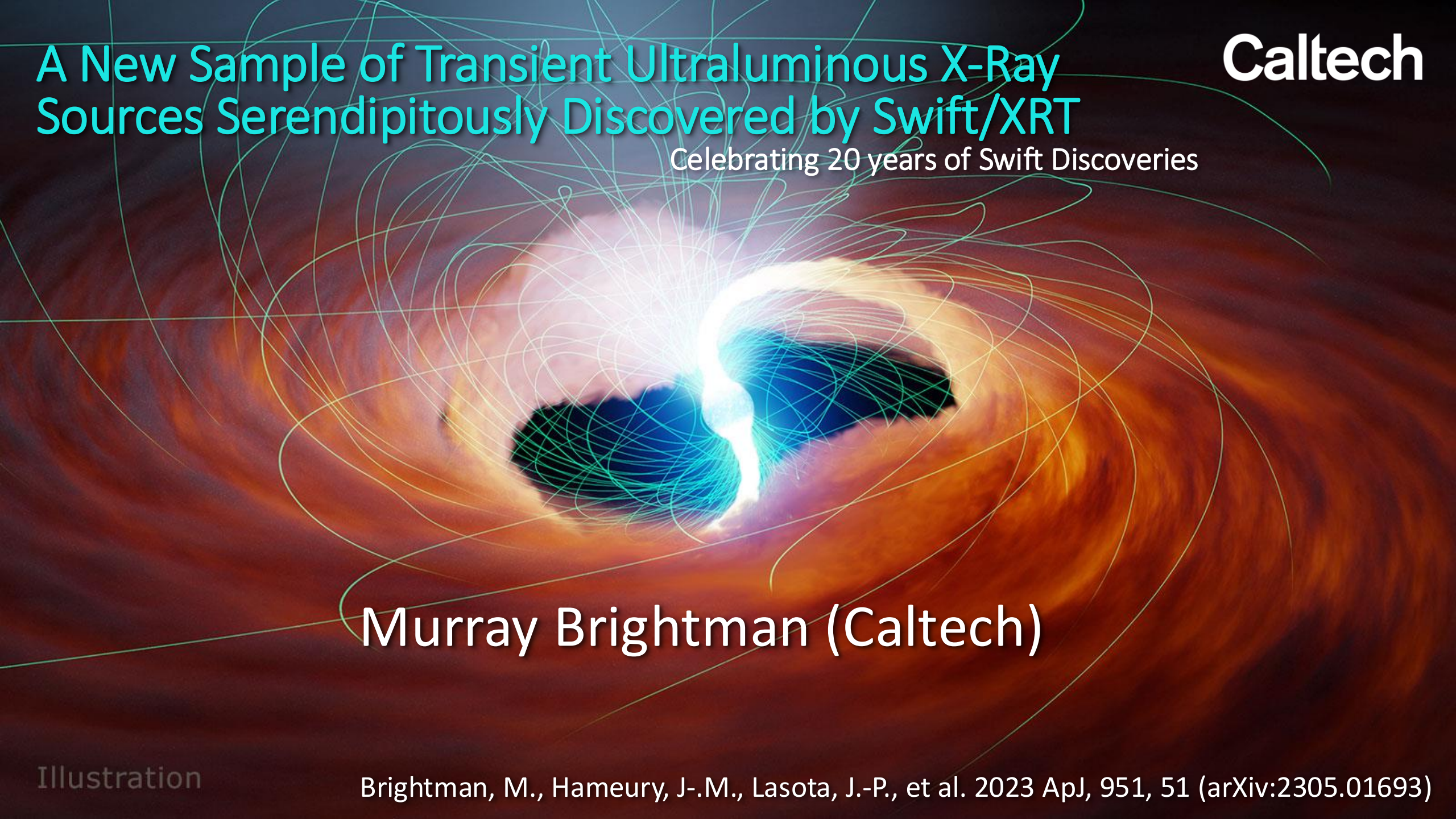
A New Sample of Transient Ultraluminous X-Ray Sources Serendipitously Discovered by Swift/XRT

Celebrating 20 years of Swift Discoveries

Caltech



Murray Brightman (Caltech)

Illustration

Brightman, M., Hameury, J-.M., Lasota, J.-P., et al. 2023 ApJ, 951, 51 (arXiv:2305.01693)

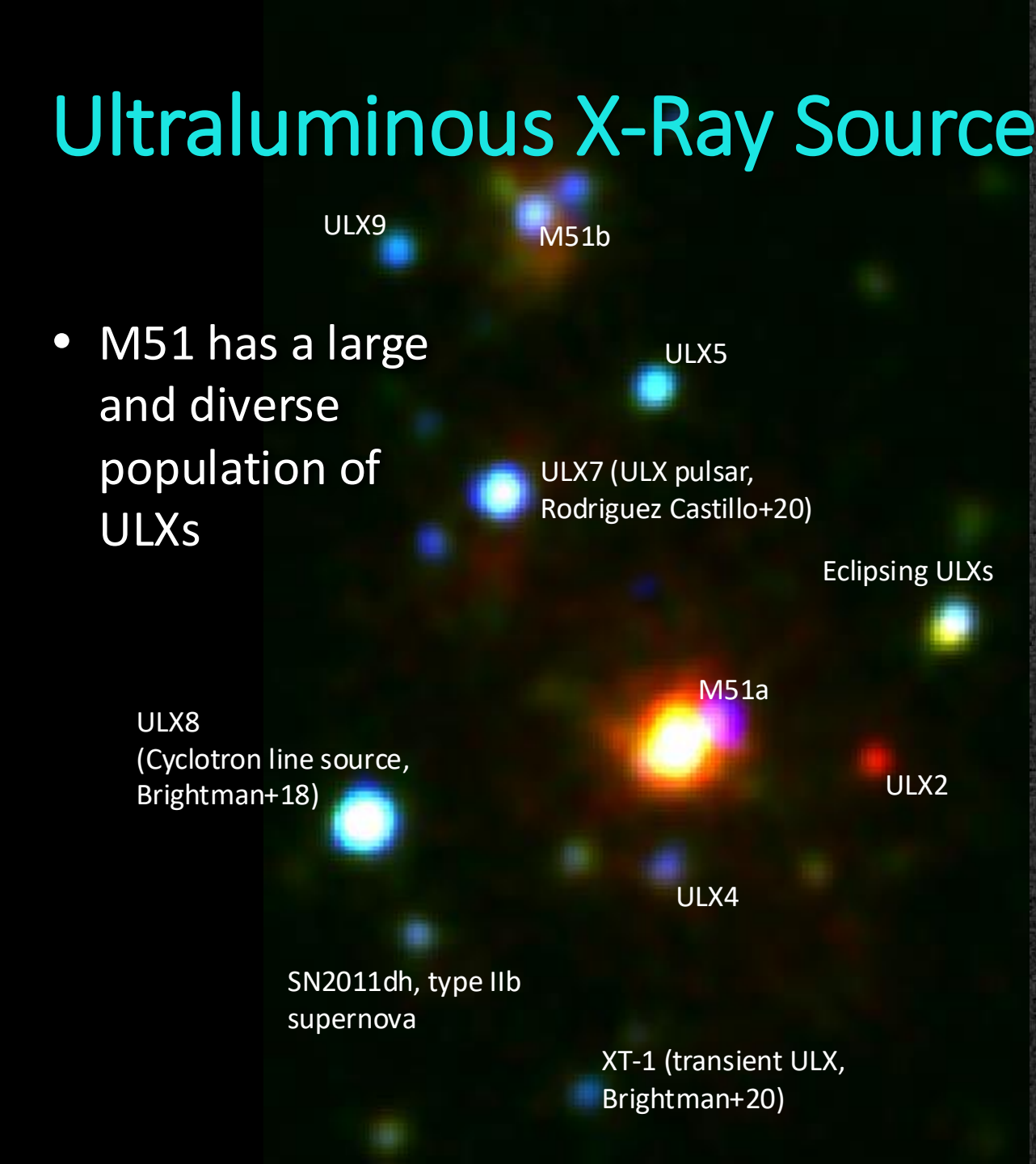
Ultraluminous X-Ray Sources

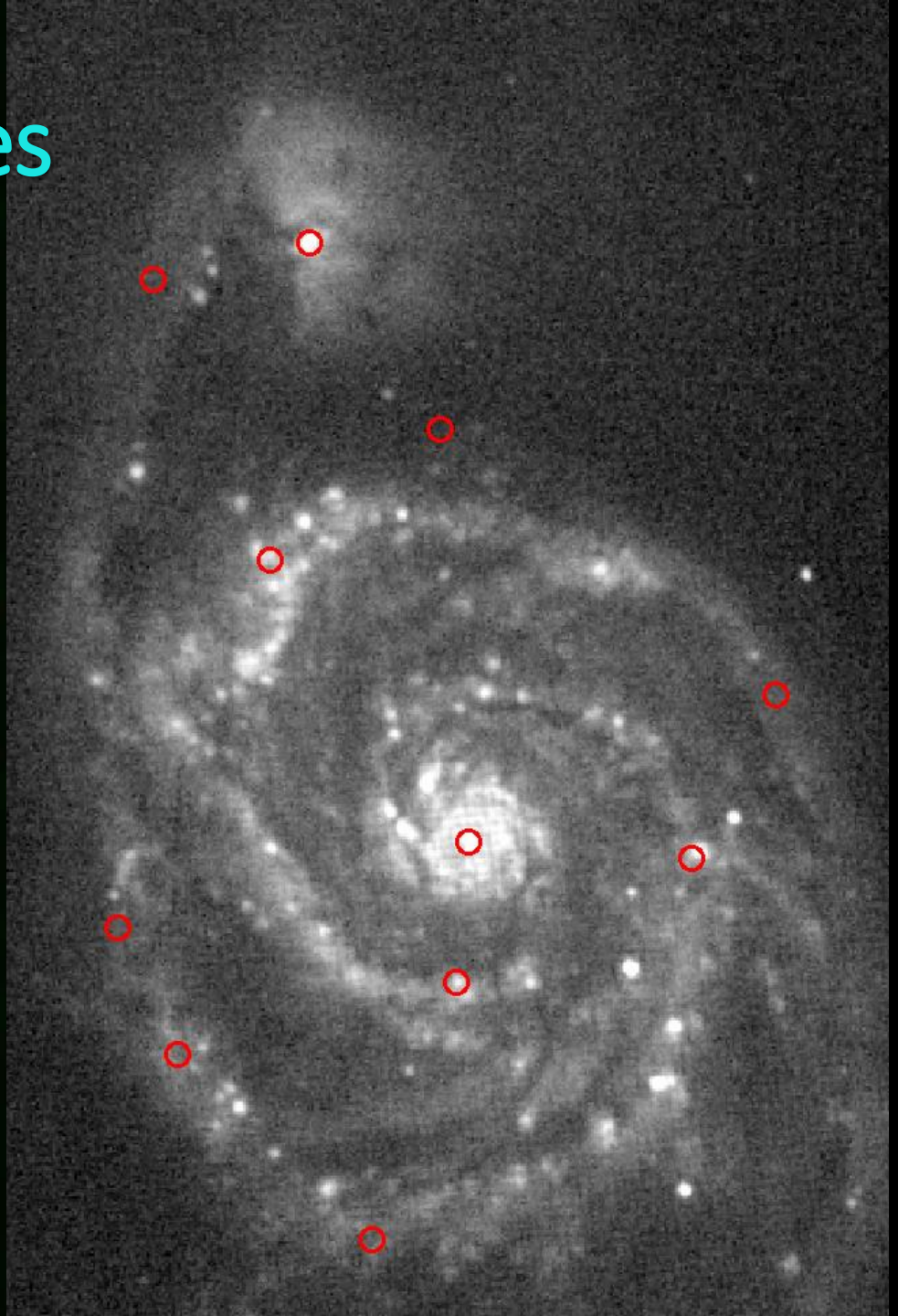
- X-ray sources with $L_X > 10^{39}$ erg s^{-1} (Eddington luminosity of 10 solar-mass black hole), not including accreting SMBHs.
- Imply more massive black holes (perhaps intermediate mass ones), or super-Eddington accretors.
- Several well known ULXs are now known to be powered by neutron stars (e.g. M82 X-2, Bachetti+14, NGC 5907 ULX1, Israel+17).
- Most well studied ULXs are persistent sources.

Illustration

Ultraluminous X-Ray Sources

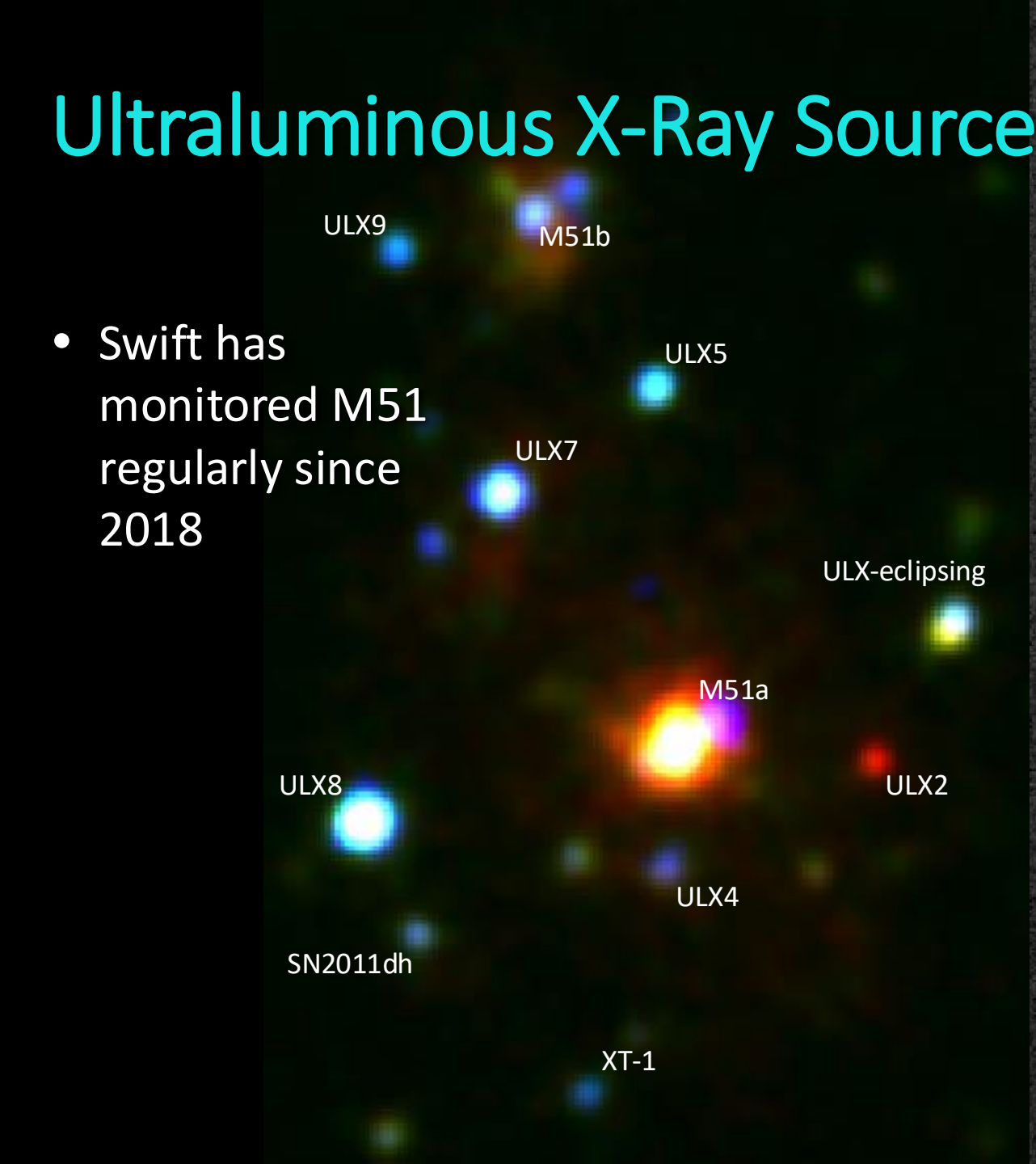
- M51 has a large and diverse population of ULXs

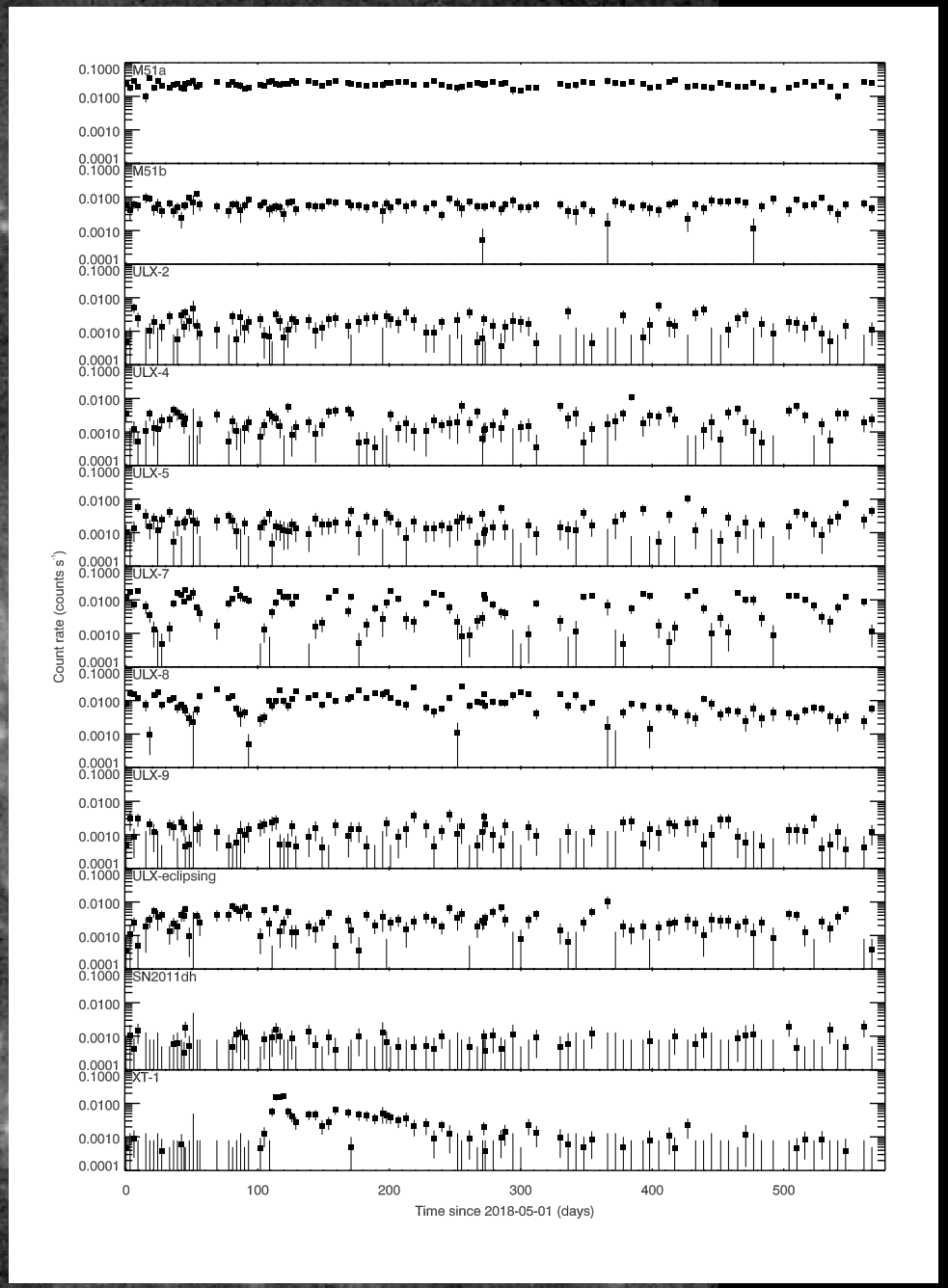




Ultraluminous X-Ray Sources

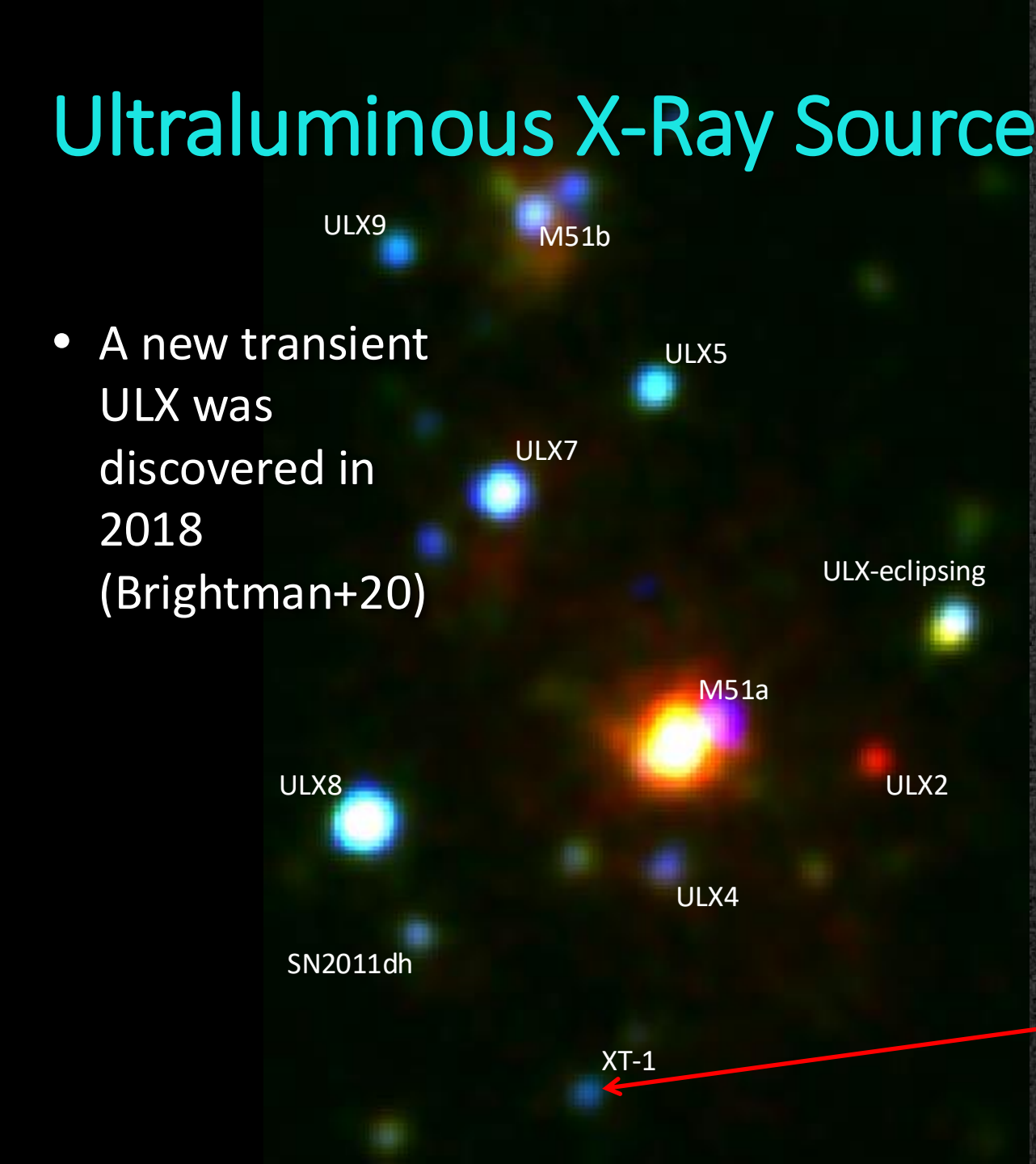
- Swift has monitored M51 regularly since 2018

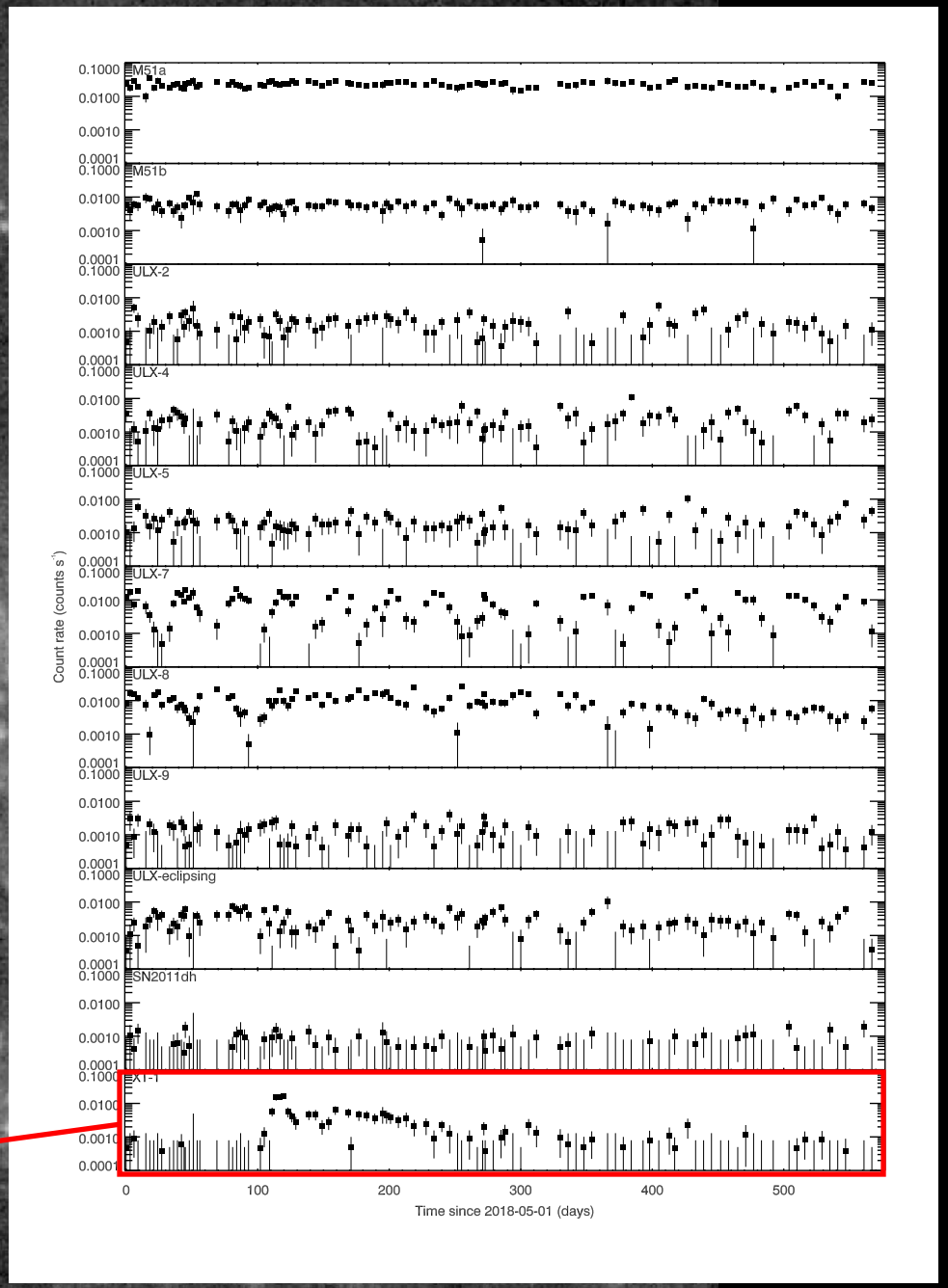




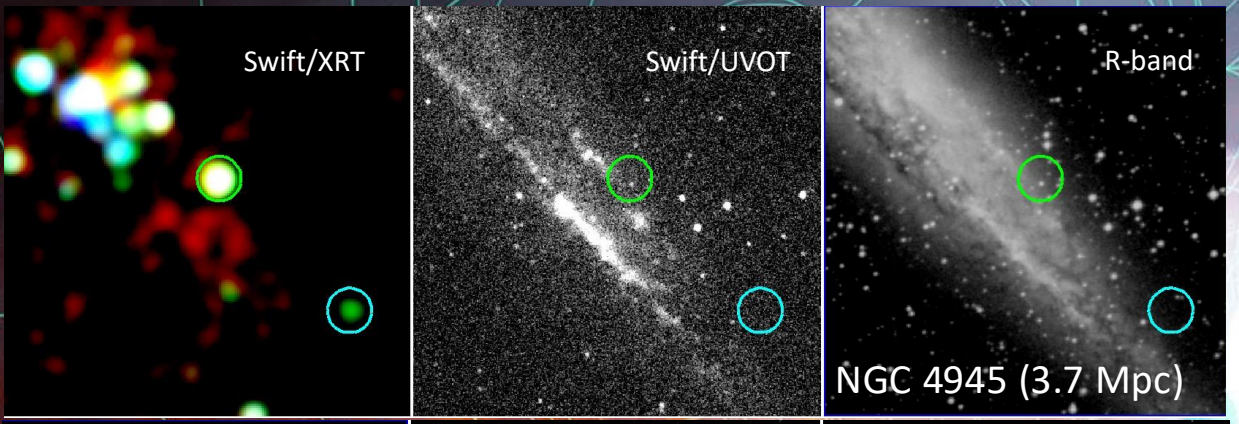
Ultraluminous X-Ray Sources

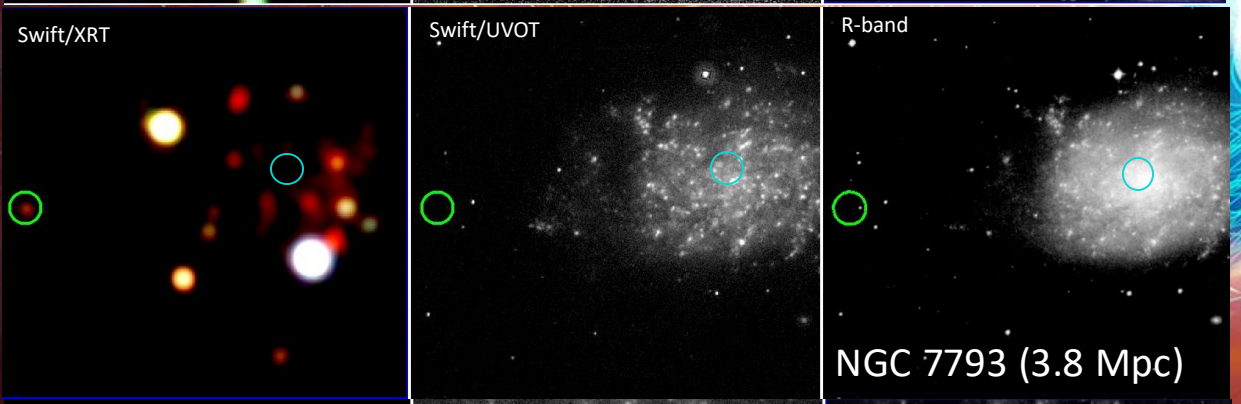
- A new transient ULX was discovered in 2018 (Brightman+20)

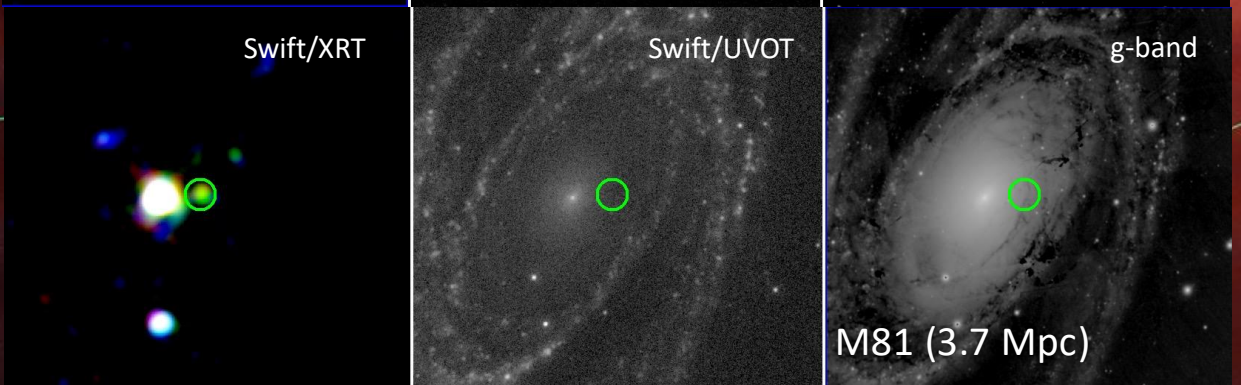




A New Sample of Transient Ultraluminous X-Ray Sources Serendipitously Discovered by Swift/XRT

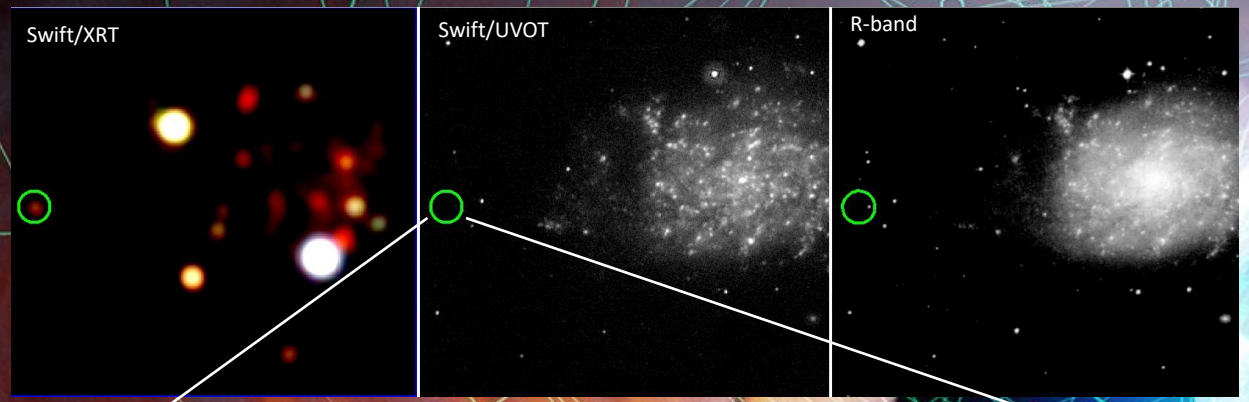




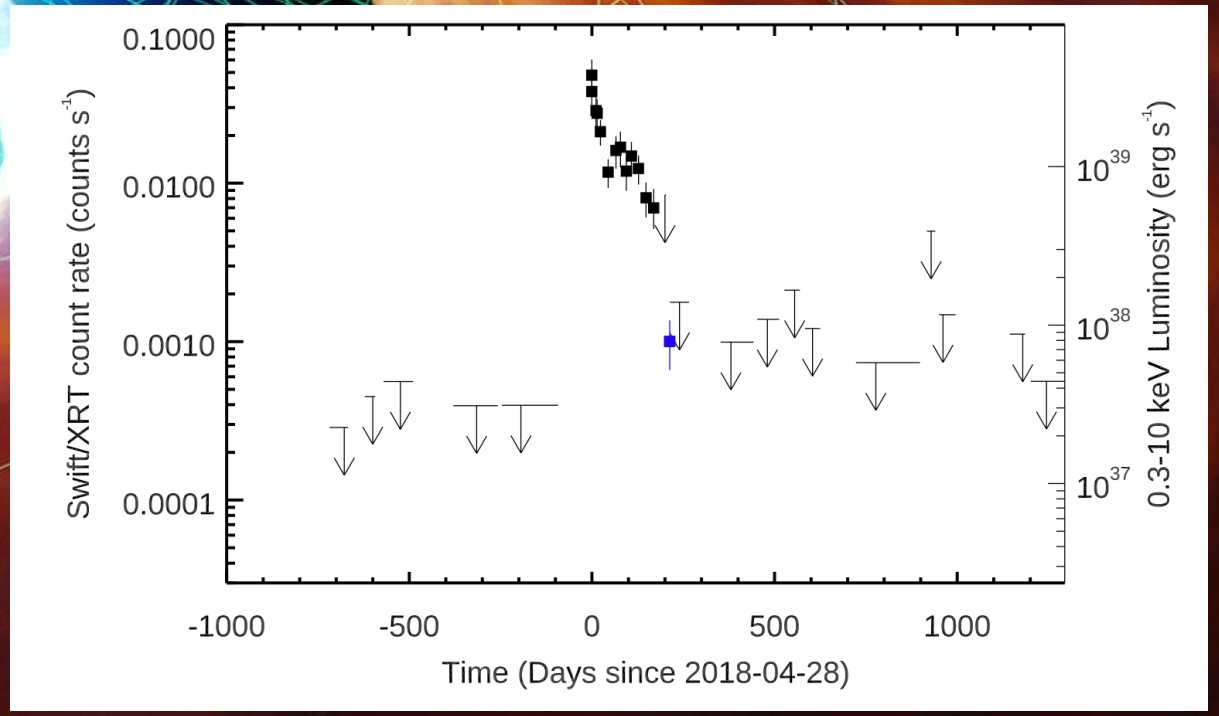


- In ~3 years of searches, we found 4 new transient ULXs in nearby galaxies, plus 1 other source in an archival search.
- The targets of the observations were the other ULXs in the galaxies, or the AGN in M81.
- Despite extensive prior X-ray studies of these galaxies, none of these sources had been previously detected.
- No counterpart optical/UV transients identified.

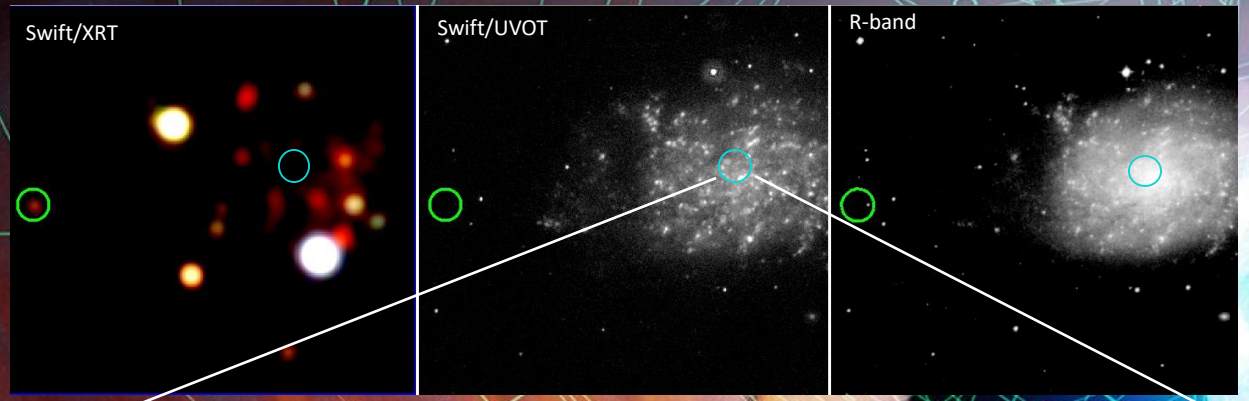
2SXPS J235825.7-323609, an X-ray transient in the field of NGC 7793

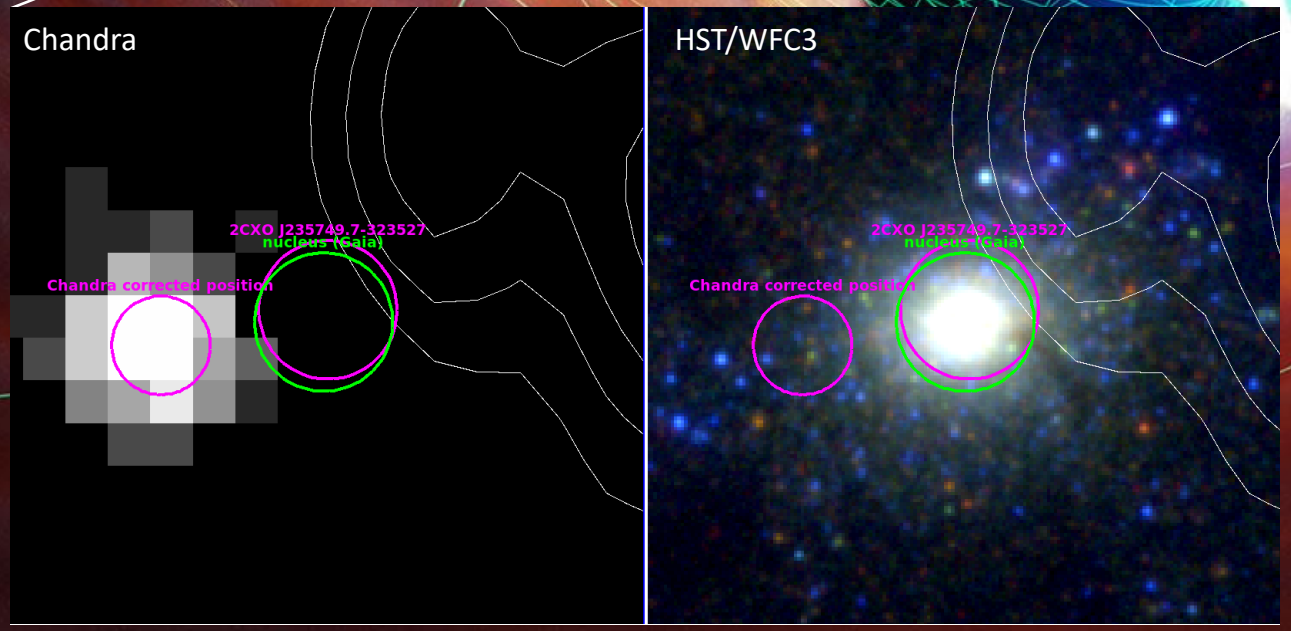


- Source found 7.6 arcmin (8.4 kpc) from the center of NGC 7793.
- No HST sources within X-ray positional error region.
- Outburst lasted for 180 days.

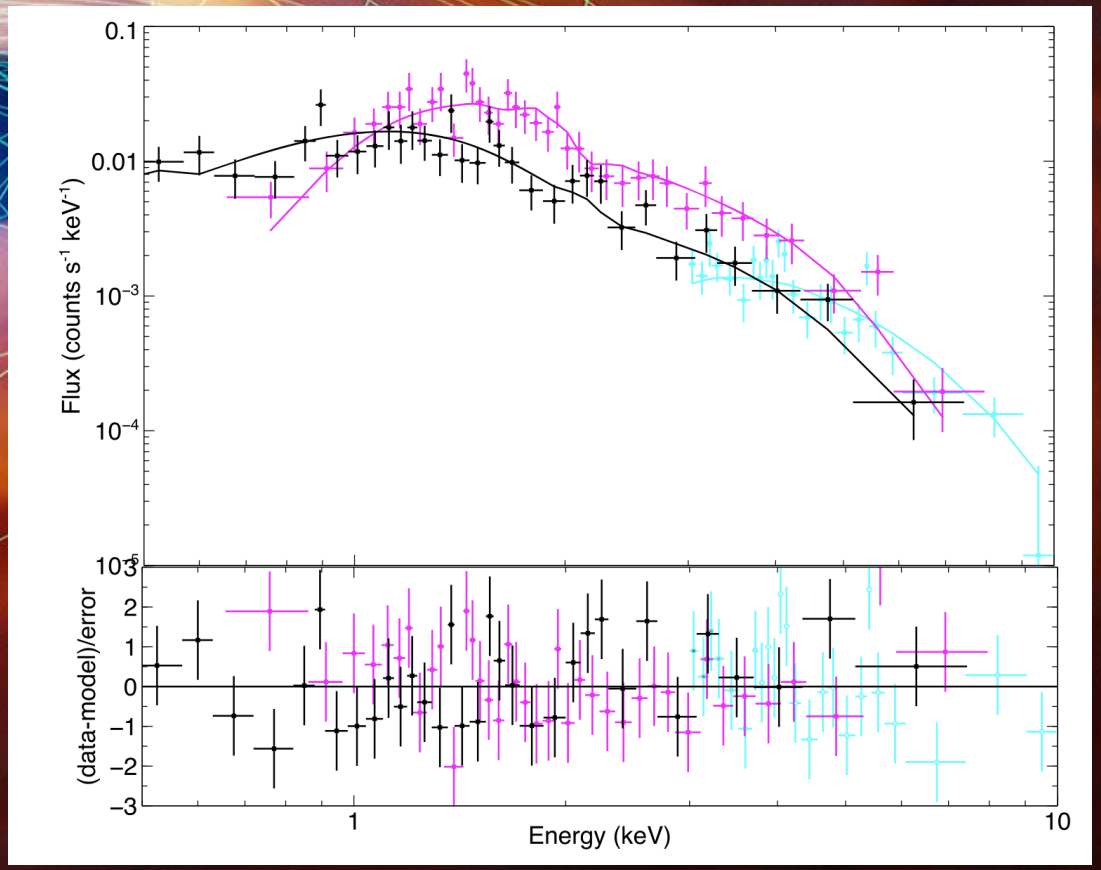


Swift J235749.9-323526, a second X-Ray transient in NGC 7793





- Source found 2.0 arcsec from the center of NGC 7793.
- Swift, Chandra and NuSTAR spectra are well fitted by a disk-like spectrum (power-law ruled out) with low level of absorption.



Source type determination

Background sources
(10^{44} erg s^{-1} @ z ~ 0.1)

- TDEs, AGN flares, gamma-ray burst afterglows are expected to show optical/UV emission (but see EP240408a, O'Connor+25)
- A host galaxy should be seen (also in optical/UV or IR).

Foreground sources
(~10^{33} erg s^{-1} @ 10 kpc)

- classical/dwarf novae are also expected to show optical/UV emission.
- Stellar flares are typically much shorter in duration, no Galactic stars in error circle.

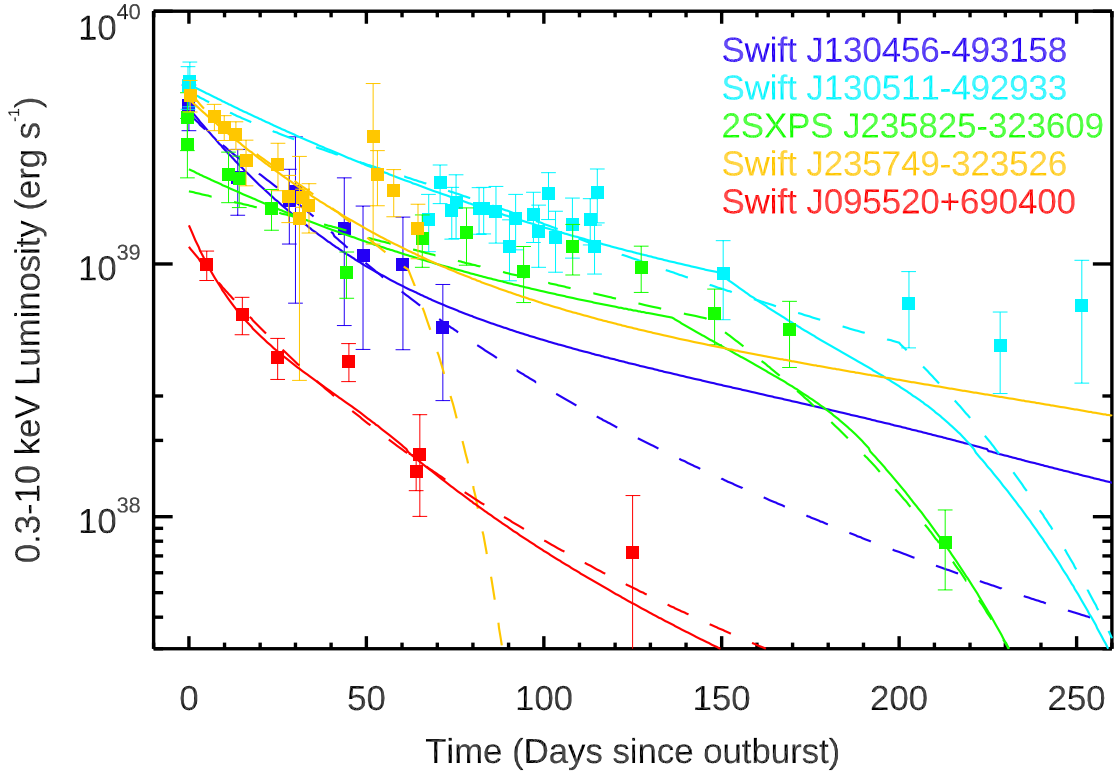
Other type of X-ray transient in the galaxy in question (~10^{39} erg s^{-1} @ 3-4 Mpc)

- supernovae also expected to show optical/UV emission.
- supernovae rates much lower.

Illustration

These X-ray transients must be ULXs!

Lightcurve fitting



- Lightcurves modelled with the disk instability model of Hameury & Lasota (2020).
- Model explains that super-Eddington outbursts can be explained by thermal-viscous instabilities in large unstable disks with outer radii greater than 10^7 km.

Illustration

Conclusions

- We have presented results on five newly found X-ray transients in the fields of nearby galaxies identified in a search of Swift/XRT observations.
- The timescales, fluxes, and lack of bright optical/UV counterparts argue against other types of X-ray transient.
- The rate of transient ULXs for these three galaxies appears high and the number of systems that produce ULX luminosities are likely dominated by transient sources.
- Still much to learn, such as the nature of the accretor (NS/BH?) and accretion mechanisms.

Illustration