

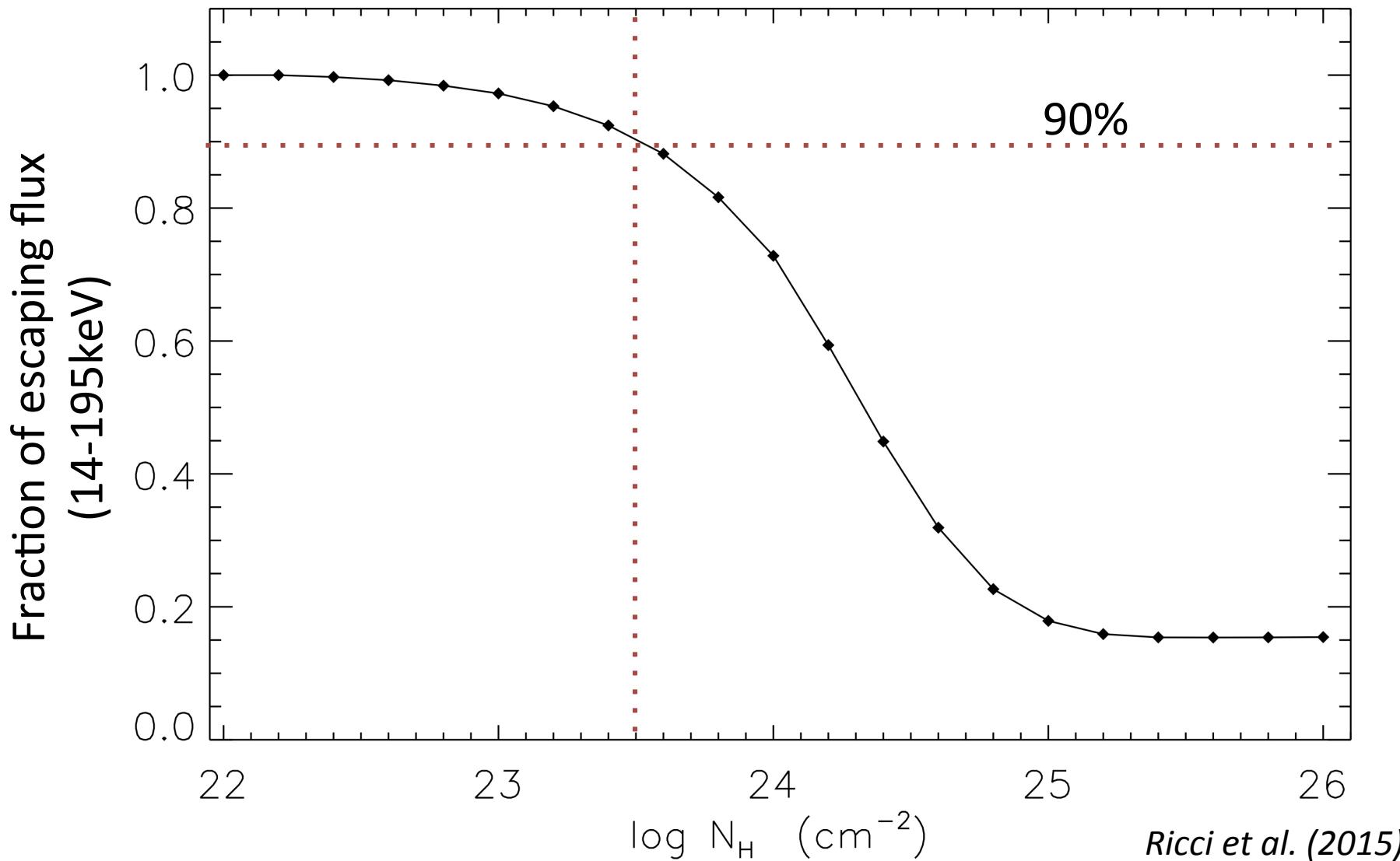
The relation between AGN obscuration and galaxy interactions

Claudio Ricci

*Pontificia Universidad Catolica de Chile &
Kavli Institute for Astronomy and Astrophysics, Beijing*

F. Bauer, E. Treister, G. Privon (PUC), Y. Ueda (Kyoto Univ.), L. Ho (KIAA), M. Koss, B. Trakhtenbrot, K. Schawinski (ETH), R. Assef (UDP), R. Mushotzky, L. Blecha (UMD), S. Paltani (Geneva Univ.), P. Arevalo (UV), D. Asmus (ESO), D. Stern (JPL), F. Harrison (Caltech), D. Sanders (U. of Hawaii), L. Armus (JPL) and many others

Obscuration in the hard X-ray band

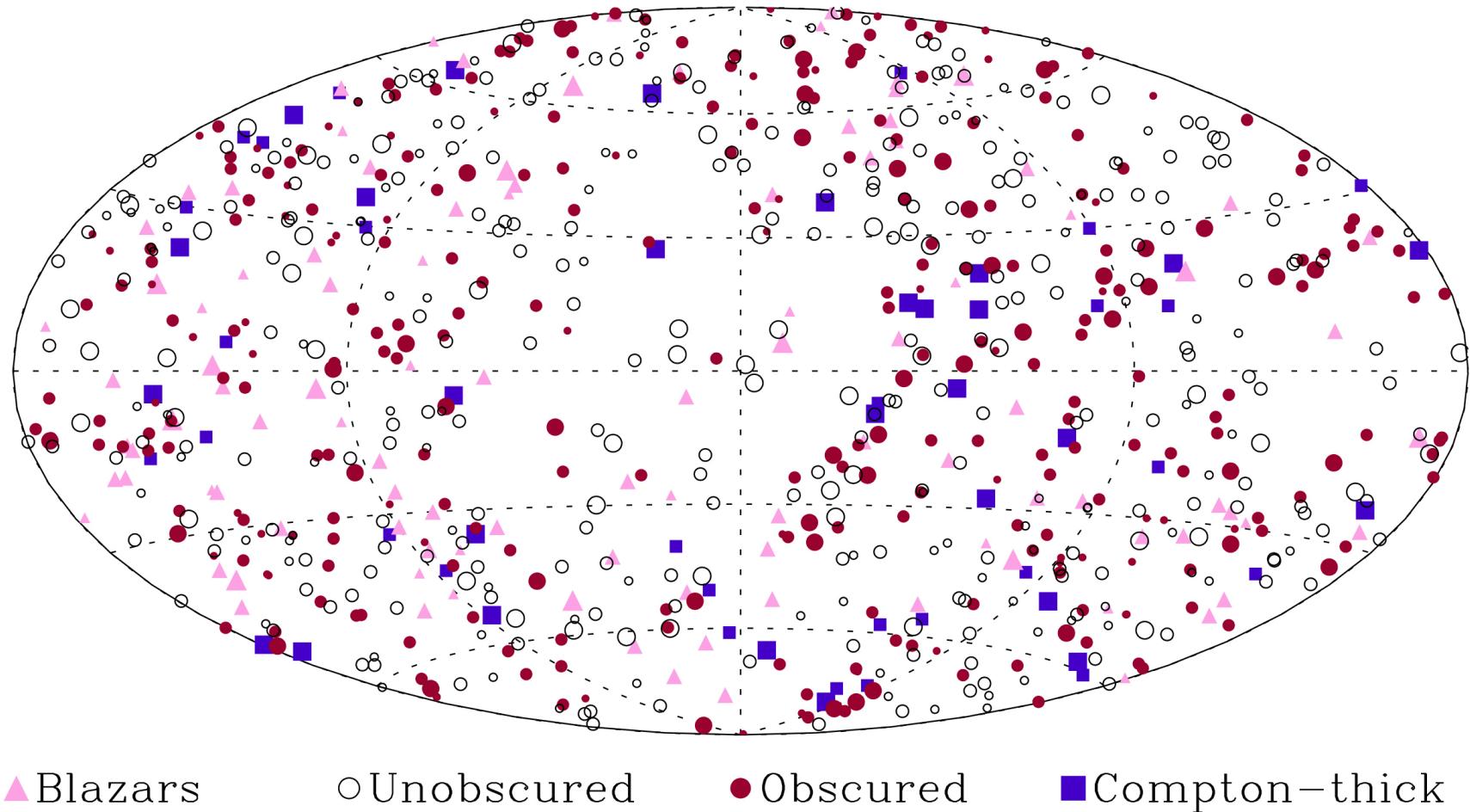


Ricci et al. (2015)

Nuclear obscuration in isolated galaxies



Swift/BAT AGN



▲ Blazars

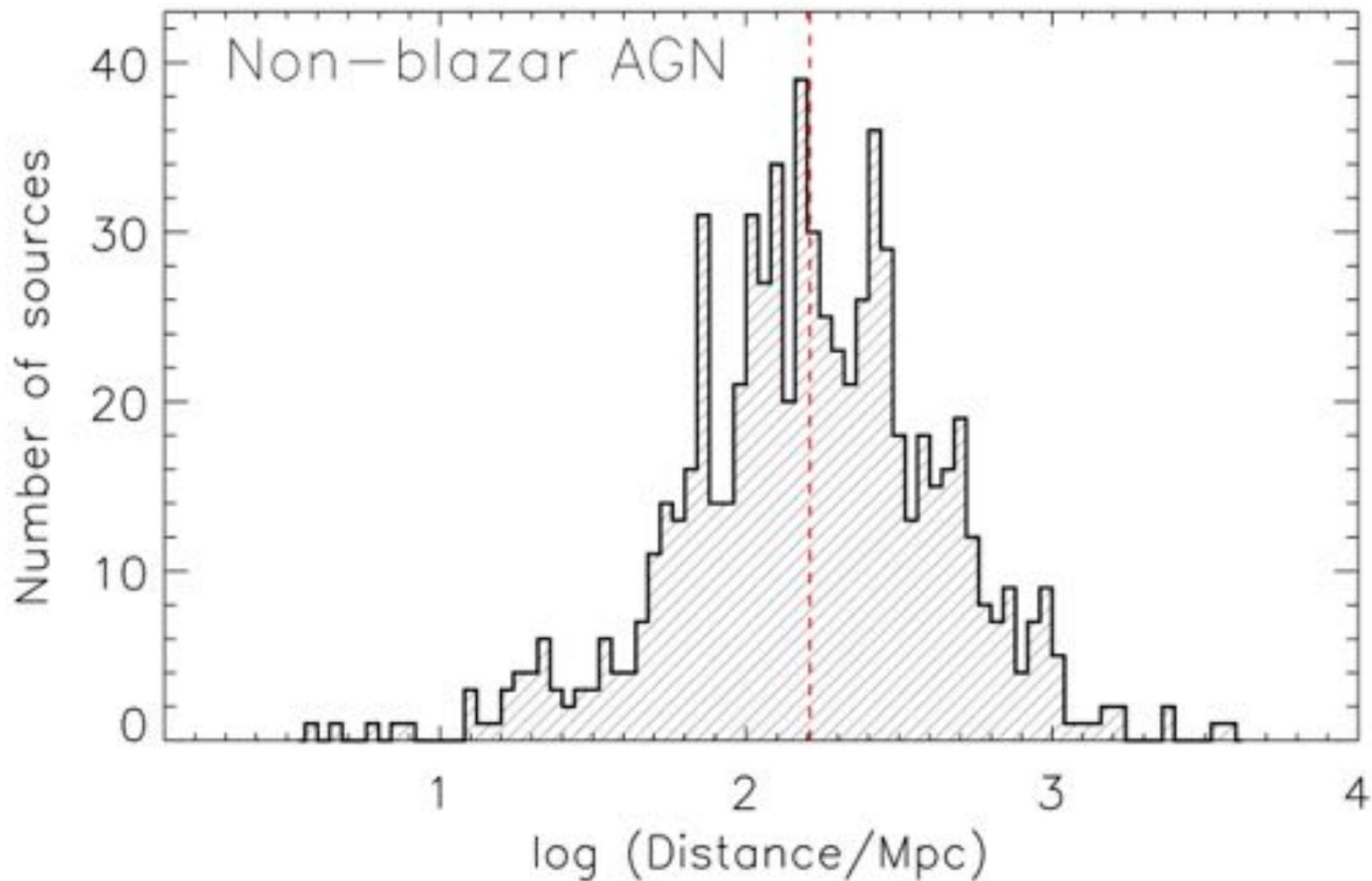
○ Unobscured

● Obscured

■ Compton-thick

(Ricci et al. 2017c, submitted to ApJS)

Swift/BAT AGN

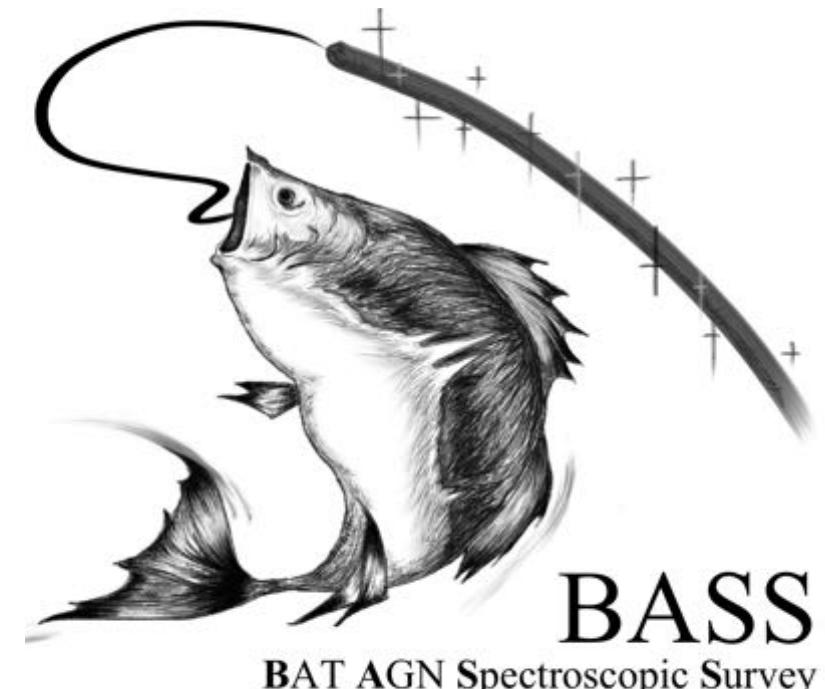


(Ricci et al. 2017c, submitted to ApJS)

The BAT AGN Spectroscopical Survey (BASS)

A multi-wavelength study of
hard X-ray detected AGN:

X-ray, optical, near-IR,
mid-IR, far-IR, radio
observations of
Swift/BAT AGN

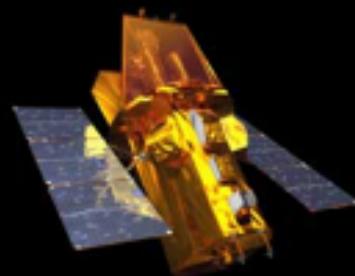


Logo by: K. Oh (ETH)

Ricci+15, Berney+15, Trakthenbrot+17, Lamperti+17, Oh+17, **Koss+17** (submitted to ApJS), **Ricci+17c** (submitted to ApJS), Oh+17 (submitted to ApJS), + many more in prep.

Soft (0.3-10 keV) X-ray observations

Swift/XRT (505)



XMM-Newton (297)



Chandra ACIS (15)



Suzaku XIS (9)

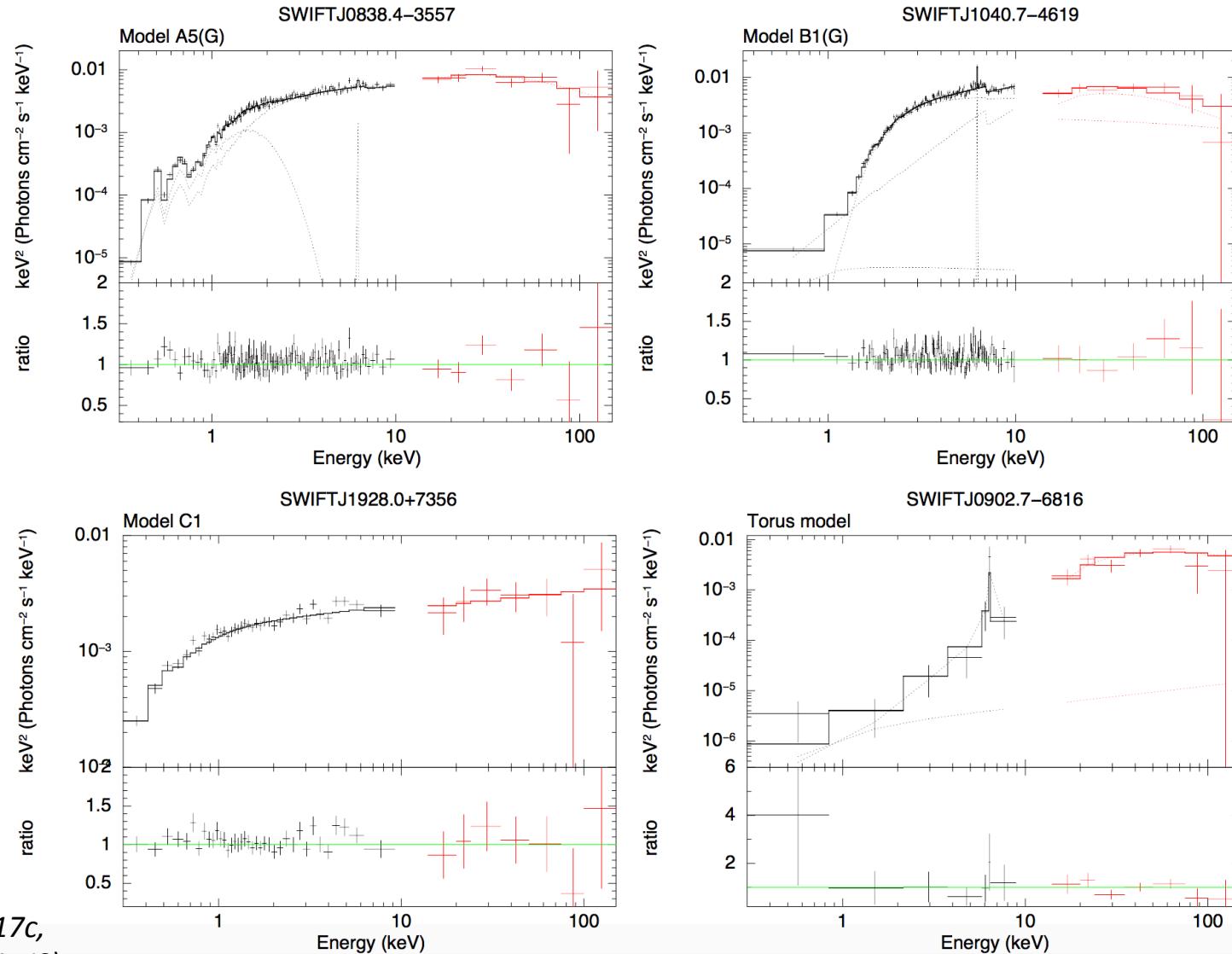


ASCA GIS/SIS (5)

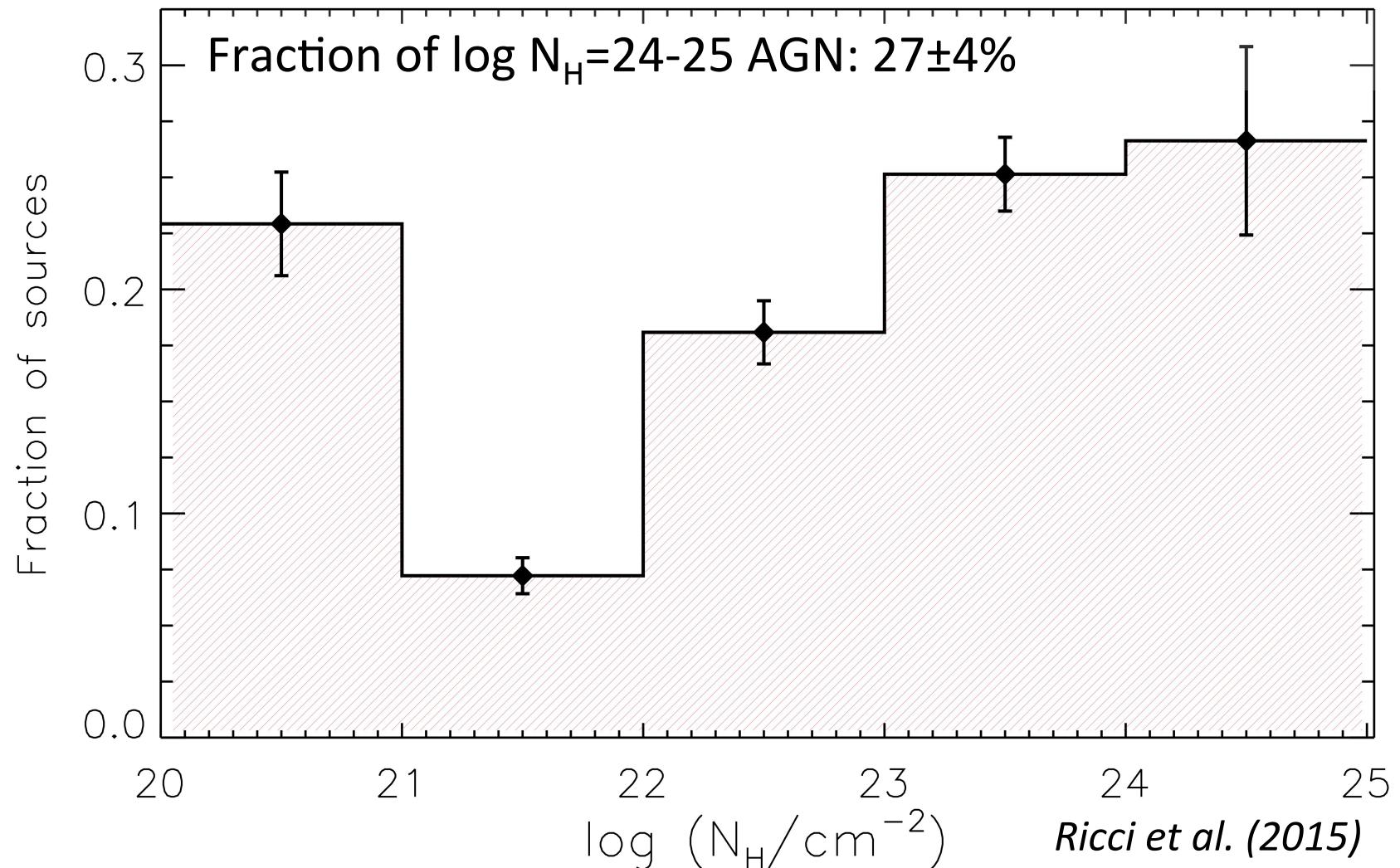


no soft X-ray observations: 2 AGN ; >1,500 spectra!

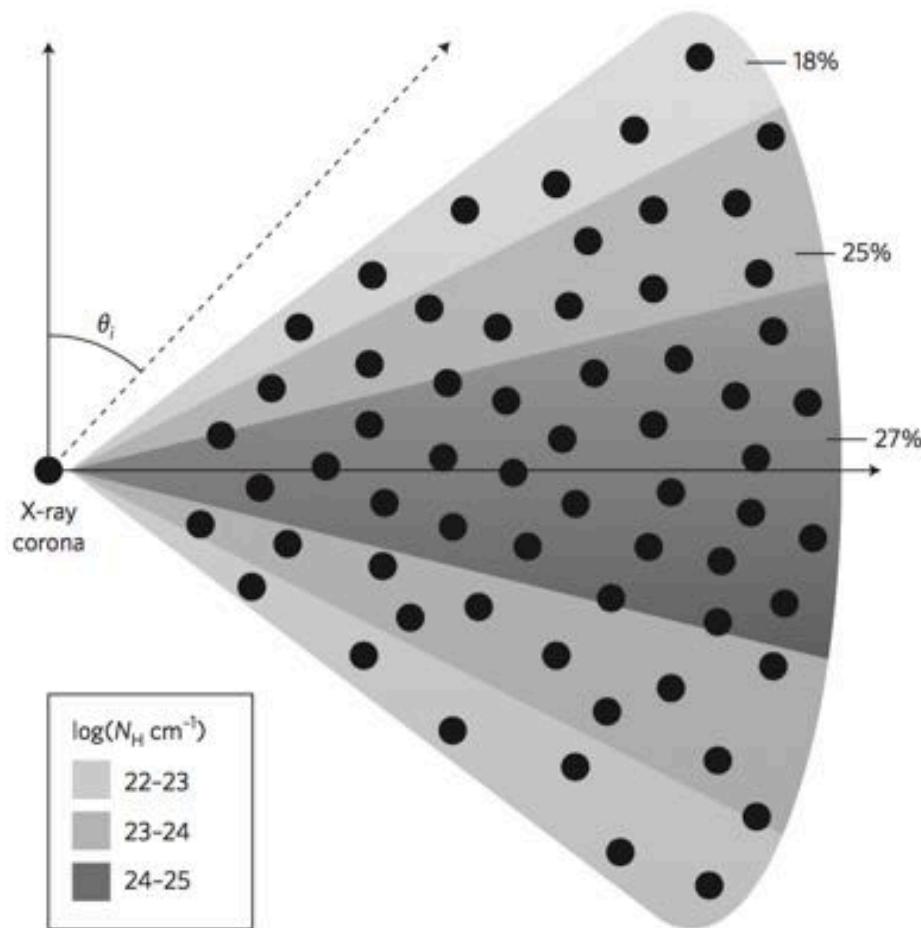
X-ray spectroscopy of BAT AGN



Intrinsic column density distribution



Intrinsic column density distribution

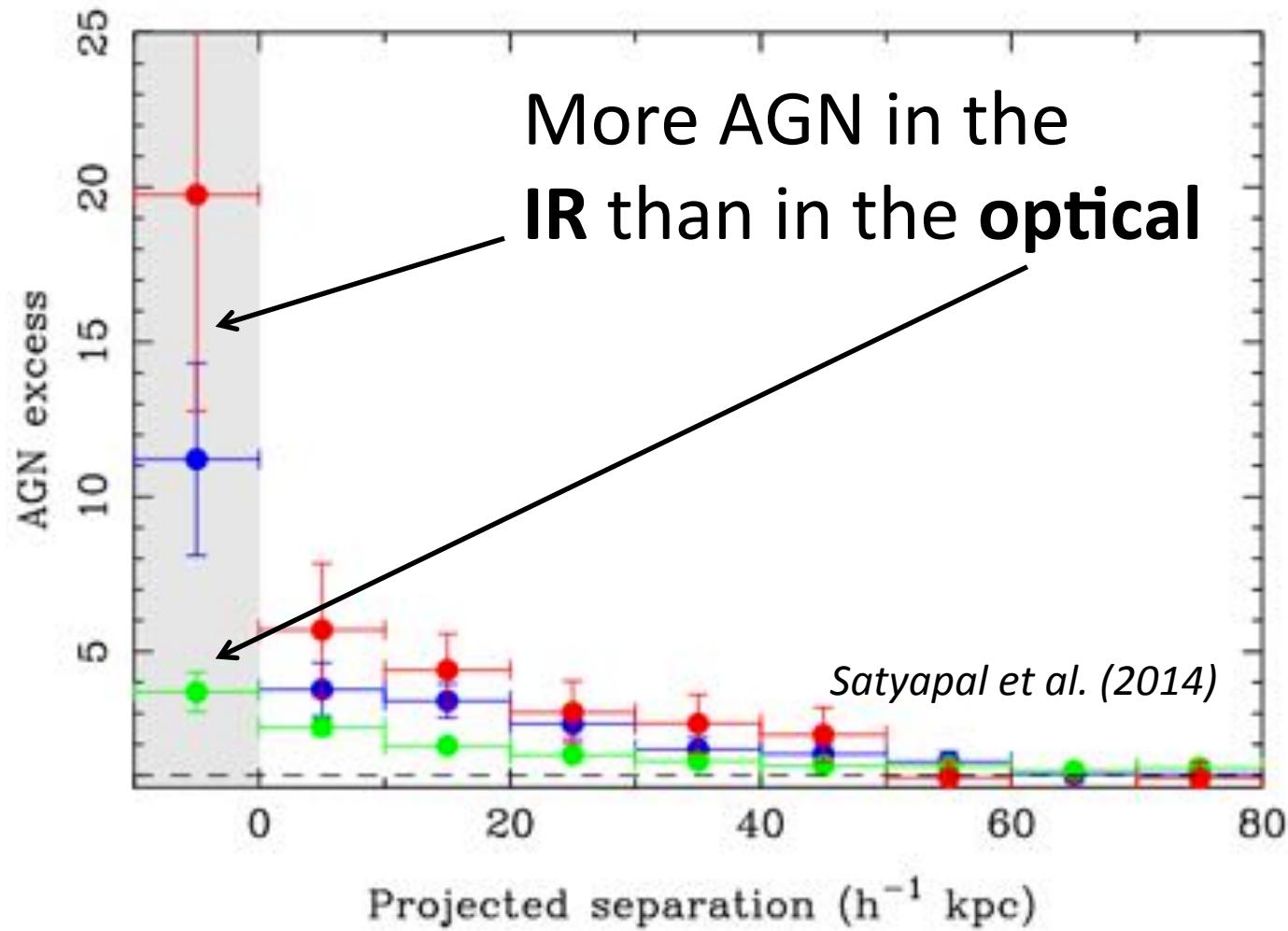


Ramos Almeida & Ricci, Nature Astronomy

Nuclear obscuration in mergers

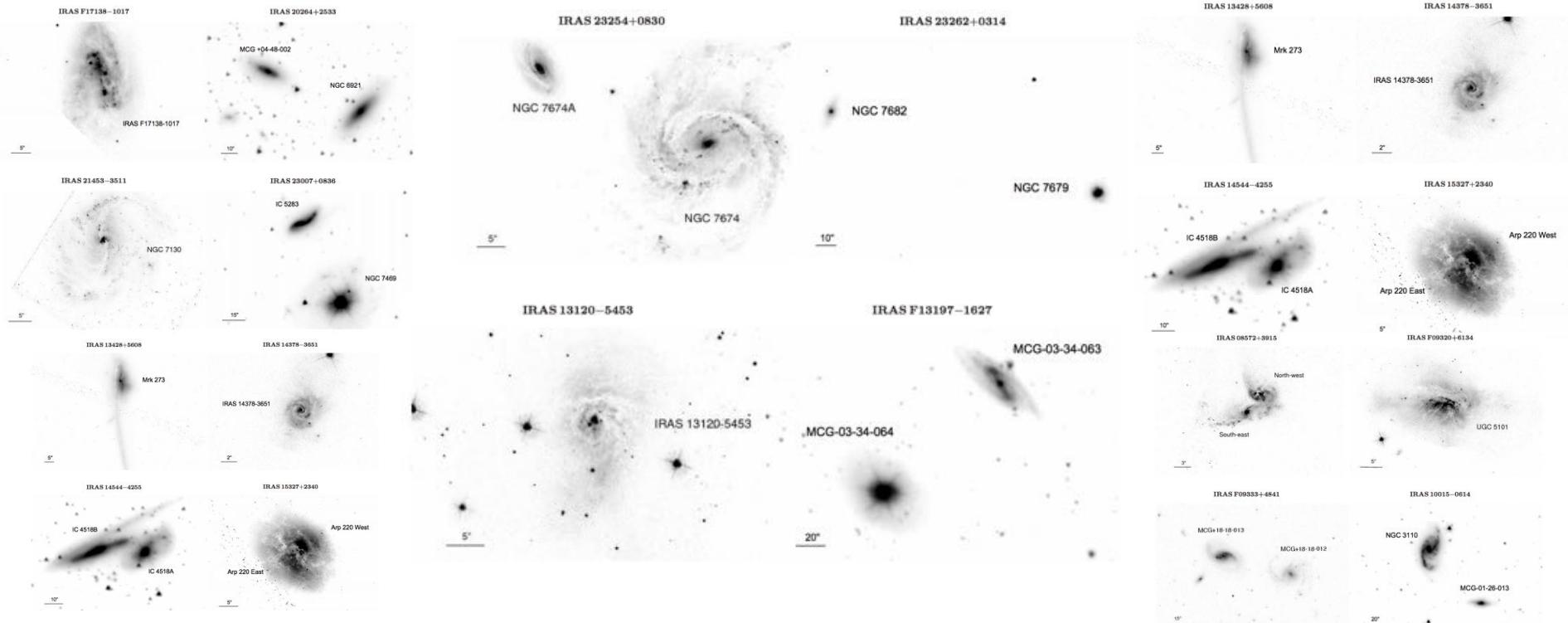


Elusive AGN in mergers



See also Kocevski et al. (2015), Lanzuisi et al. (2015), Koss et al. (2016)

The GOALS sample

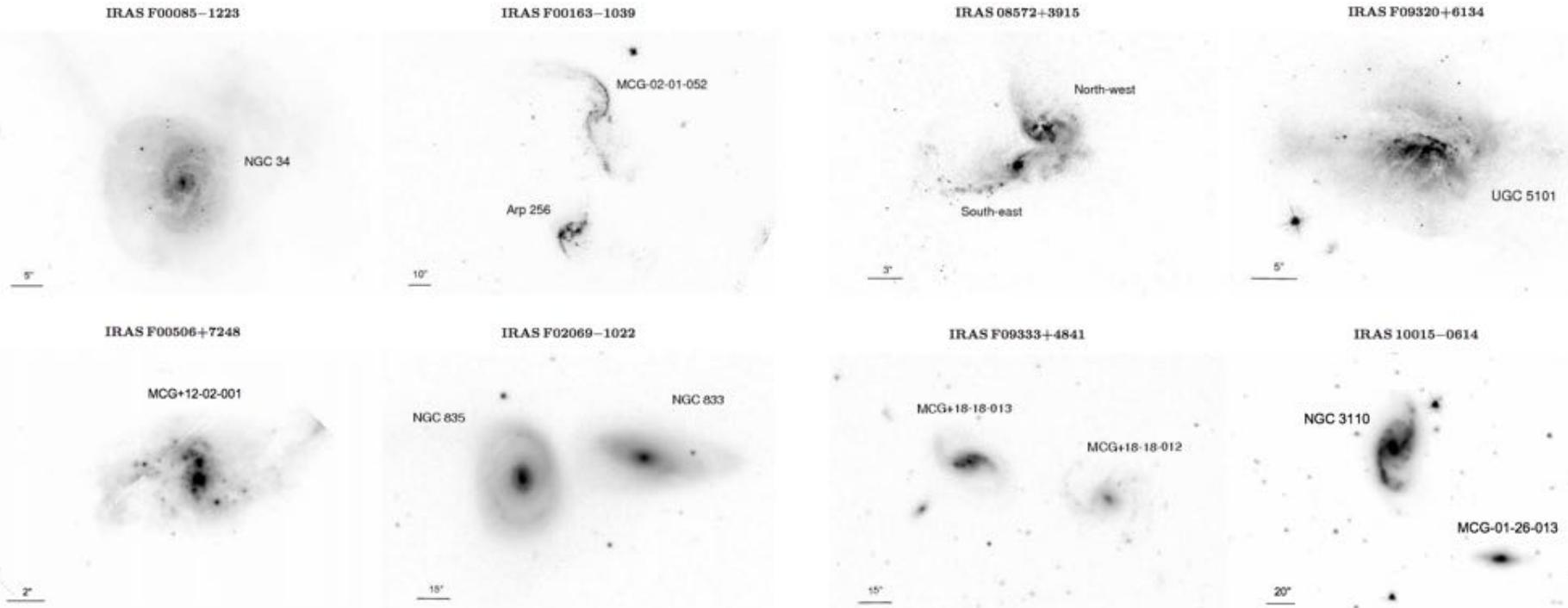


Local IR-selected sample (≤ 200 Mpc): 180 LIRGs, 22 ULIRGs

*Spitzer, Herschel, Hubble Space Telescope, Chandra, XMM-Newton,
Radio observations*

See Armus et al. (2009), Iwasawa et al. (2011) and many more (<http://goals.ipac.caltech.edu/>)

The NuSTAR GOALS sample



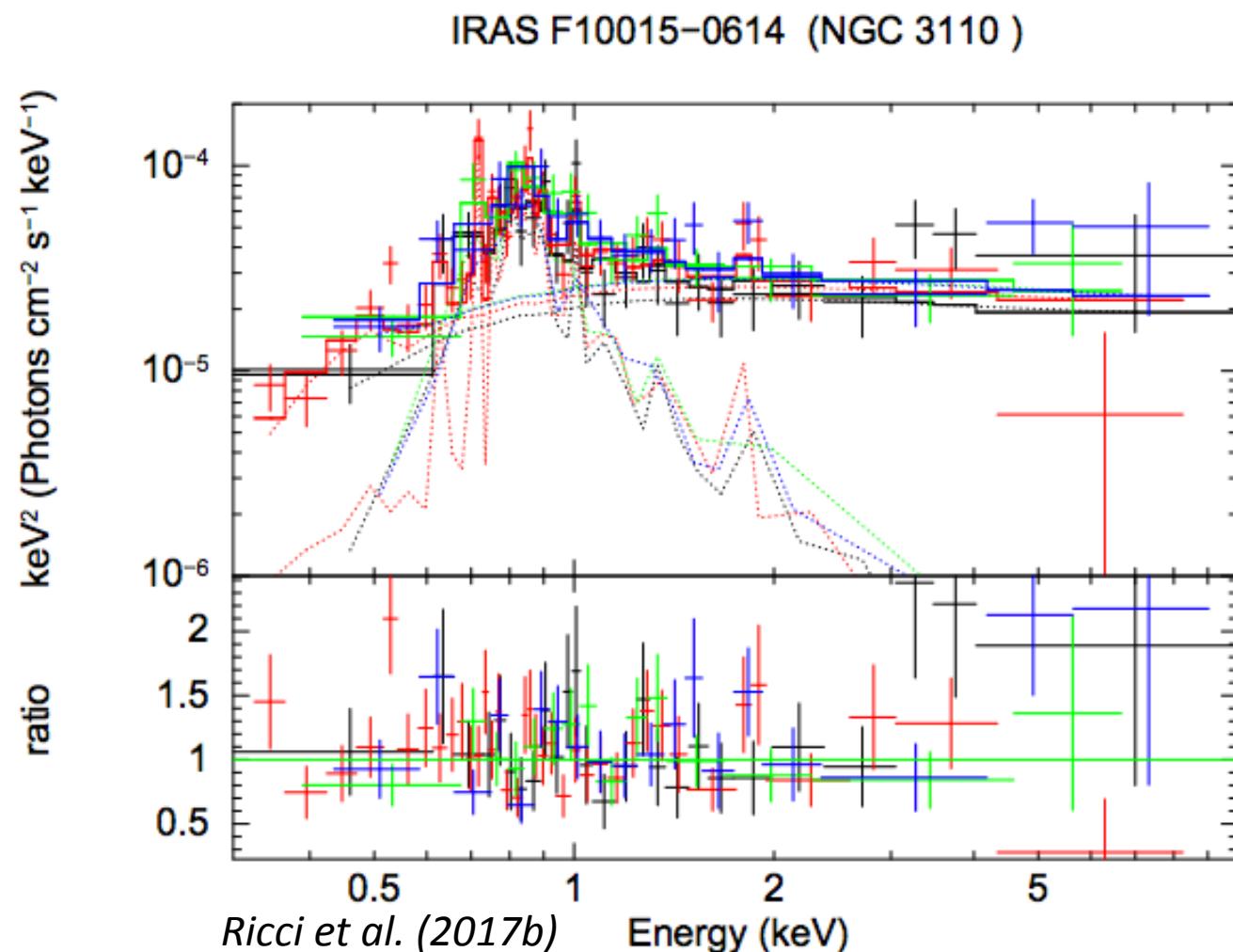
30 systems, 52 individual Galactic nuclei

Combined Spectral analysis in the 0.3- 50 keV band:
NuSTAR + Chandra + XMM-Newton

X-ray spectra of U/LIRGs



Some of the objects show no evidence of AGN activity.....

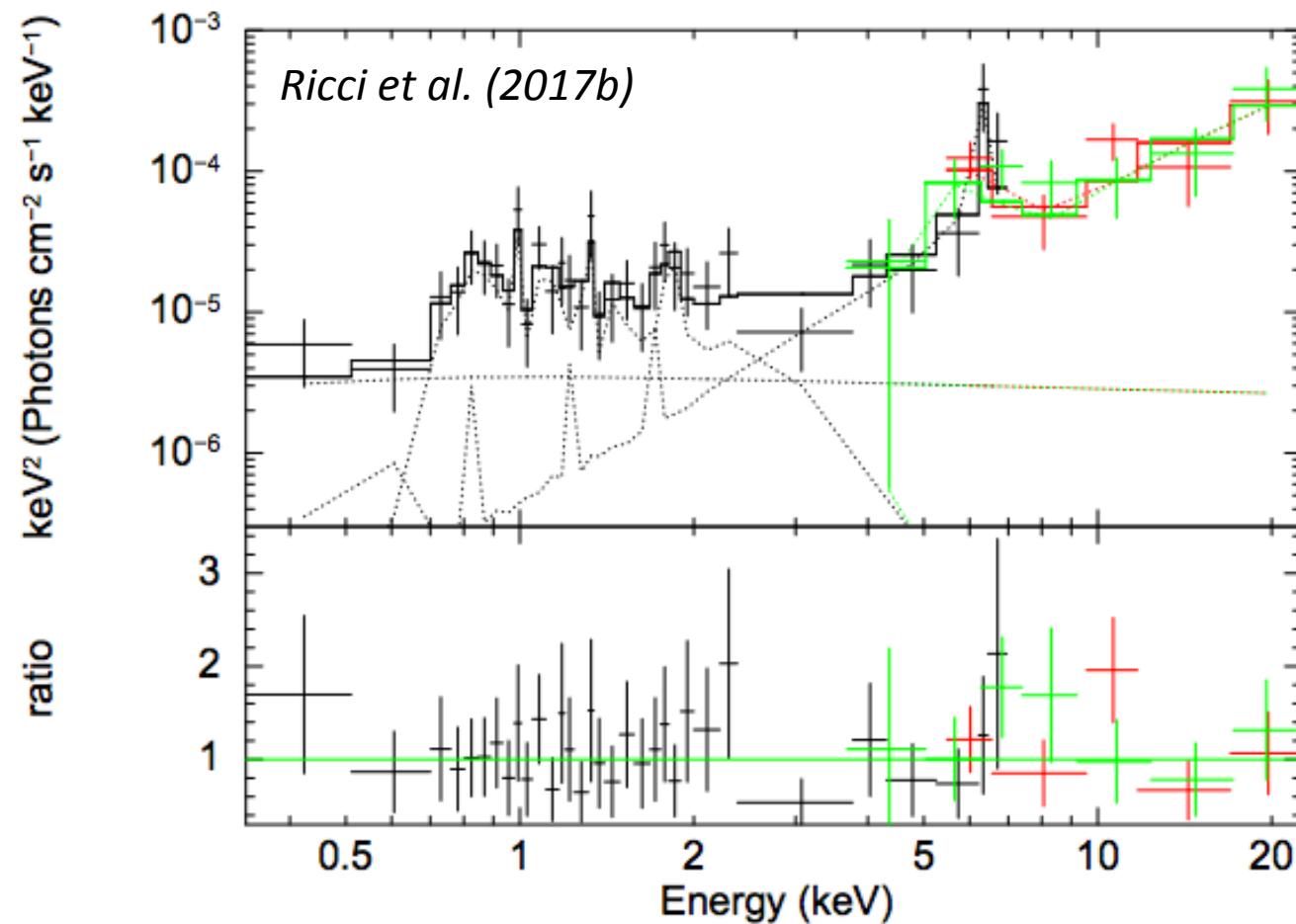


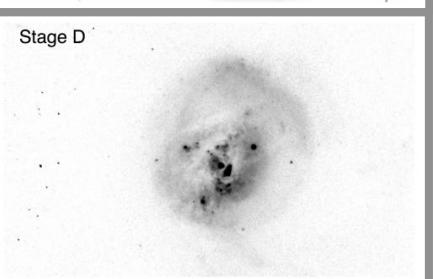
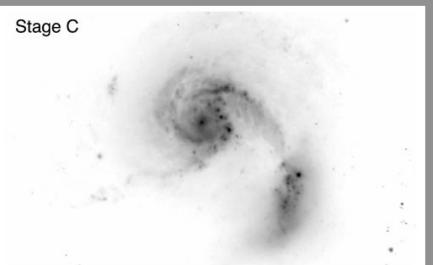
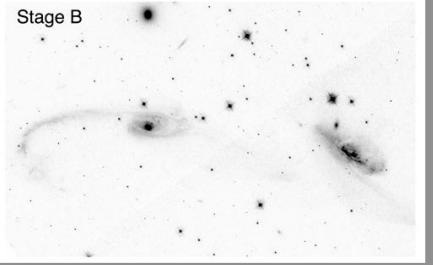
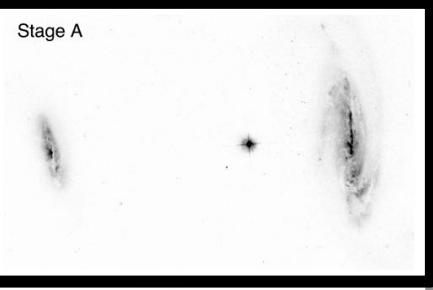
X-ray spectra of U/LIRGs



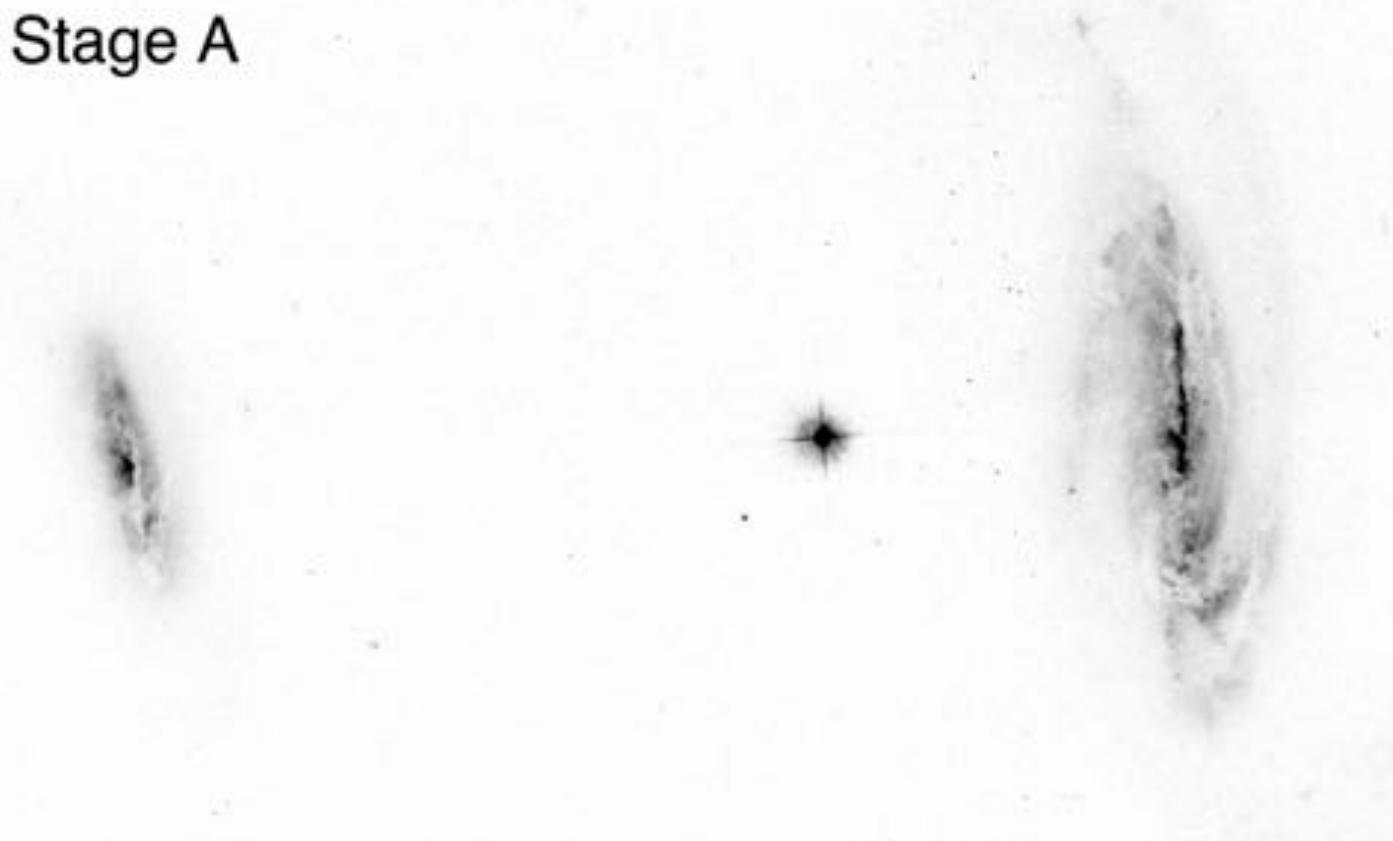
While others are hiding buried AGN!

IRAS F12590+2934 (NGC 4922N)

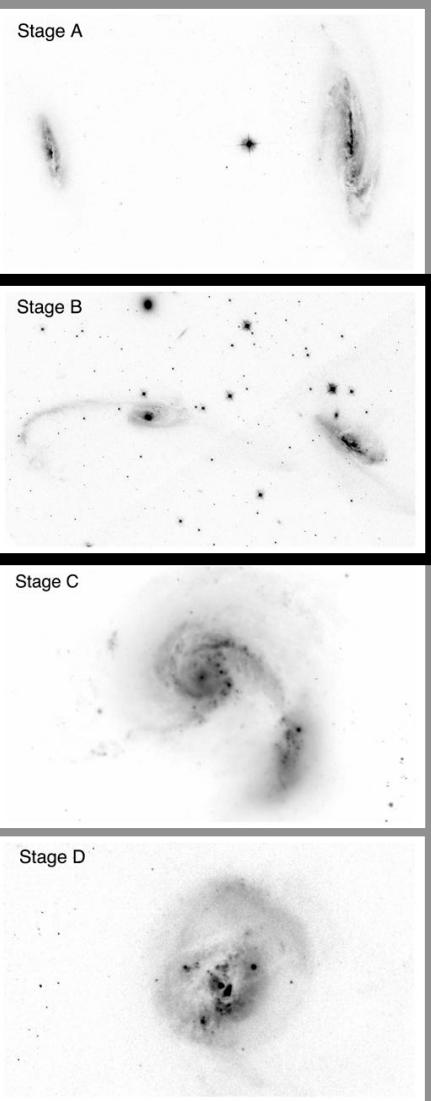




Stage A

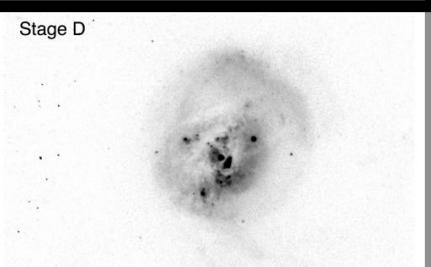
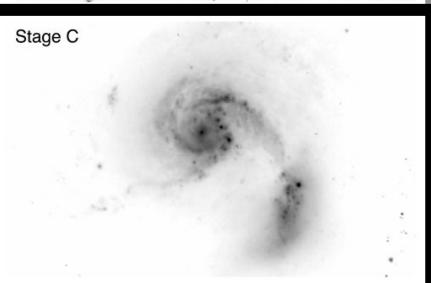
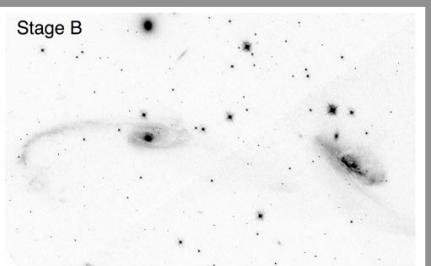
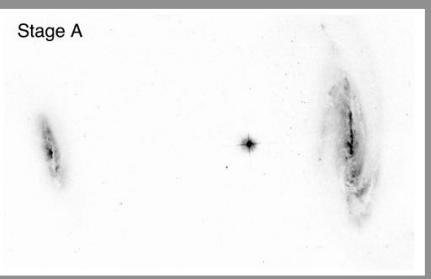


Early stages of mergers

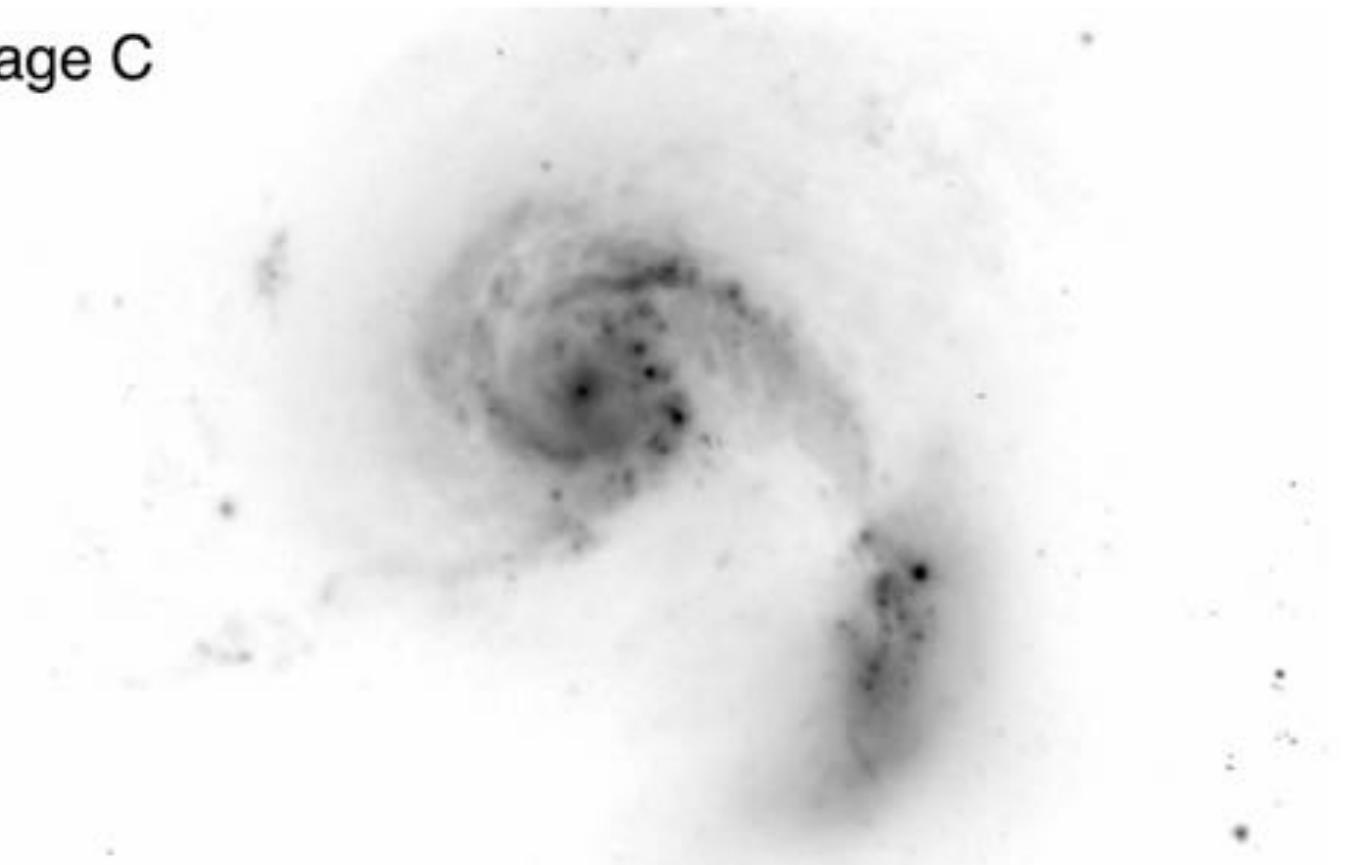


Stage B

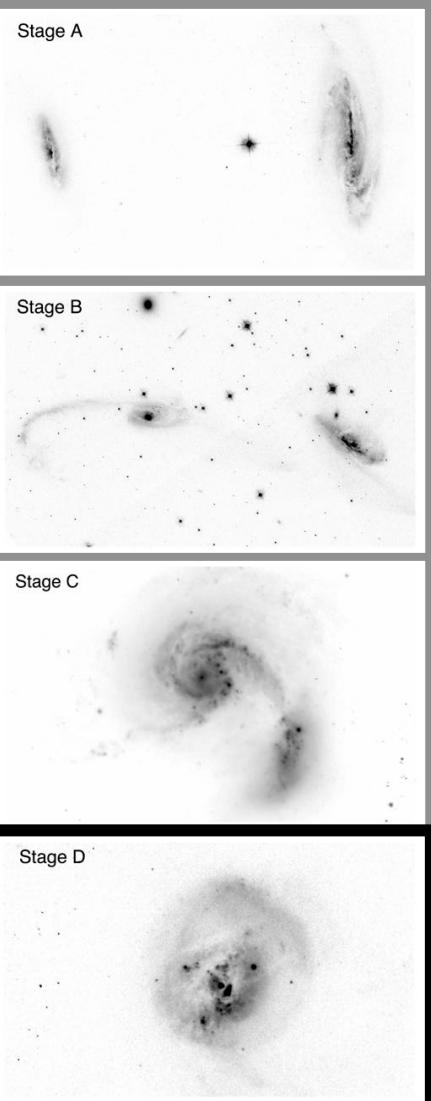
Early stages of mergers



Stage C



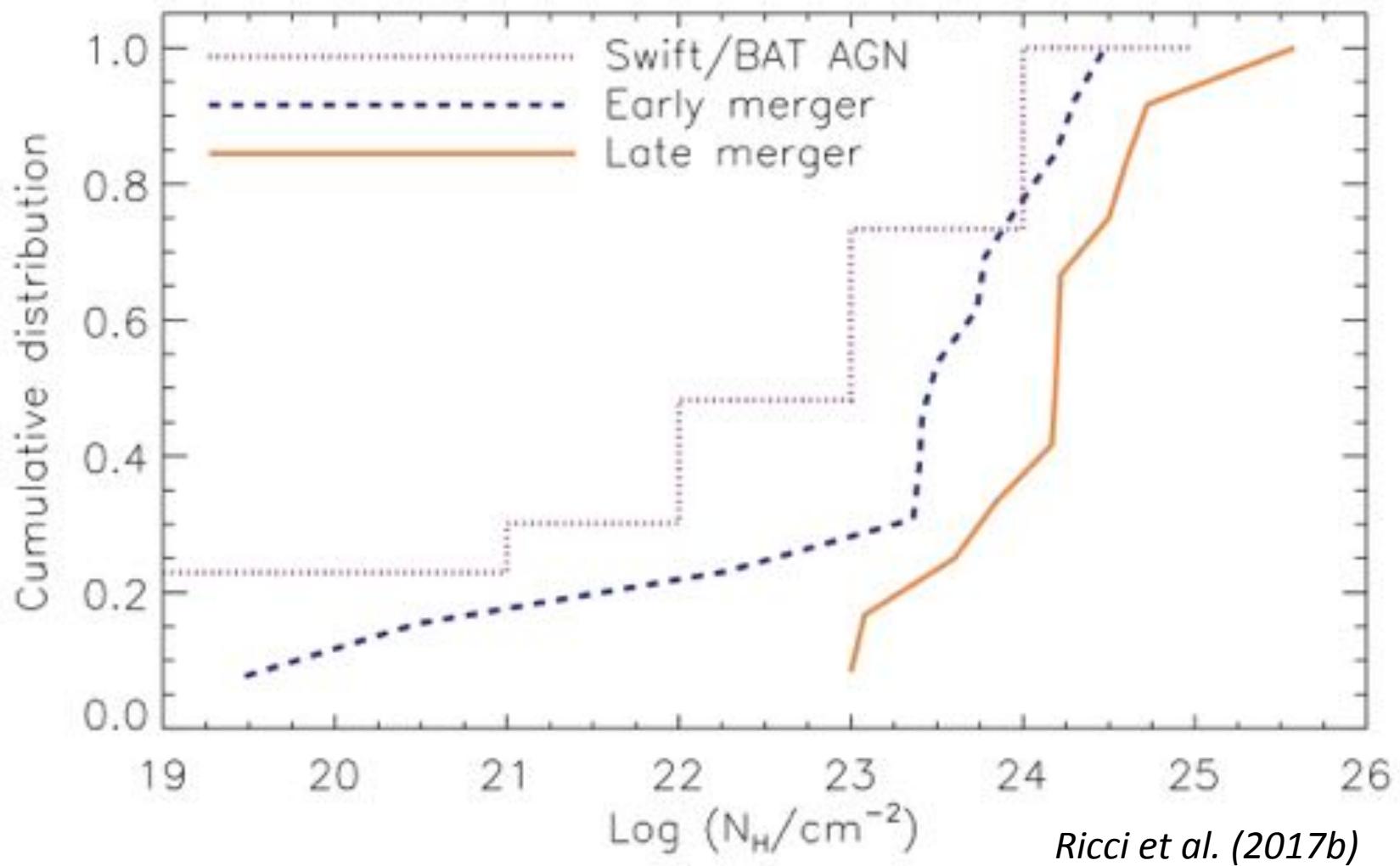
Late stages of mergers



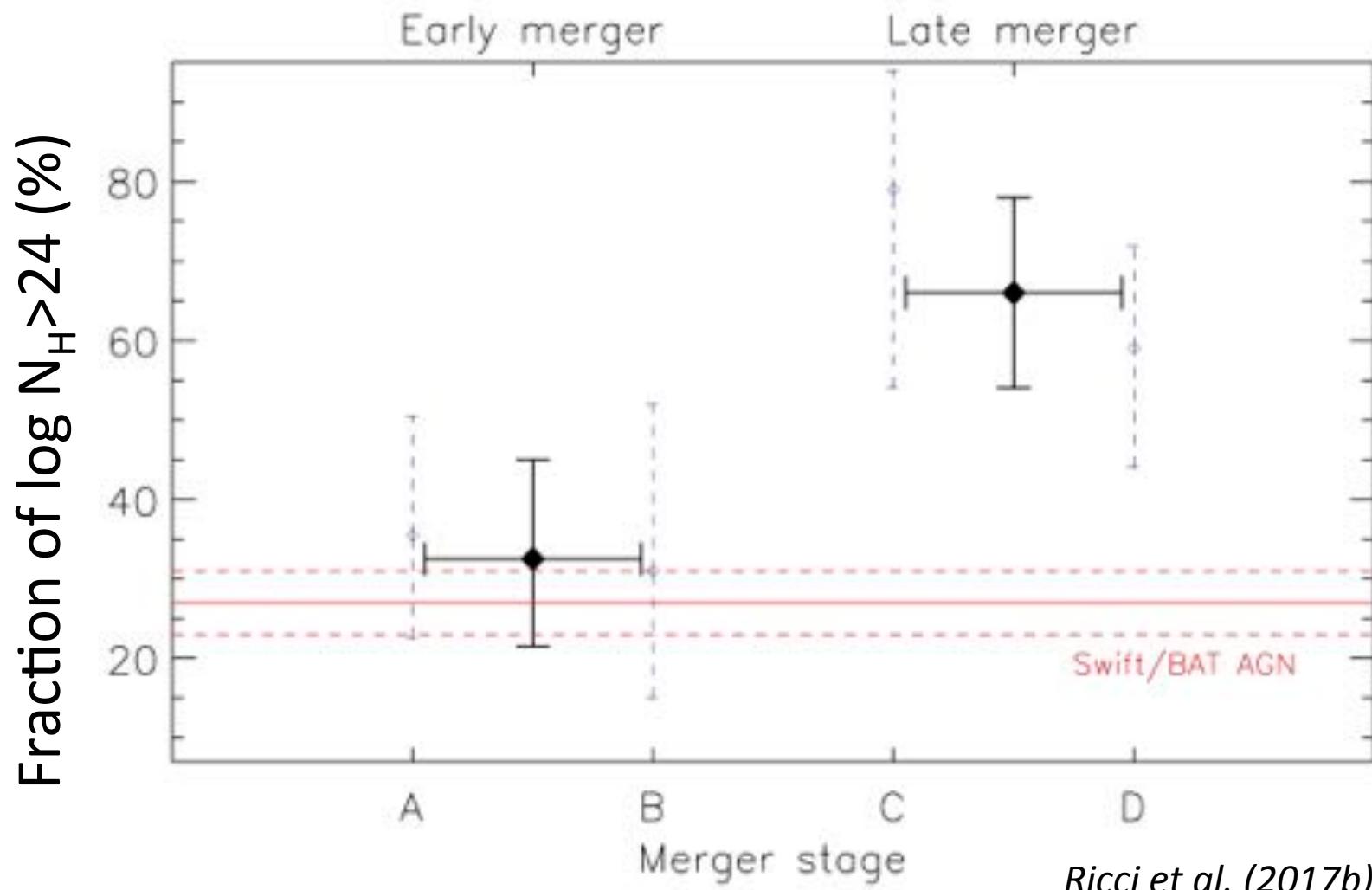
Stage D

Late stages of mergers

Obscuration properties of mergers

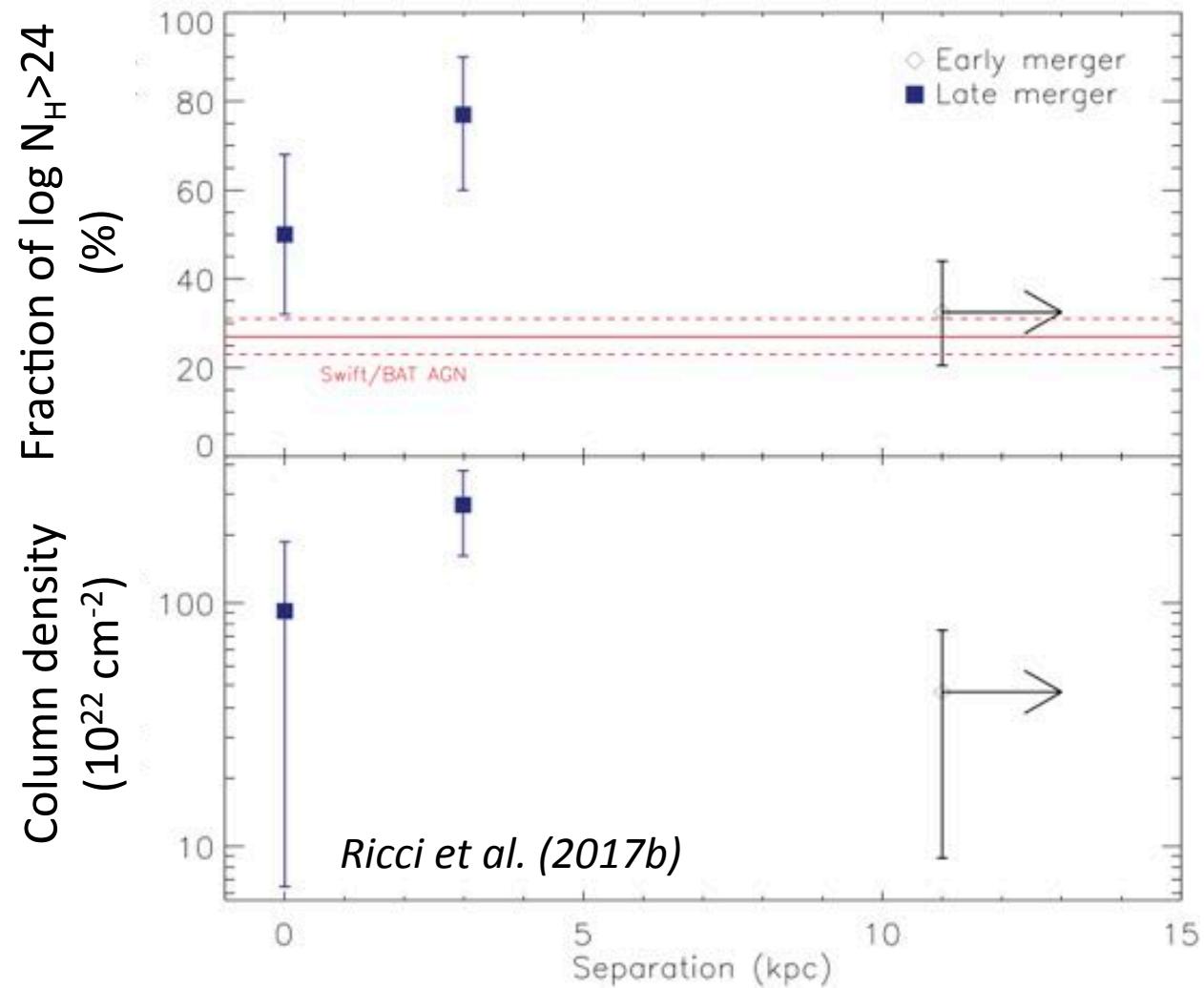


Obscuration properties of mergers



Ricci et al. (2017b)

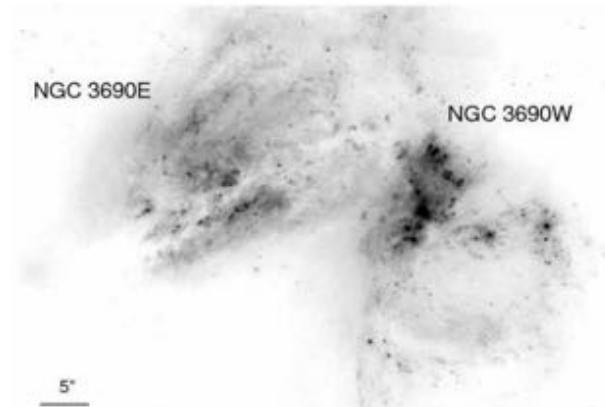
Obscuration properties of mergers



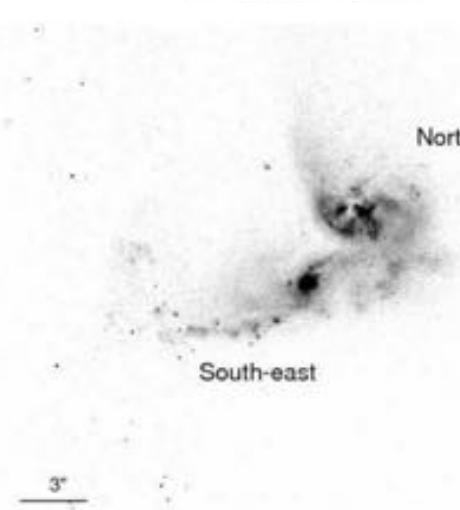
U/LIRGs seen by *NuSTAR*



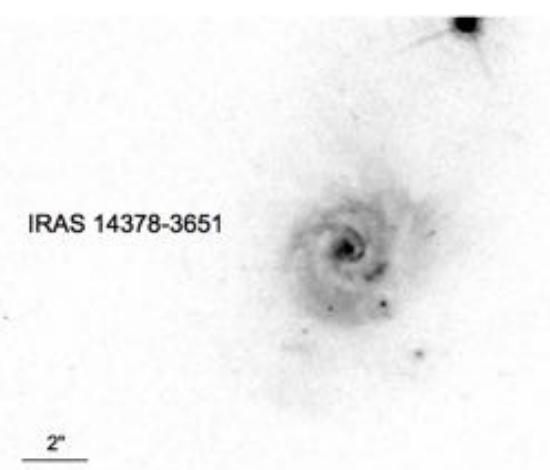
IRAS 11257+5850



IRAS 08572+3915



IRAS 14378-3651



AGN activity from MW proxies,
no detection with NuSTAR

Isolated galaxies

$\text{Log } N_{\text{H}} > 23$ $52 \pm 4\%$

$\text{Log } N_{\text{H}} > 24$ $27 \pm 4\%$

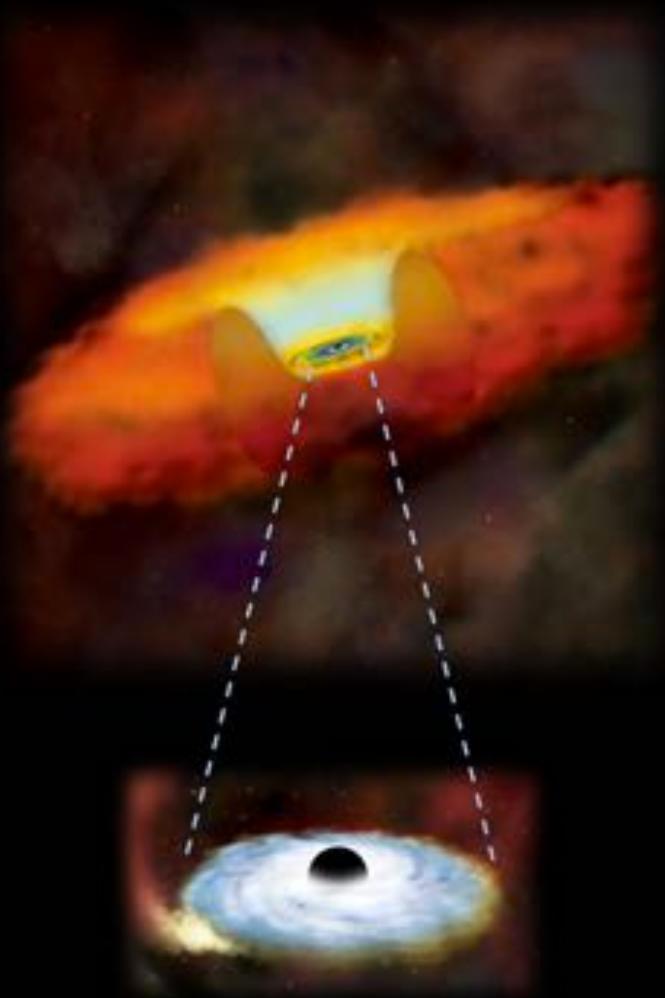
Late stages of merger

Isolated galaxies

Late stages of merger

$\text{Log } N_{\text{H}} > 23$ $52 \pm 4\%$

$\text{Log } N_{\text{H}} > 24$ $27 \pm 4\%$



Credits: NAOJ/NASA/CXC/M. Weiss

Isolated galaxies

$\text{Log } N_{\text{H}} > 23$

$52 \pm 4\%$

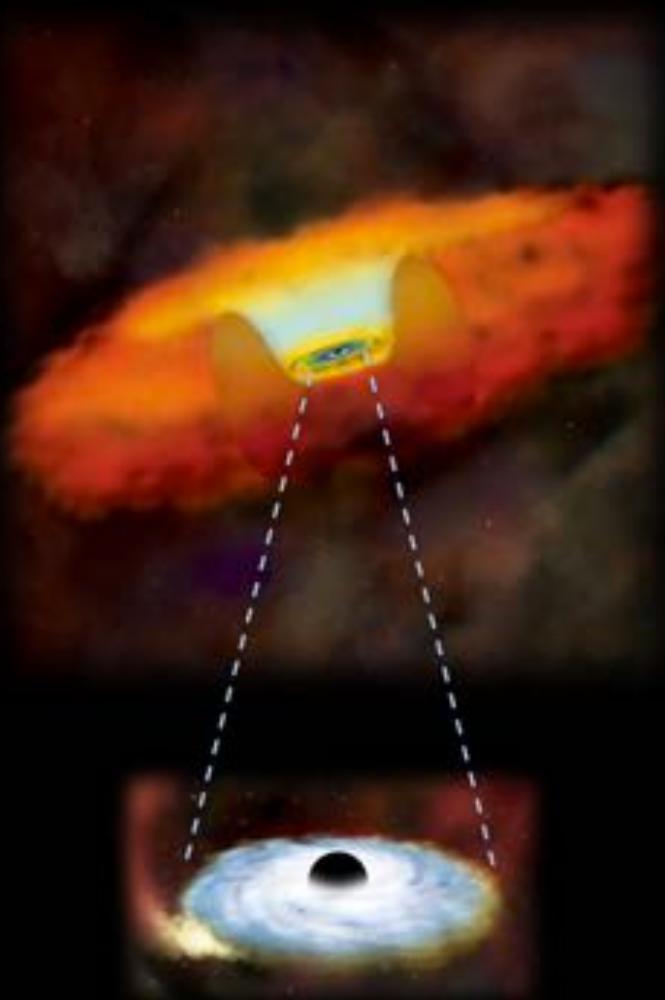
$\text{Log } N_{\text{H}} > 24$

$27 \pm 4\%$

Late stages of merger

$95 \pm 5\%$

$65 \pm 12\%$



Credits: NAOJ/NASA/CXC/M. Weiss

Isolated galaxies

$\text{Log } N_{\text{H}} > 23$

$52 \pm 4\%$

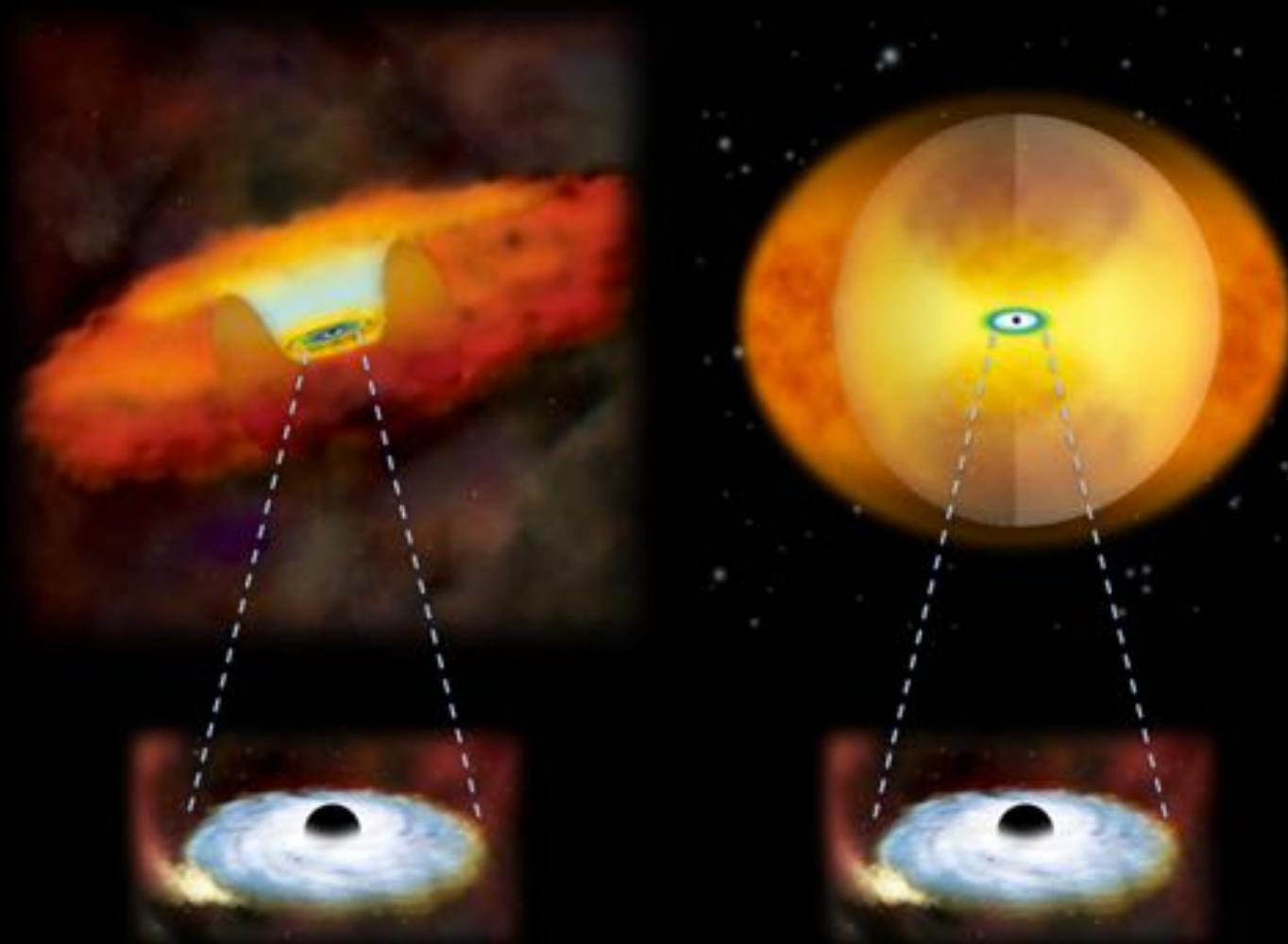
$\text{Log } N_{\text{H}} > 24$

$27 \pm 4\%$

Late stages of merger

$95 \pm 5\%$

$65 \pm 12\%$



Credits: NAOJ/NASA/CXC/M. Weiss



Summary

- Obscuration properties of AGN allow to probe the close environment of accreting SMBHs
- About 70% of the AGN in the local Universe are obscured, ~1/3 of them are Compton-thick
- AGN in U/LIRGs in advanced mergers are heavily obscured: ~100% are obscured, ~2/3 are Compton-thick