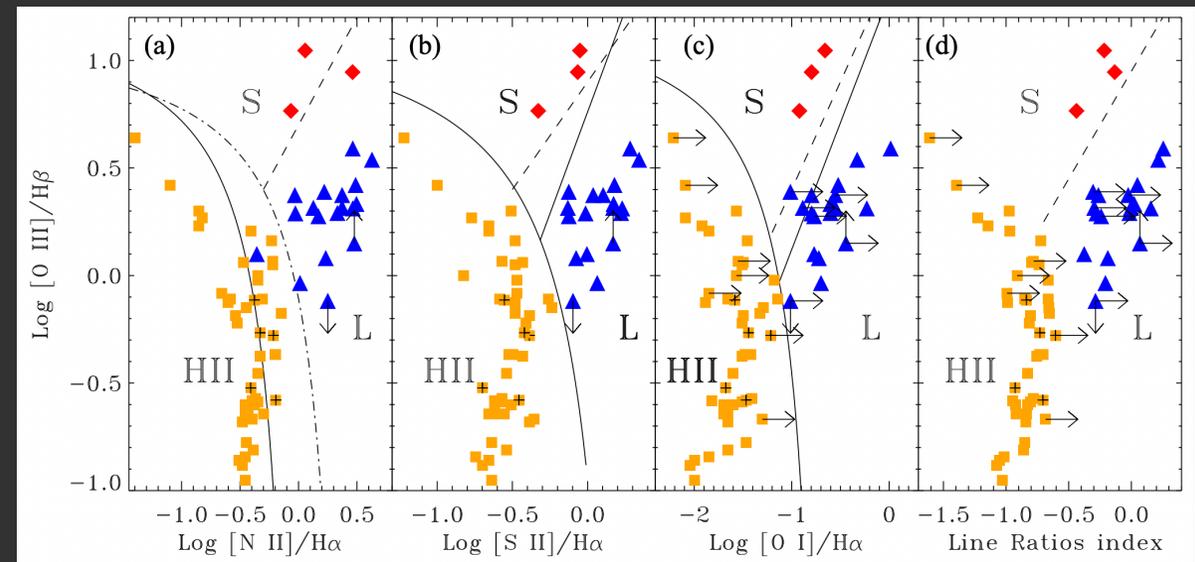


THE LEMMINGS SURVEY

*David Williams, Rob Beswick,
(Manchester), Ranieri Baldi
(INAF-Bologna), Ian McHardy
(Southampton) et al.*

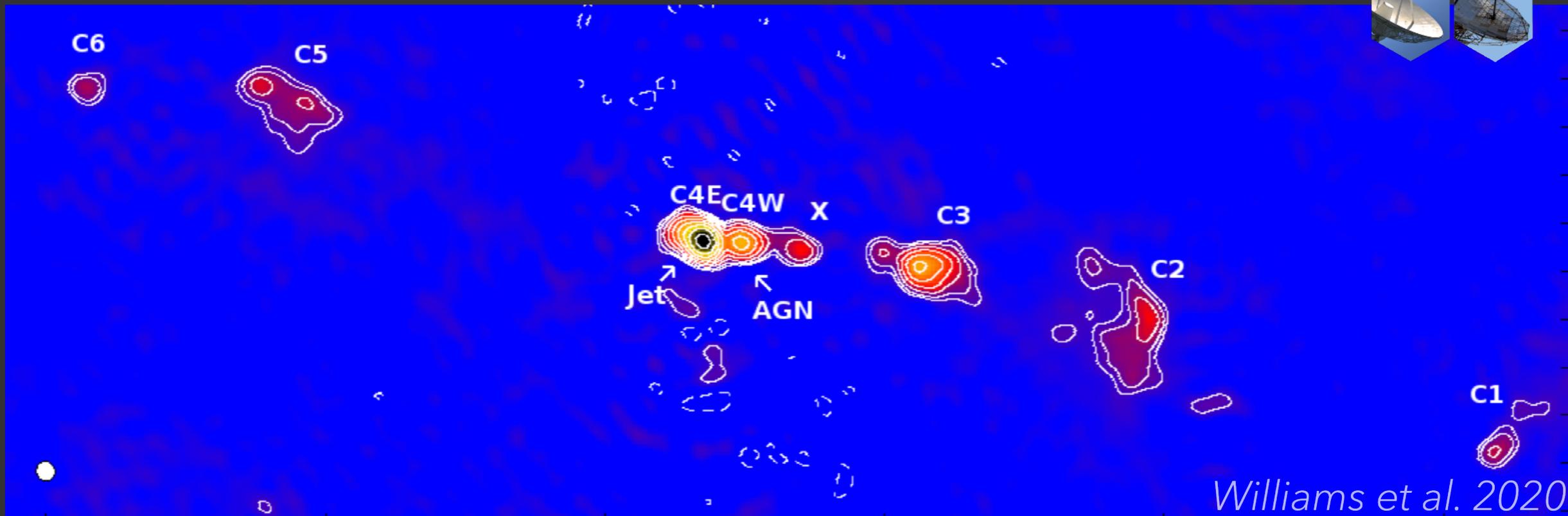
OVERVIEW

- Legacy e-MERLIN Multi-band Imaging of Nearby Galaxies survey
- 280 galaxies sub-selected from a statistically-complete optical survey (Ho et al 1997)
- All optical AGN classifications and Hubble types
- Declination limit > 20 degrees
- e-MERLIN observations at 1.5 GHz (150 mas resolution) and 5 GHz (50 mas)
- ‘Deep’ sample (6 objects) and ‘shallow’ sample (280 objects)
- Observations complete!



Baldi et al. 2021a

LEMMINGS DEEP SURVEY



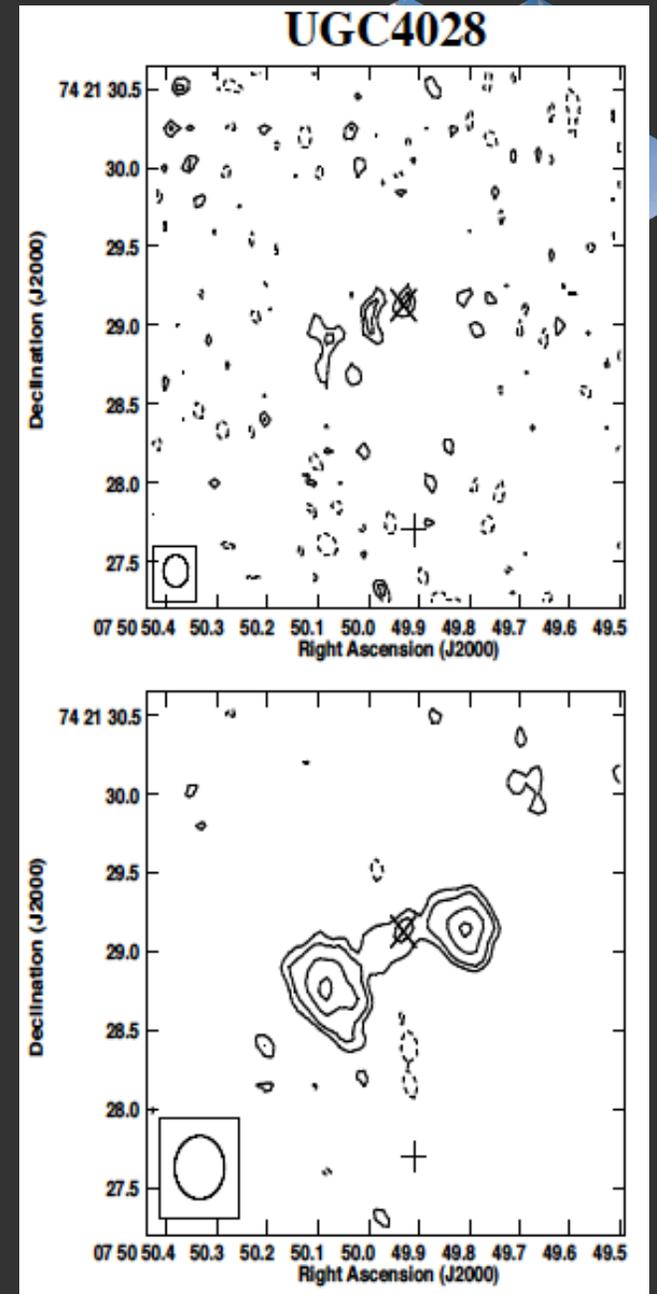
- Nearby Seyfert NGC 4151 showed radio variability in the core region over 20 years
- e-MERLIN 5 GHz data showed the jet component (not the AGN) was the cause

LEMMINGS SHALLOW SAMPLE

Radio Results from the full 1.5 GHz sample

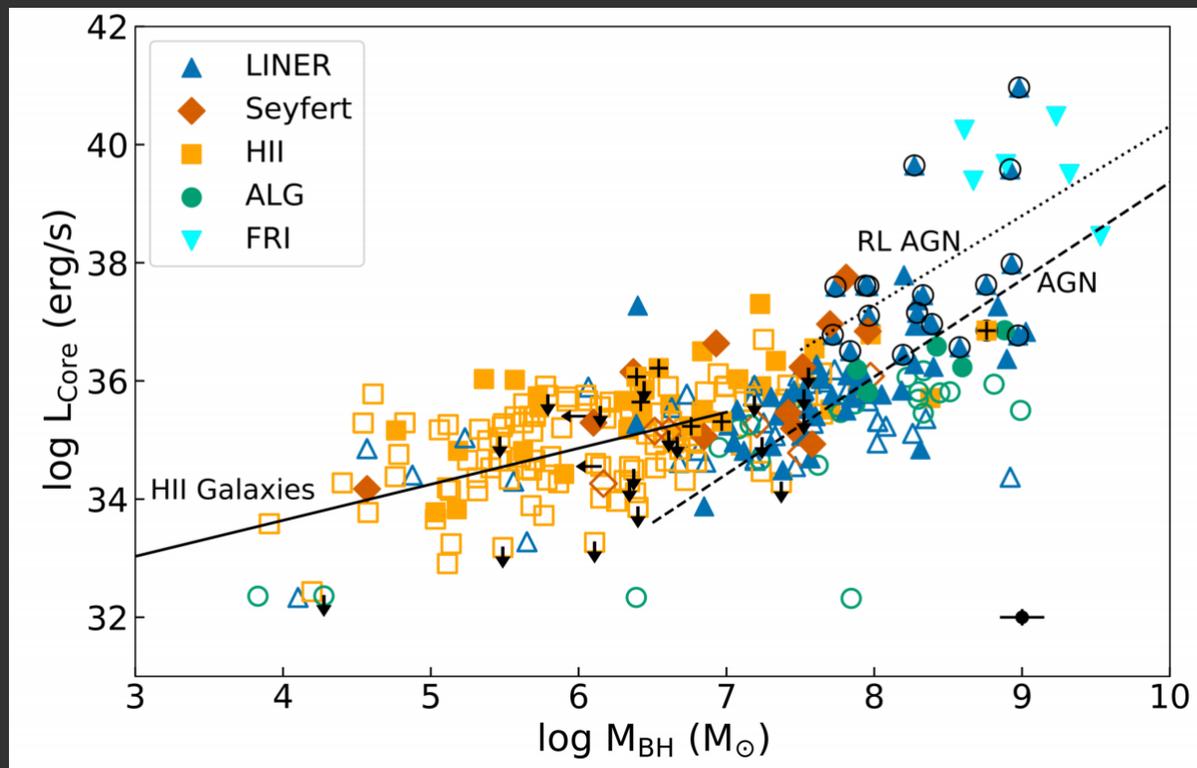
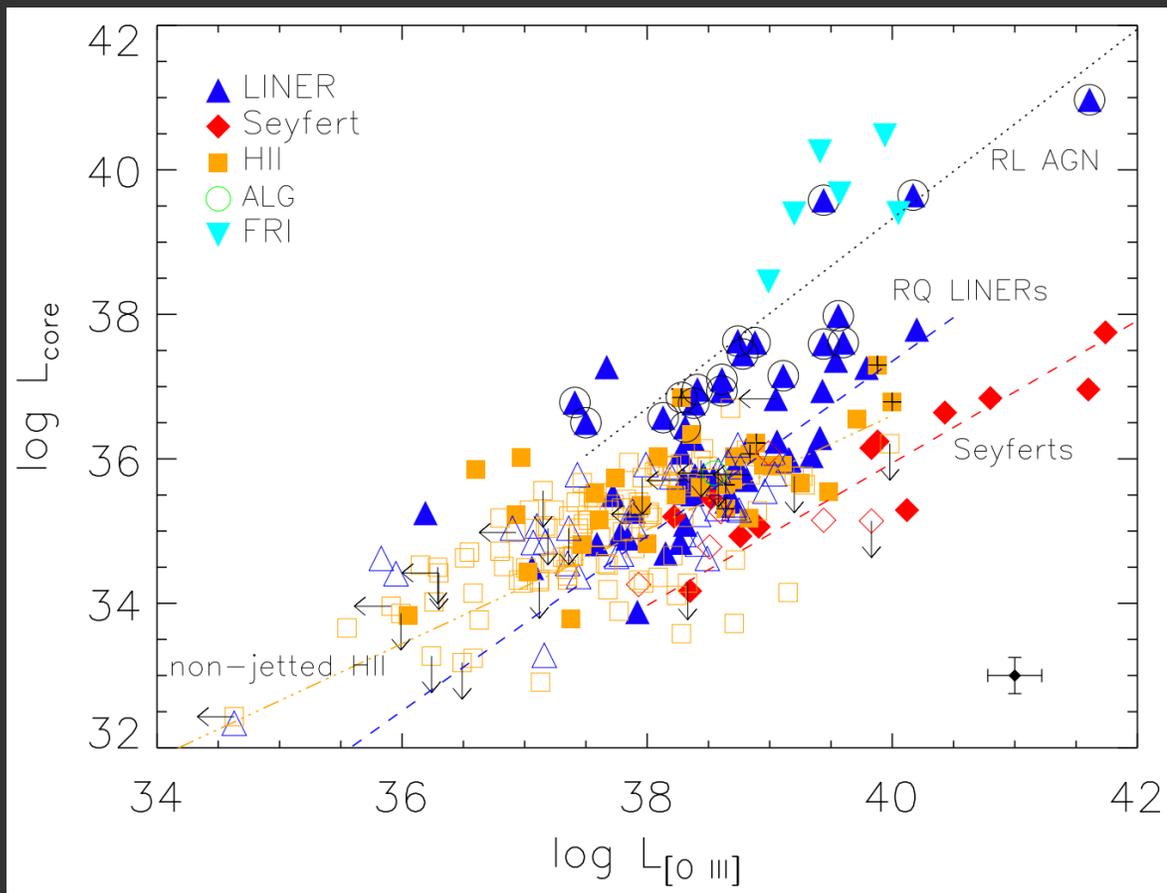
See Baldi et al. 2018, 2021a, 2021b

- ~44% of sources detected
58/94 LINERs; 16/18 Seyferts; 47/140 HII galaxies; 7/28 ALGs
- ~38% detection of radio core
- Radio jets on scales of 3-6600 pc, incl. jetted HII galaxies
- Noise level ~0.8 mJy/beam



Baldi et al. 2018

LEMMINGS SHALLOW SAMPLE



Baldi et al. 2018, 2021a, 2021b

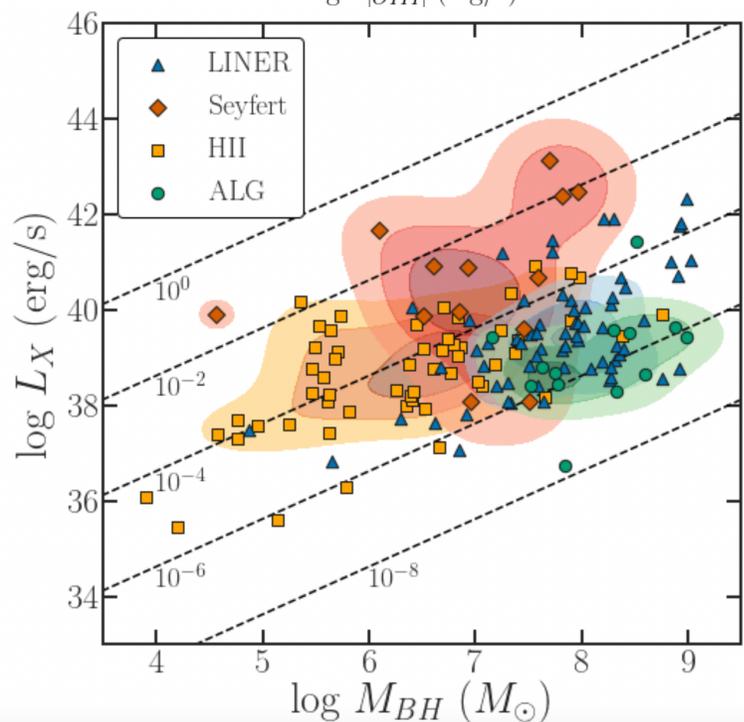
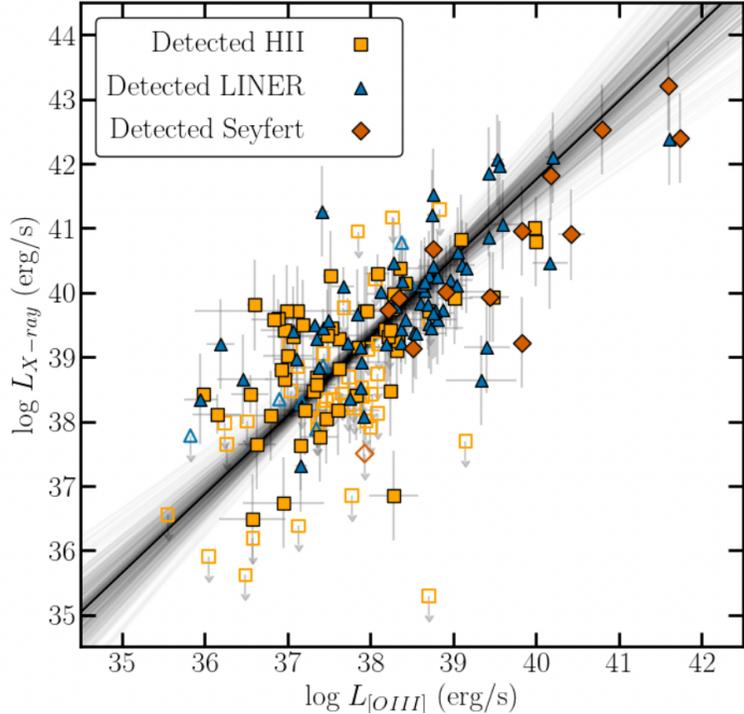


NEW & RECENT WORK





CHANDRA – X-RAY

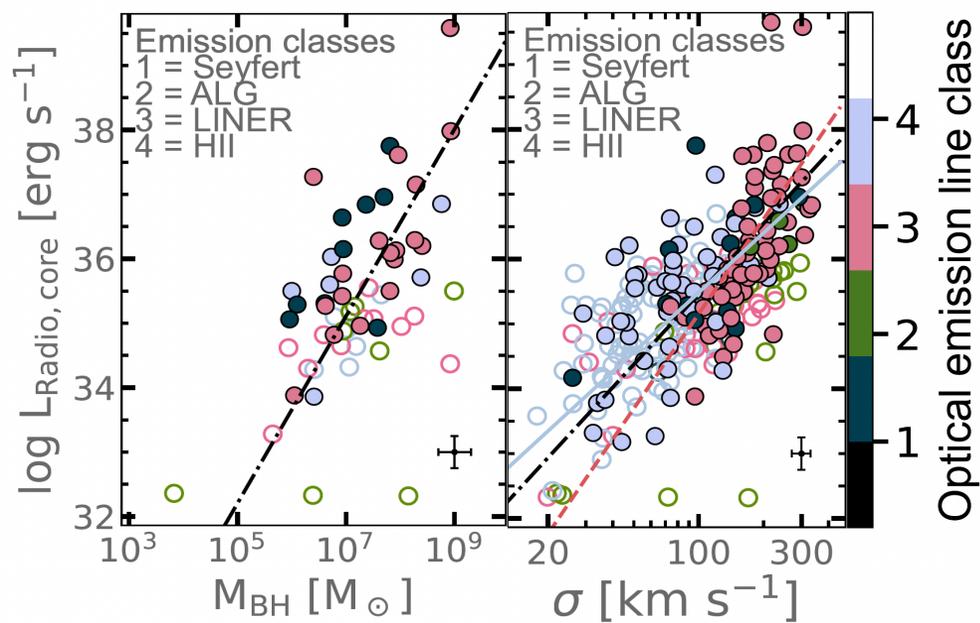
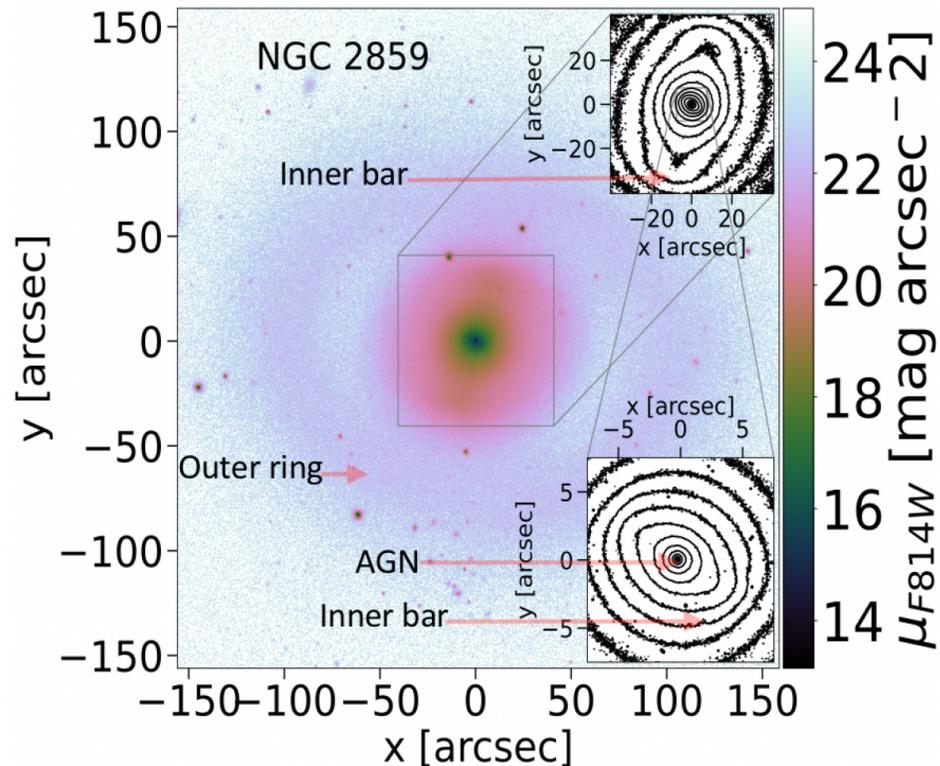


- 150/213 LeMMINGs sources show X-ray sources in nuclear region, aligned with optical nucleus
13/14 Seyferts, 68/77 LINERs, 13/22 ALGs and 56/100 H ii galaxies detected
- Correlations between X-ray and [O III] line luminosity to low levels
- Different AGNs separate out by accretion rate – Seyferts higher rate than LINERs/ALGs

Williams et al. 2022, Pahari et al., in prep.



HUBBLE – OPTICAL



- 173 LeMMINGs galaxies have Hubble optical data
- Full isophotal analysis to fit AGN, bars, bulges, rings and spiral arms
- Radio core vs bulge mass shows a turn off at $M_{*,\text{bulge}} \sim 10^{9.8} M_{\odot}$ ($M_{\text{BH}} \sim 10^{6.8} M_{\odot}$)
- Radio detection fraction increases with bulge mass (77% at $> 10^{11} M_{\odot}$ \rightarrow 24% at $< 10^{10} M_{\odot}$)

Dullo et al. 2022a subm., b in prep.

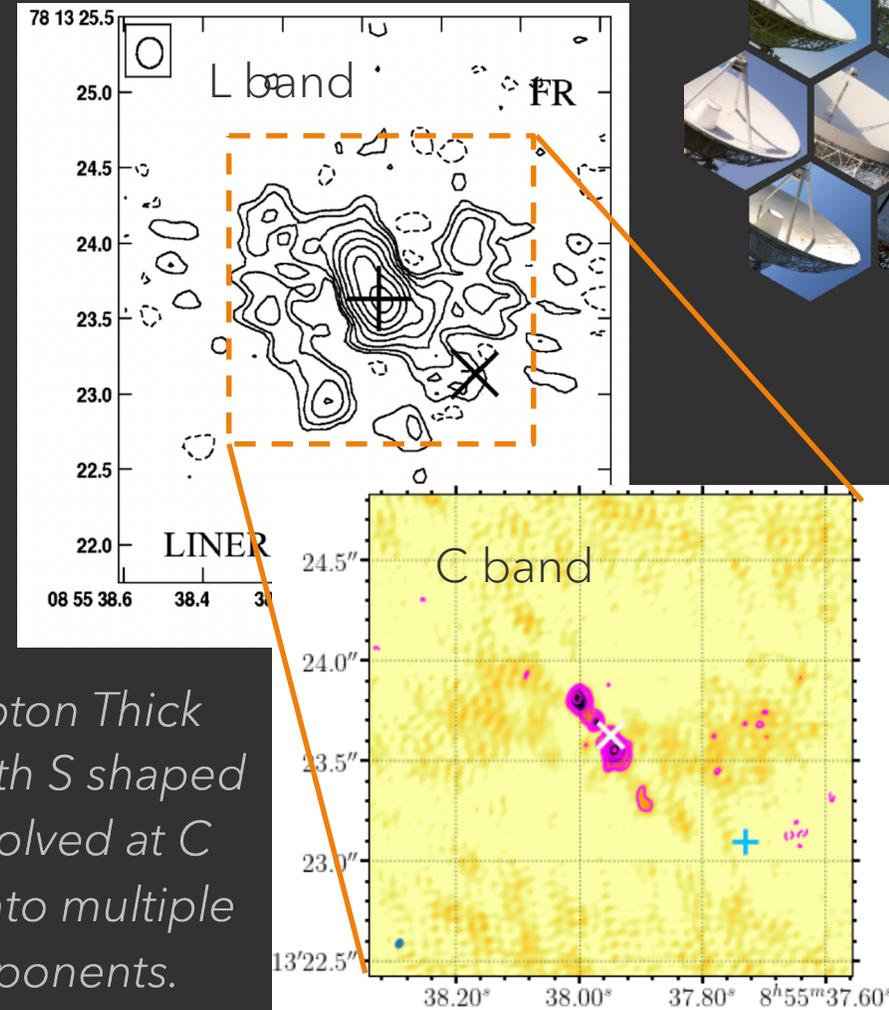
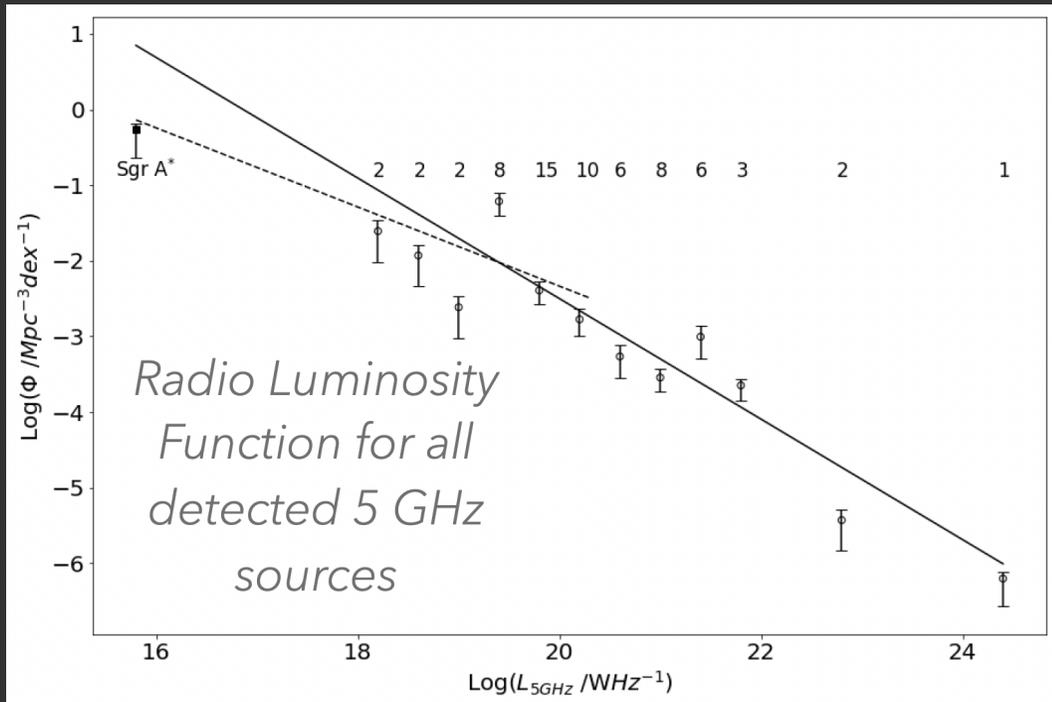


ONGOING & FUTURE WORKS



C BAND – RADIO

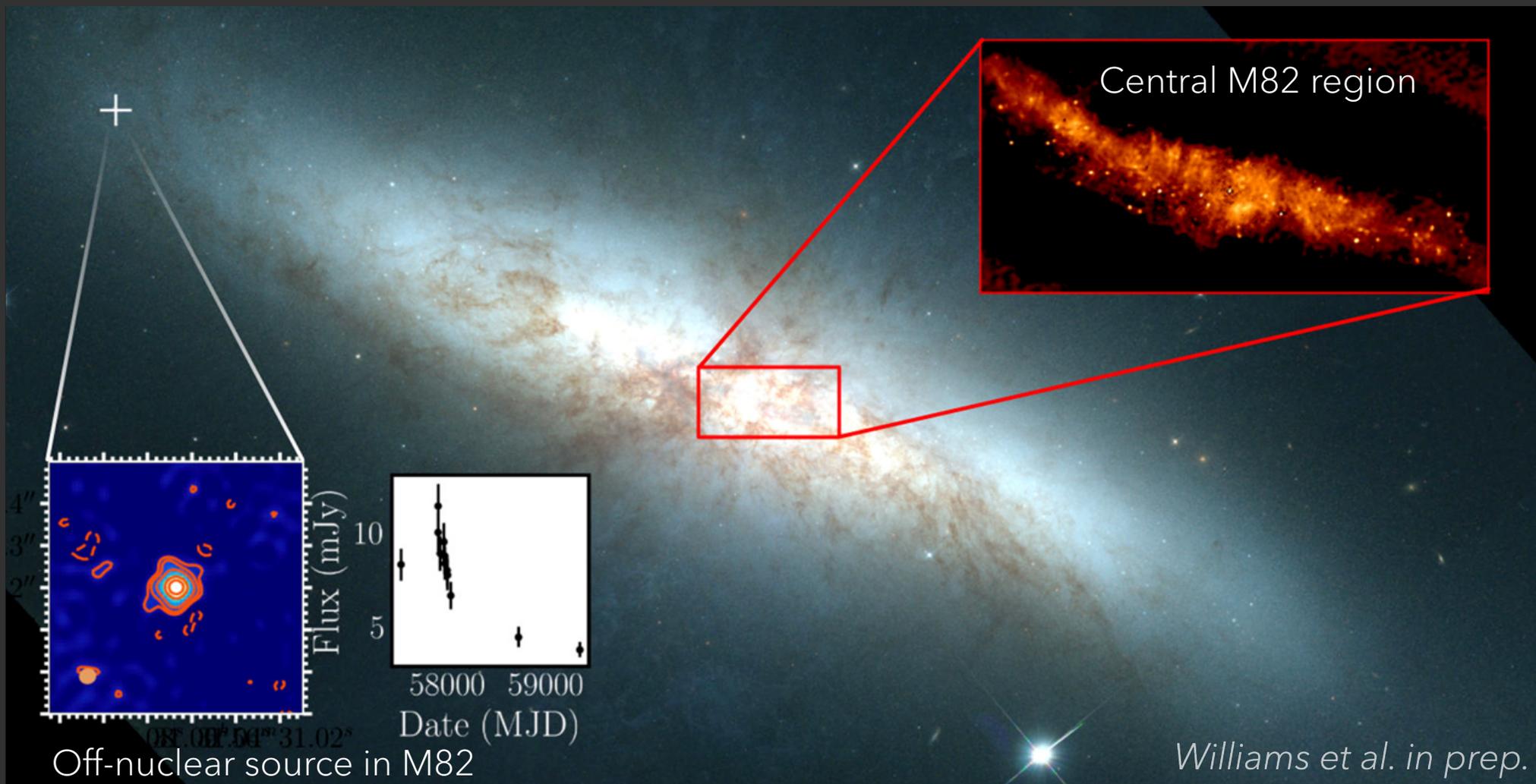
- Southampton Master's Students
*Emma Carver, Jake Clifford, Nick Kill +
 Bhairavi Krishnamoorthi*



*Compton Thick
 AGN with S shaped
 jet resolved at C
 band into multiple
 components.*

*Williams, Carver, Clifford, Kill,
 Krishnamoorthi et al. in prep.*

WIDEFIELD IMAGING – RADIO



CONCLUSIONS

- High resolution *LeMMINGs* radio observations of nearby galaxies show a ~40% detection rate
- Reveals *sub-kpc-scale* radio jets in galaxies not known to harbour AGN
- These sources are crucial for understanding the *radio luminosity function* of the local Universe
- Multi-wavelength observations at matching resolution enable exploration of *galaxy evolution and emission mechanisms*
- More work on its way with 5 GHz sample, Hubble data and widefield imaging