

Galaxy mergers and obscured black hole growth, an hard X-ray view

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Galaxy mergers and obscuration



T = 0 Myr

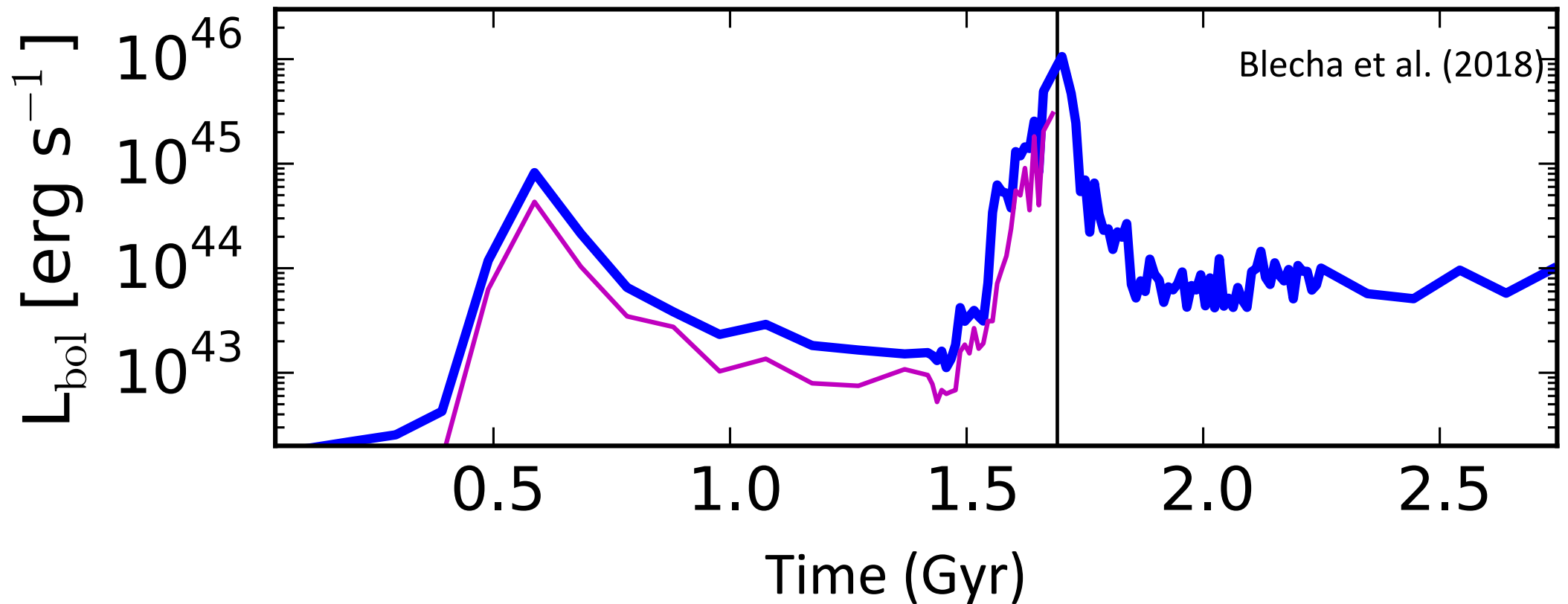
Gas



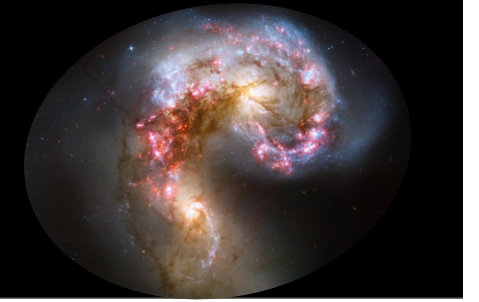
The strongest accretion events are powered by galaxy mergers?



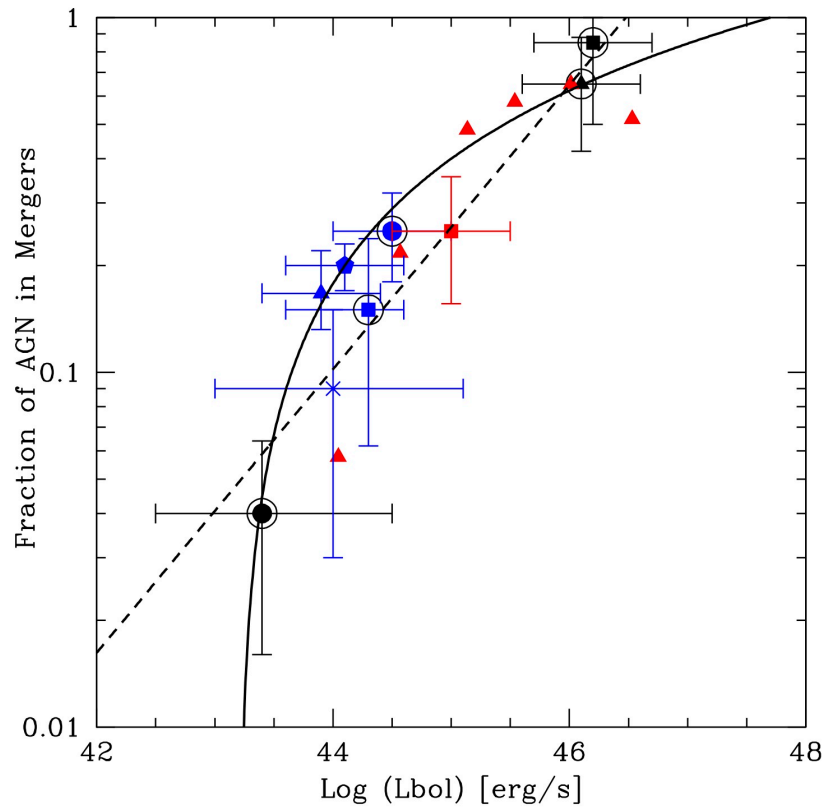
Increase of AGN activity



The strongest accretion events are powered by galaxy mergers?

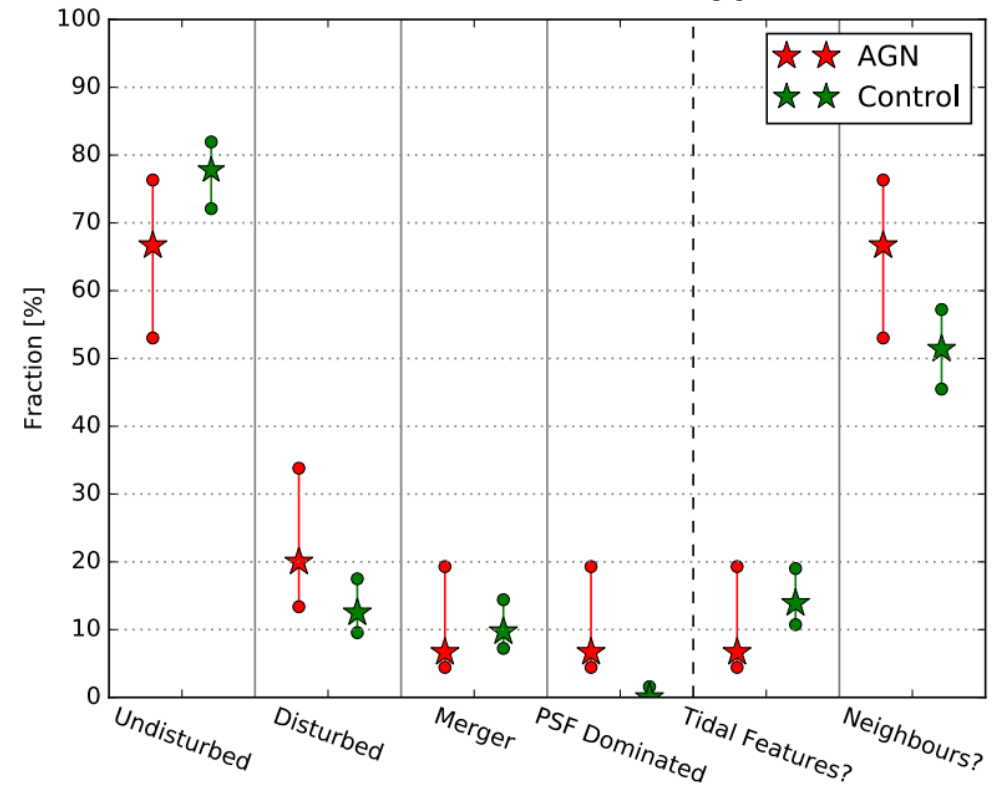


Various selection methods



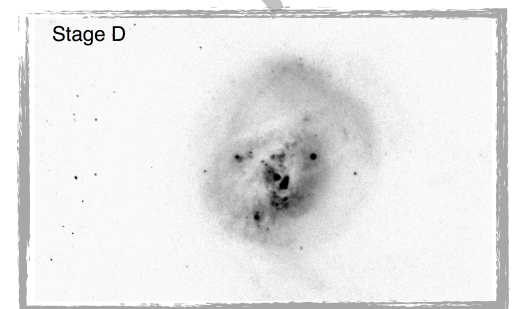
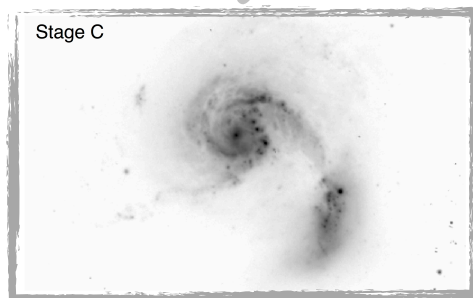
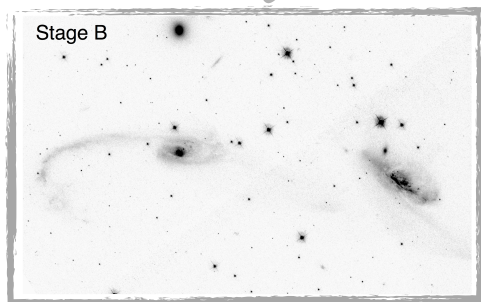
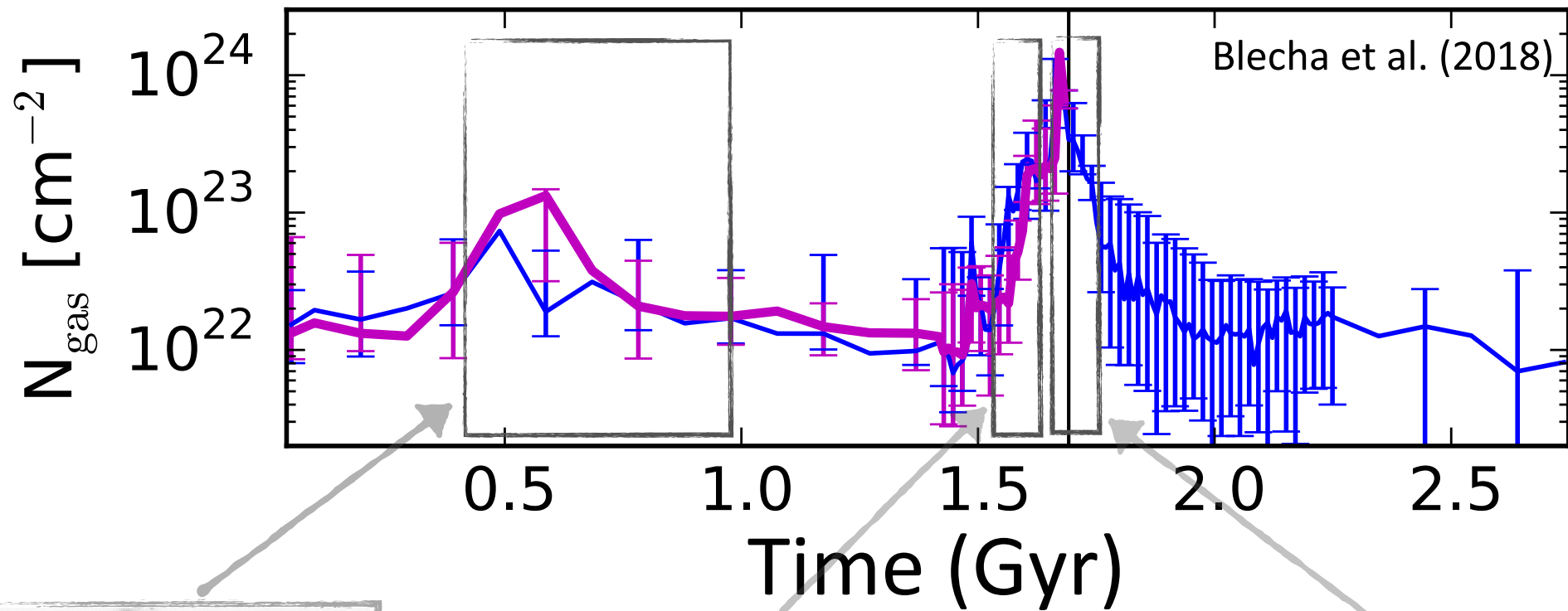
Treister et al. (2012)

ROSAT-selected or type 1s

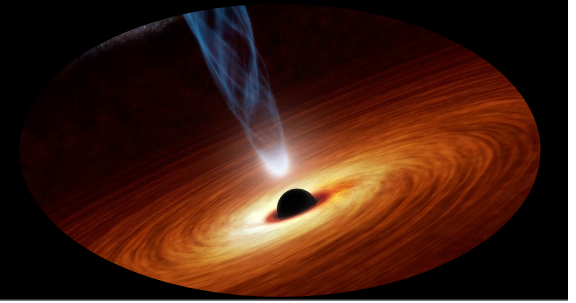


Villforth et al. (2017), Marian et al. 2019

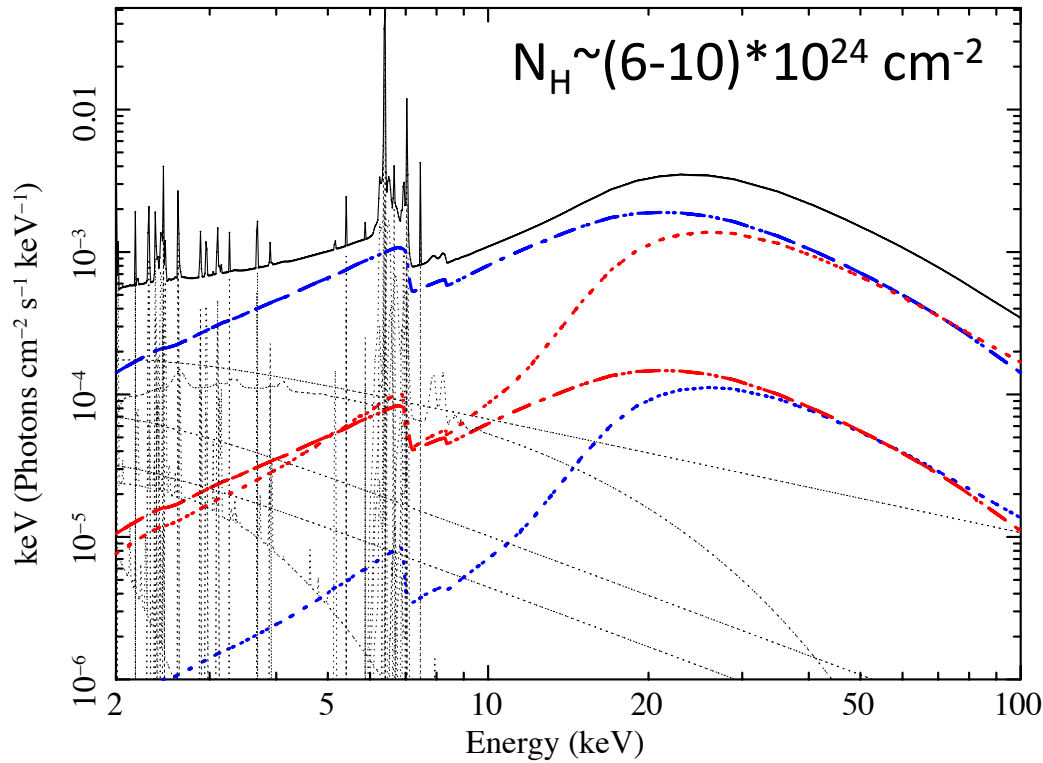
Galaxy mergers and obscuration



Obscured AGN in the hard X-ray band

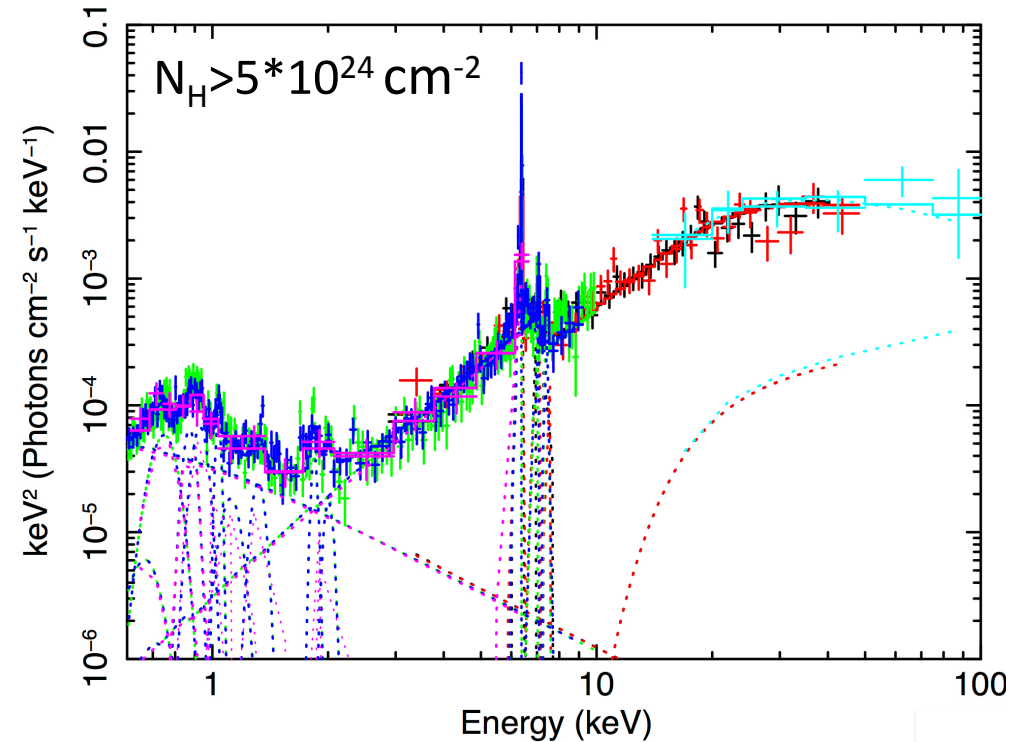


Circinus Galaxy



Arevalo et al. (2014)

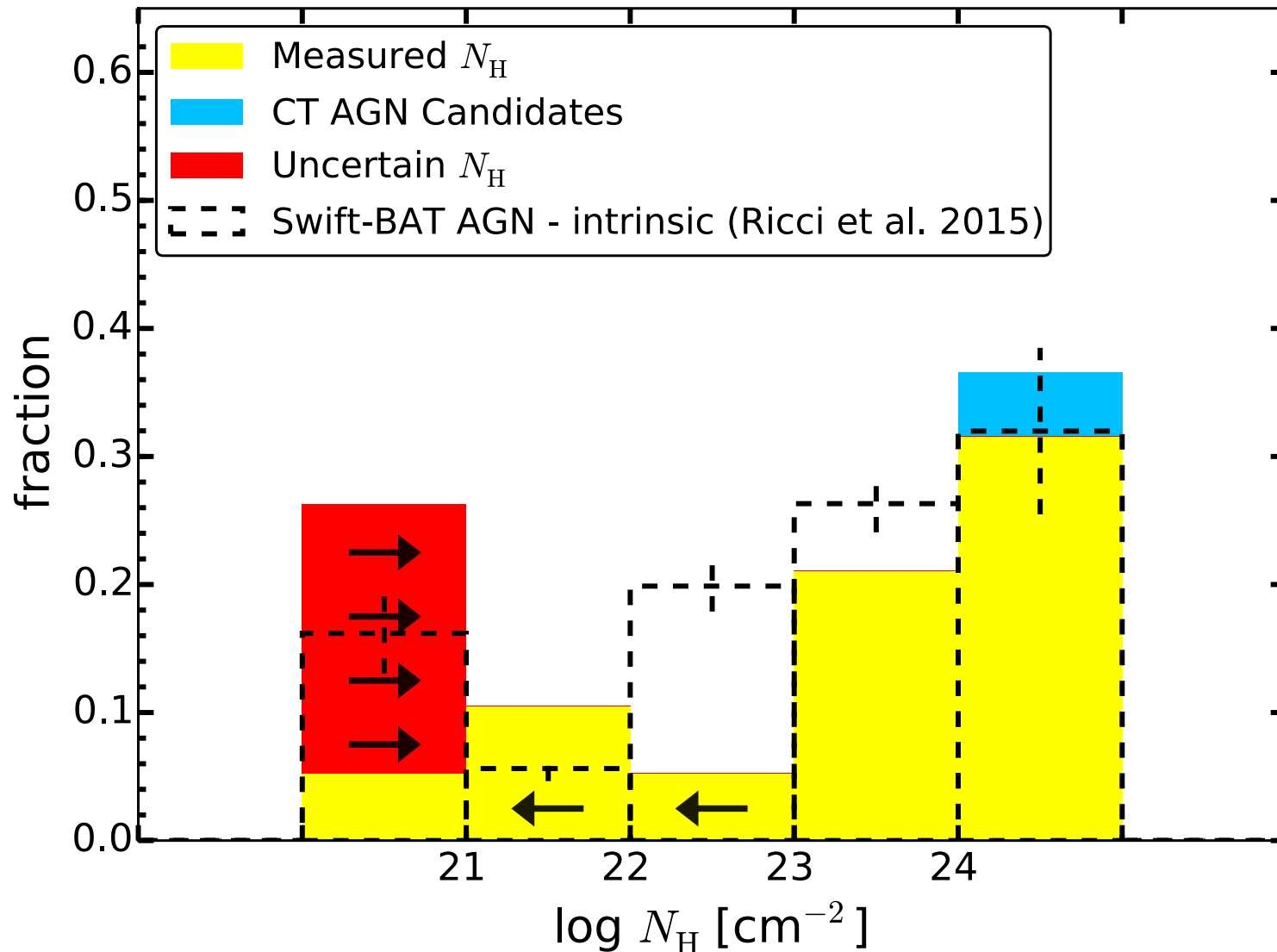
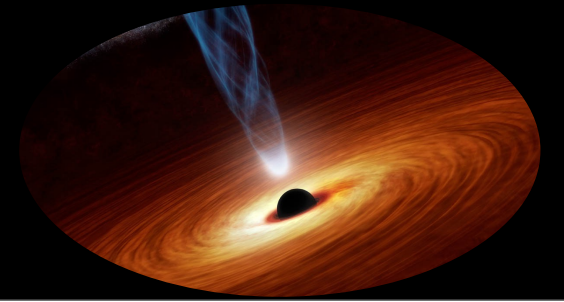
NGC 5643



Annuar et al. (2015)

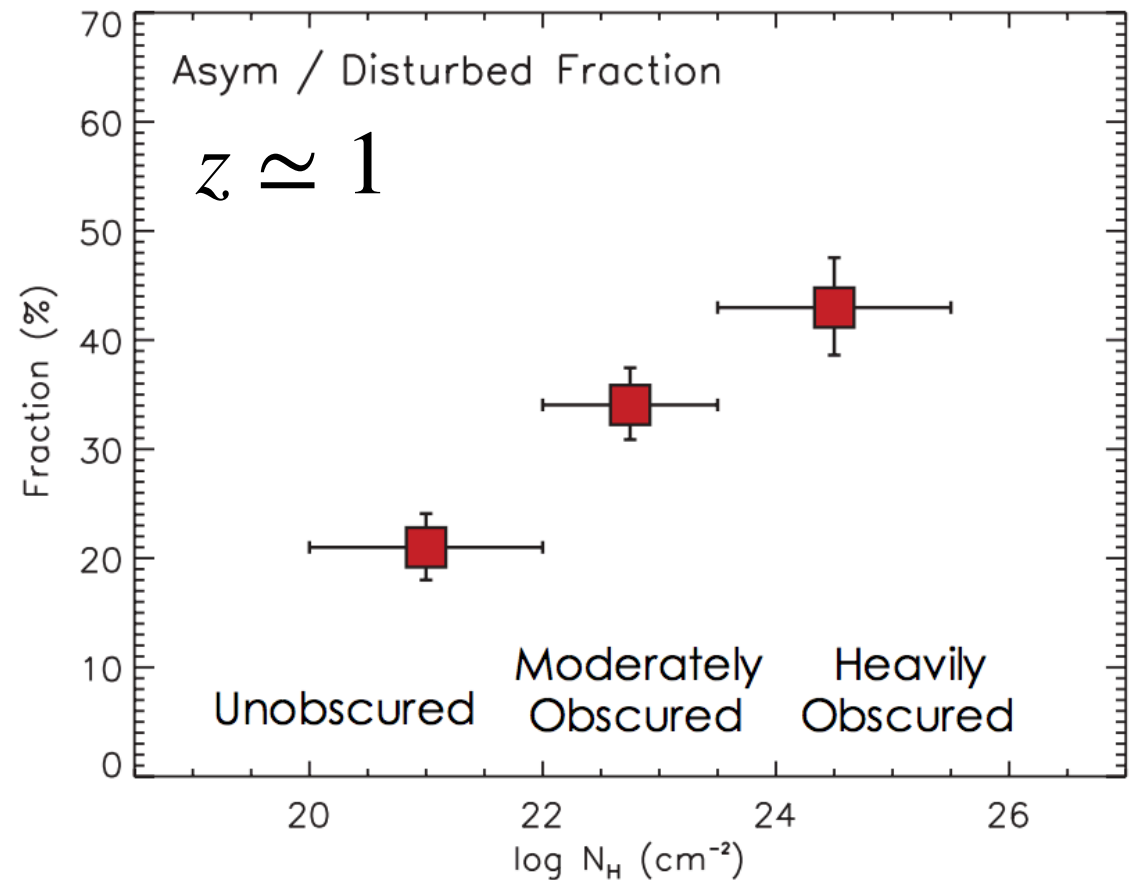
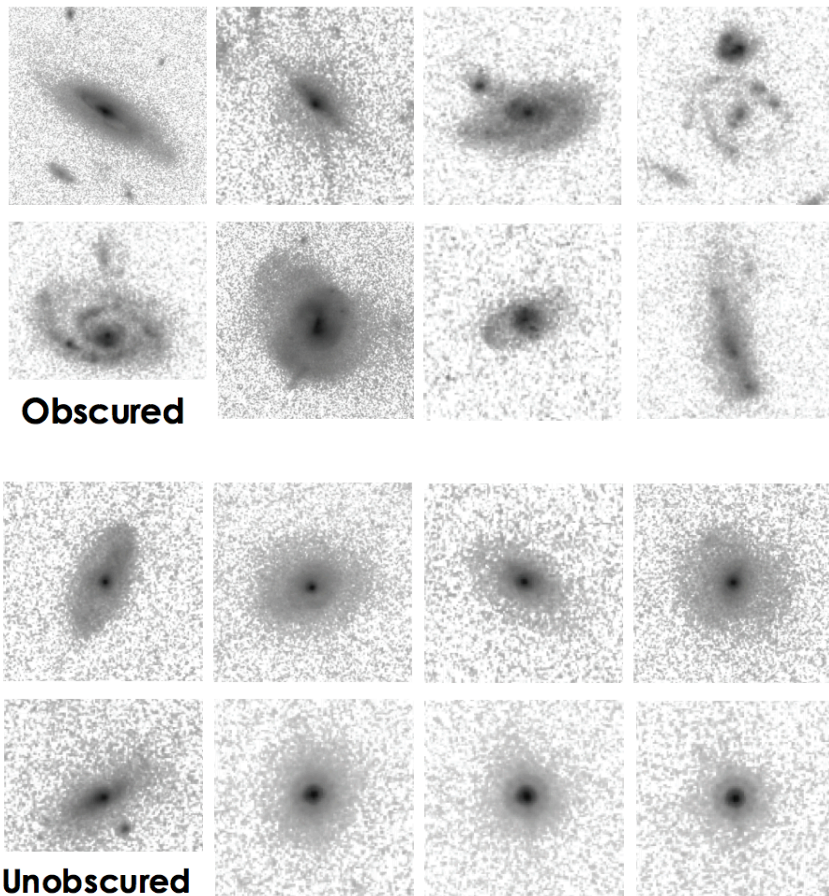
No prominent transmitted component

Obscured AGN in the hard X-ray band



Annuar et al. (in prep.; see talk by D. Alexander),
see also Ricci et al. (2015), Burlon et al. (2011), Akylas et al. (2016), Marchesi et al. (2018)

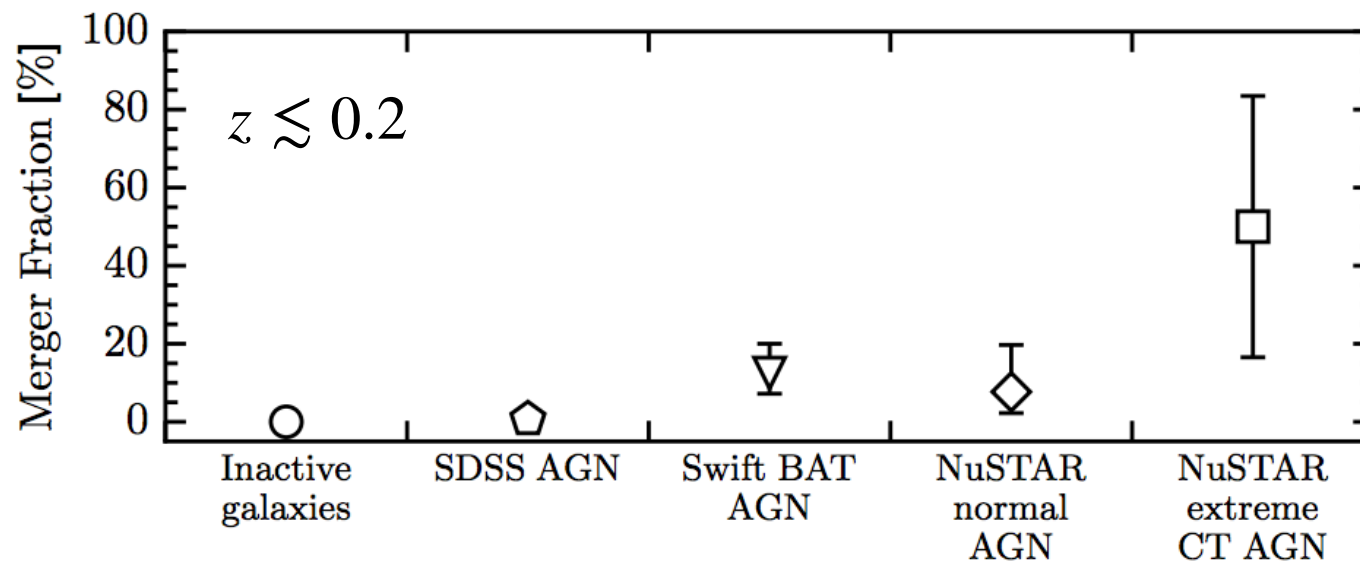
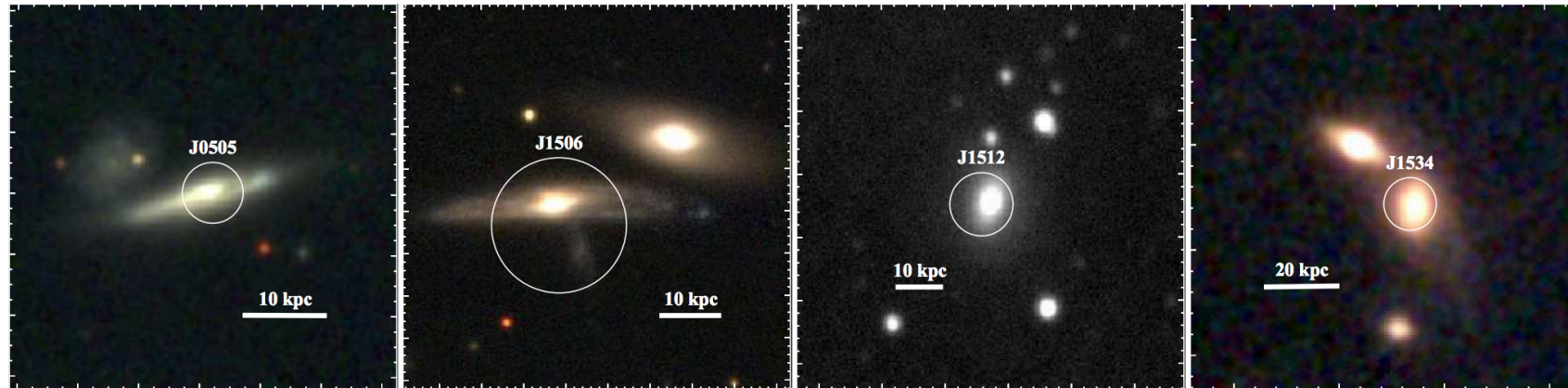
Galaxy mergers and obscuration



Kocevski et al. (2015)

See also Lanzuisi et al. (2015), Lansbury et al. (2017b), Del Moro et al. (2016), Koss et al. (2016), DeRosa et al. (2018), Koss et al. (2019), Pfeifle et al. (2019), Yamada et al. (2019)

Galaxy mergers and obscuration



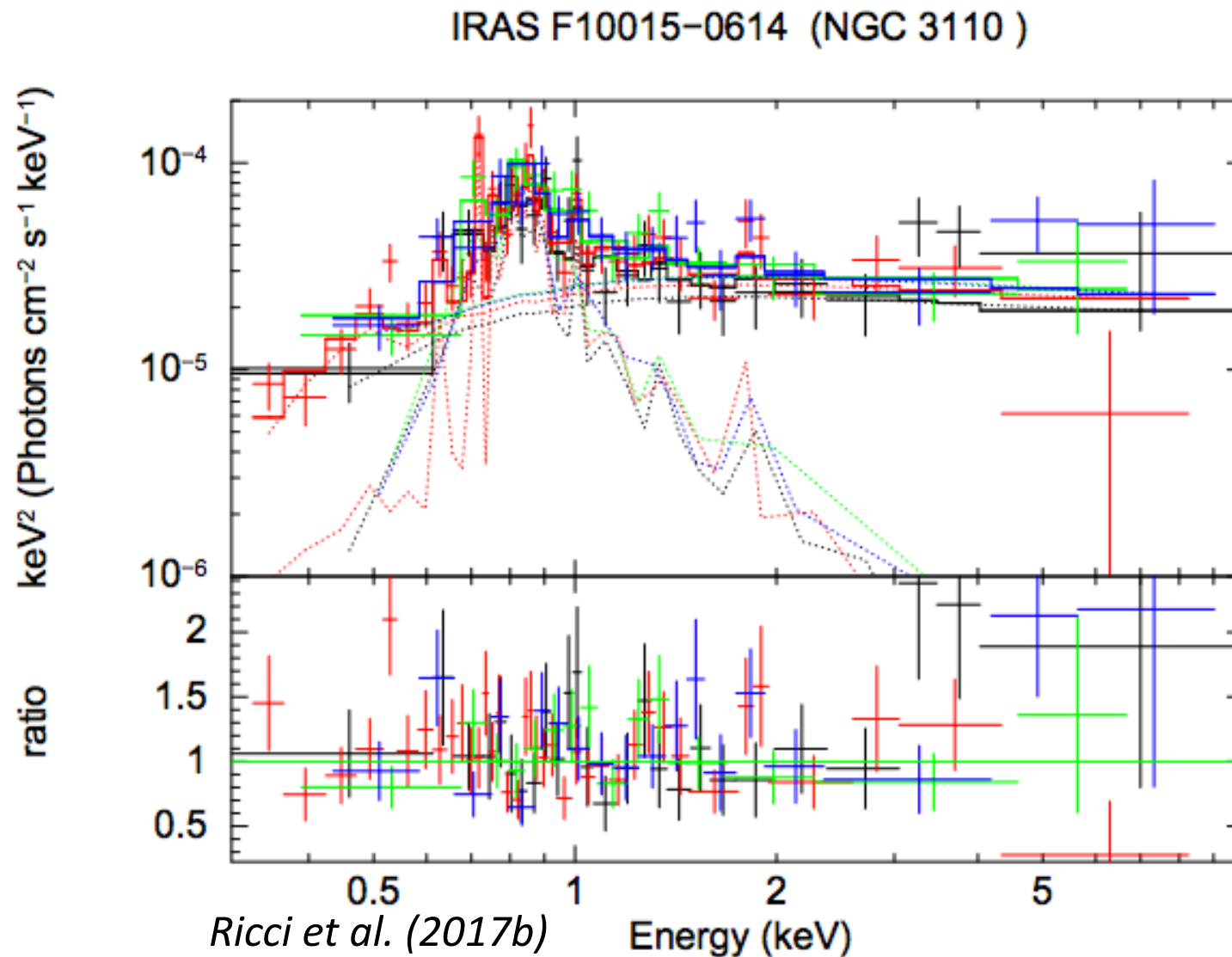
Lansbury et al. (2017)

See also Kocevski et al. (2015), Lanzuisi et al. (2015), Del Moro et al. (2016), Koss et al. (2016), De Rosa et al. (2018), Koss et al. (2019), Pfeifle et al. (2019), See G. Lanzuisi and R. Pfeifle's talk

X-ray spectra of U/LIRGs



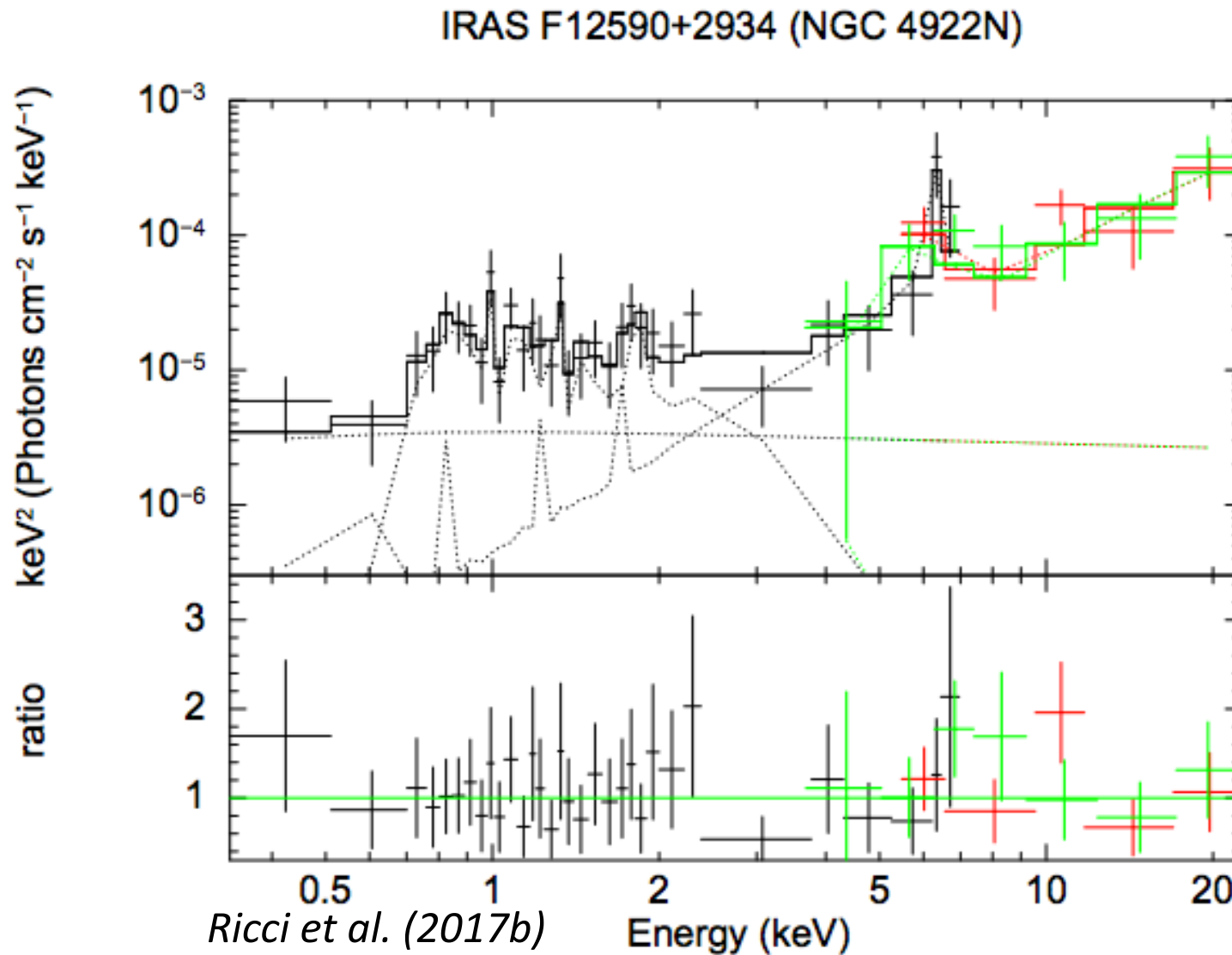
Some of the objects show no evidence of AGN activity.....

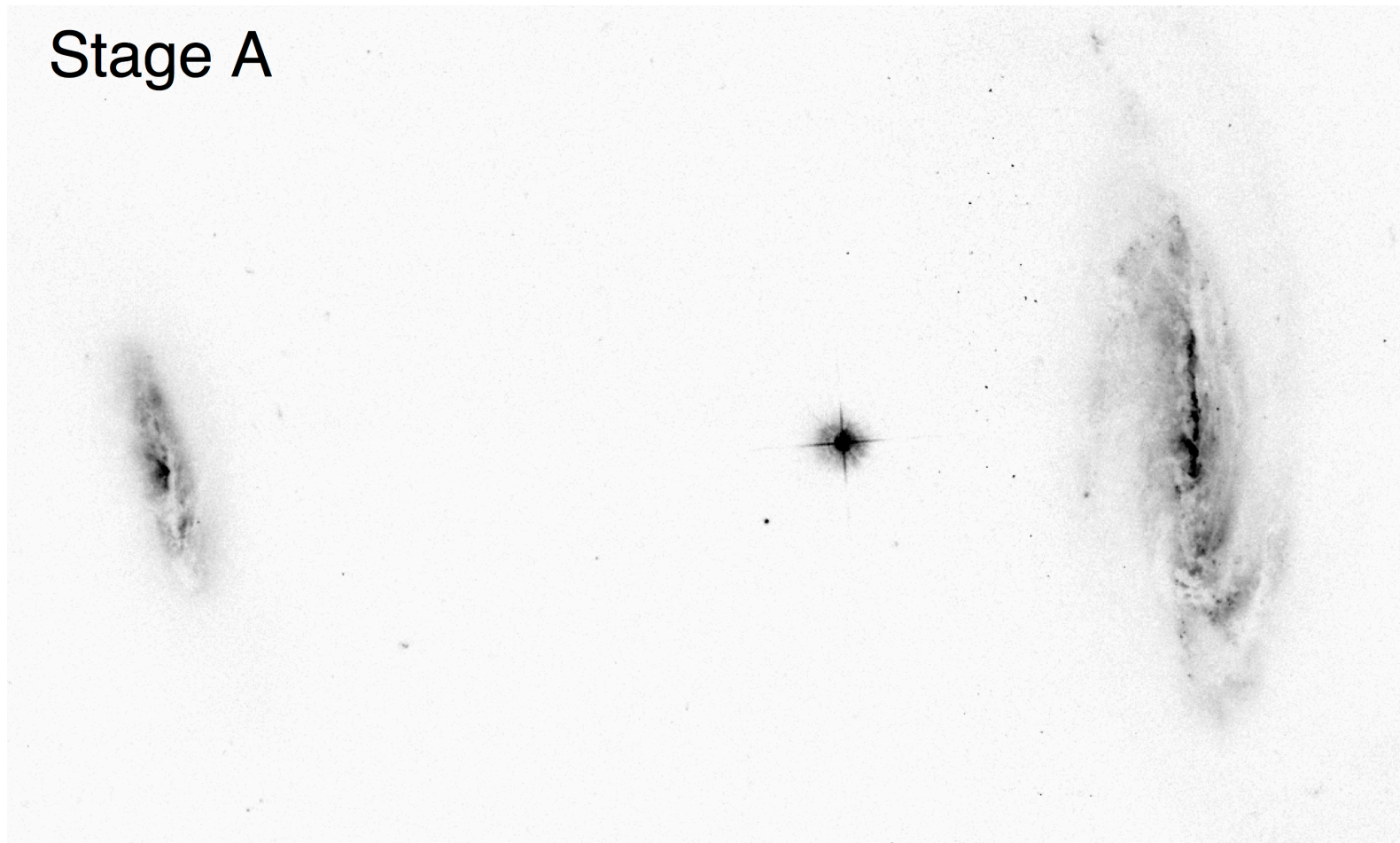
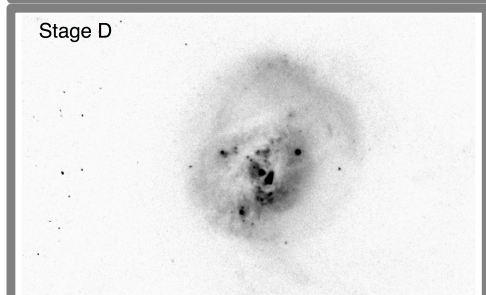
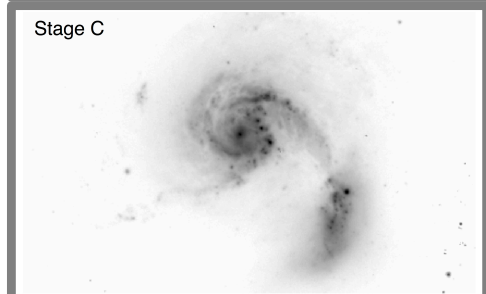
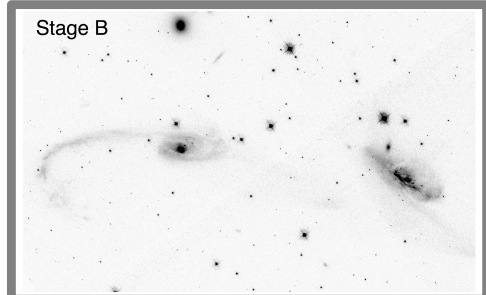
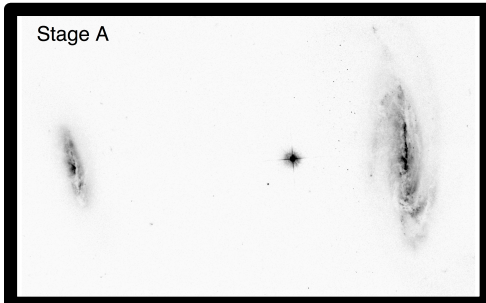


X-ray spectra of U/LIRGs



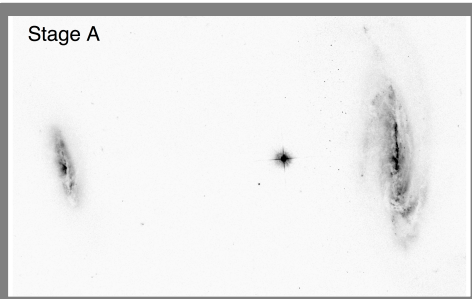
While others are hiding buried AGN!



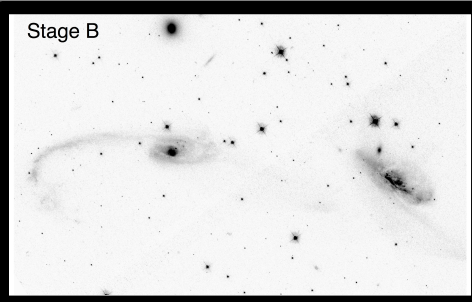


Early stages of mergers

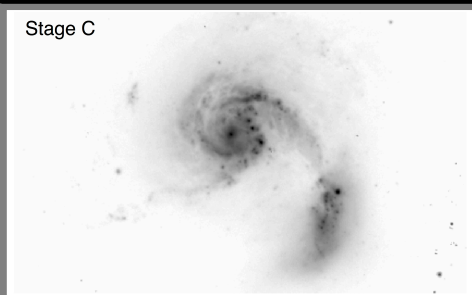
Stage A



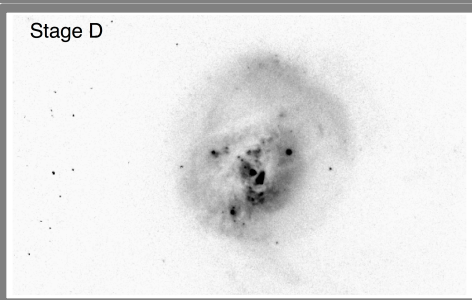
Stage B



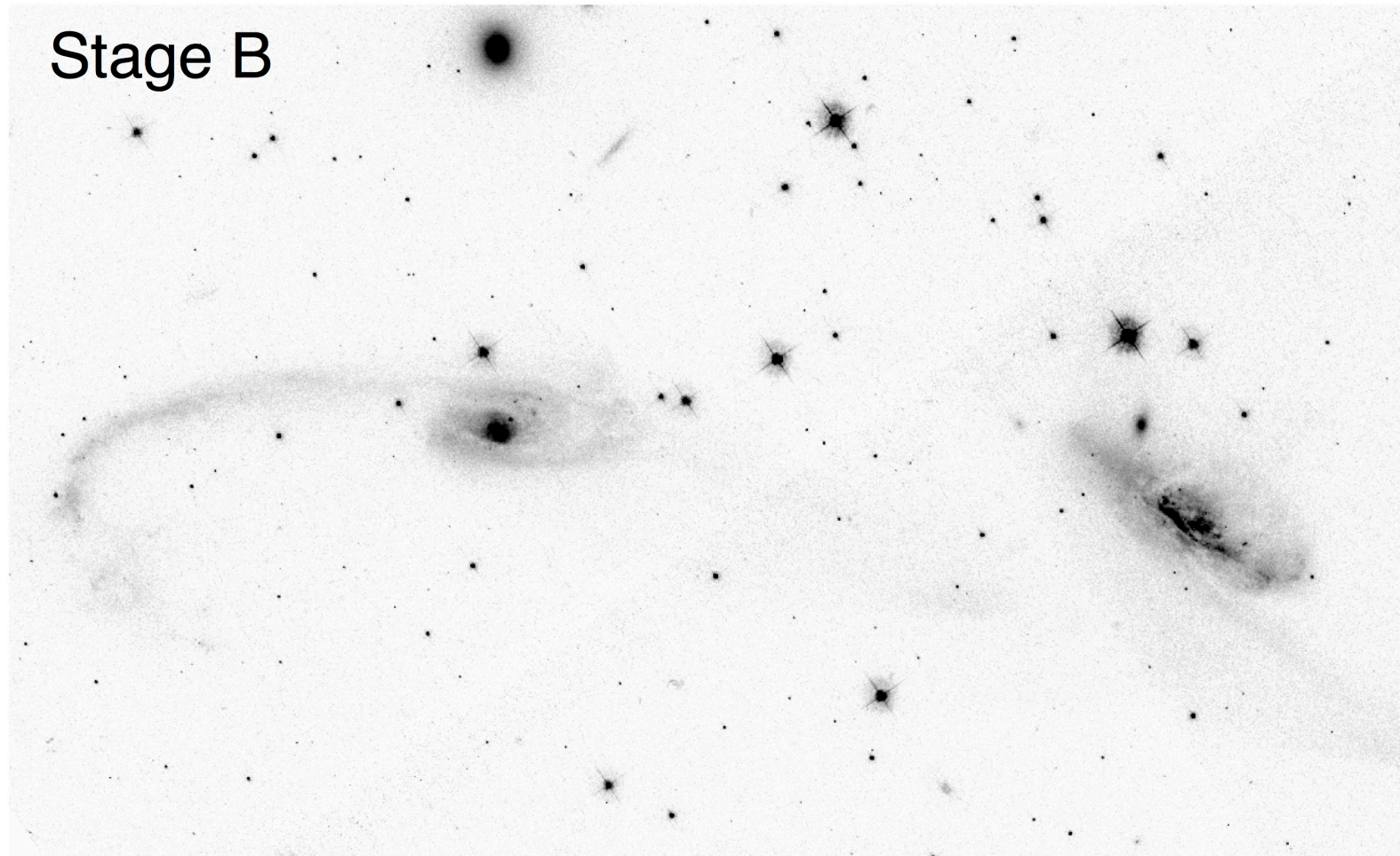
Stage C



Stage D

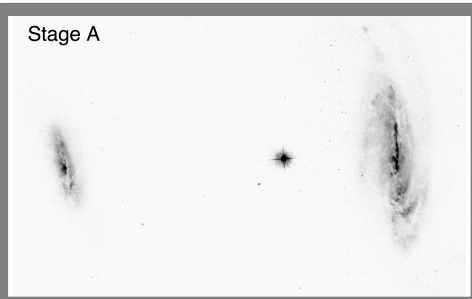


Stage B

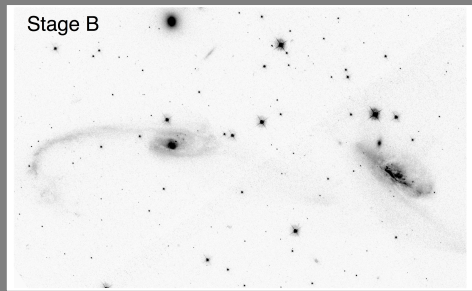


Early stages of mergers

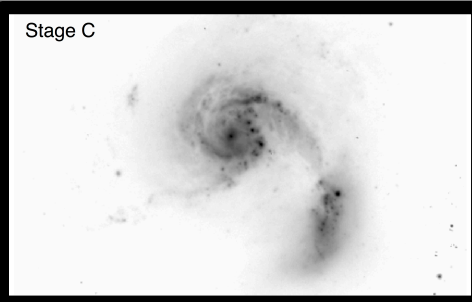
Stage A



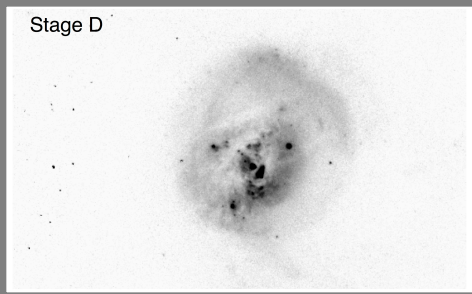
Stage B



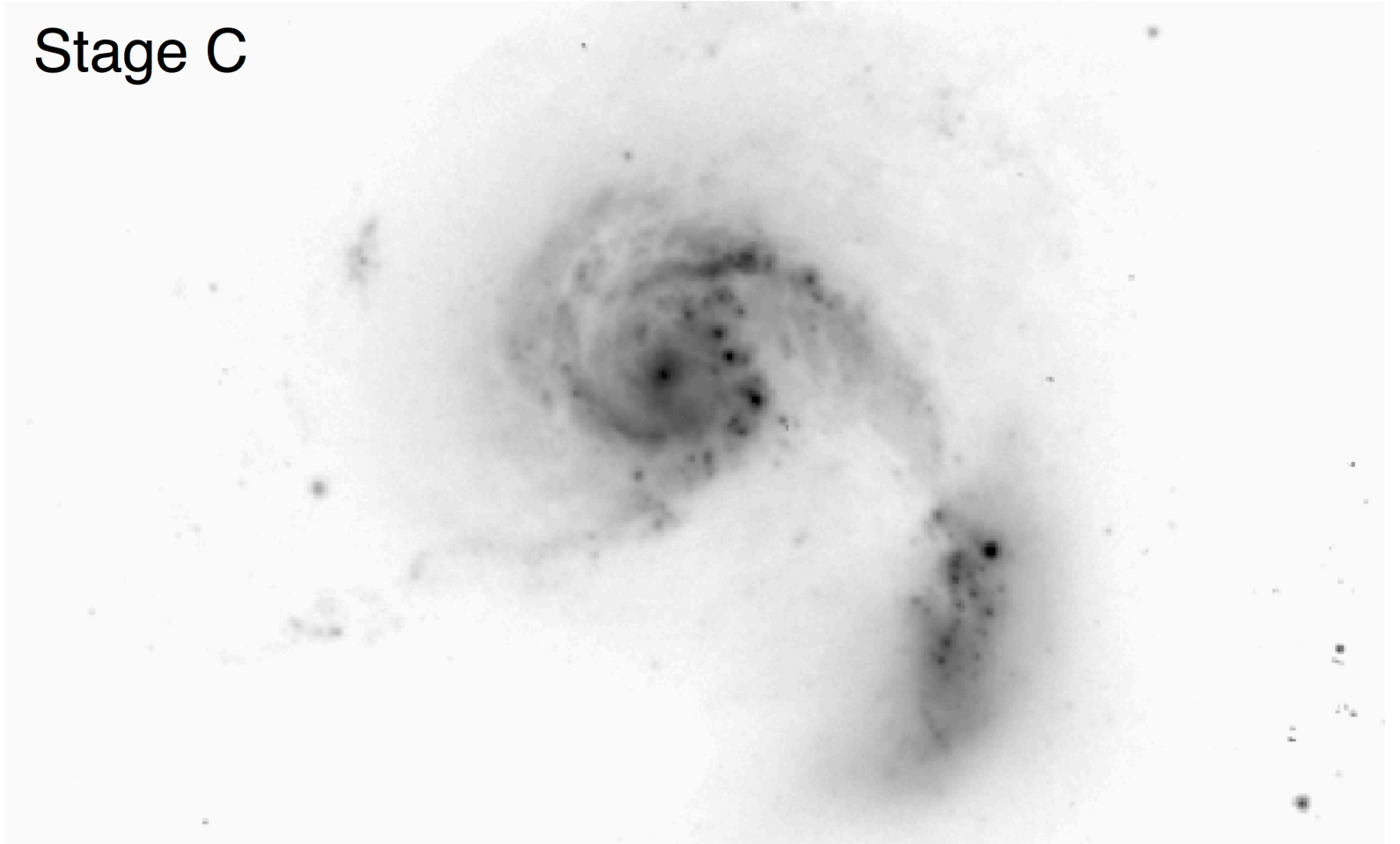
Stage C



Stage D

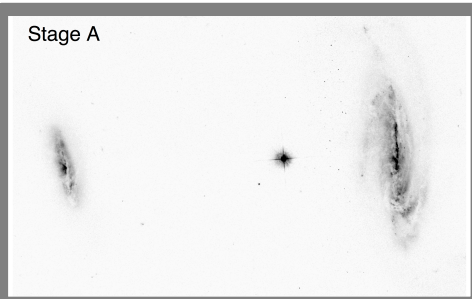


Stage C

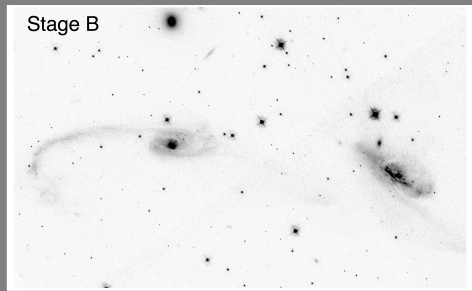


Late stages of mergers

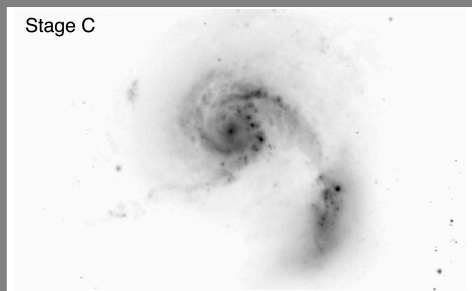
Stage A



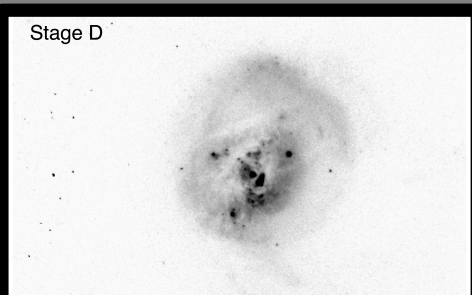
Stage B



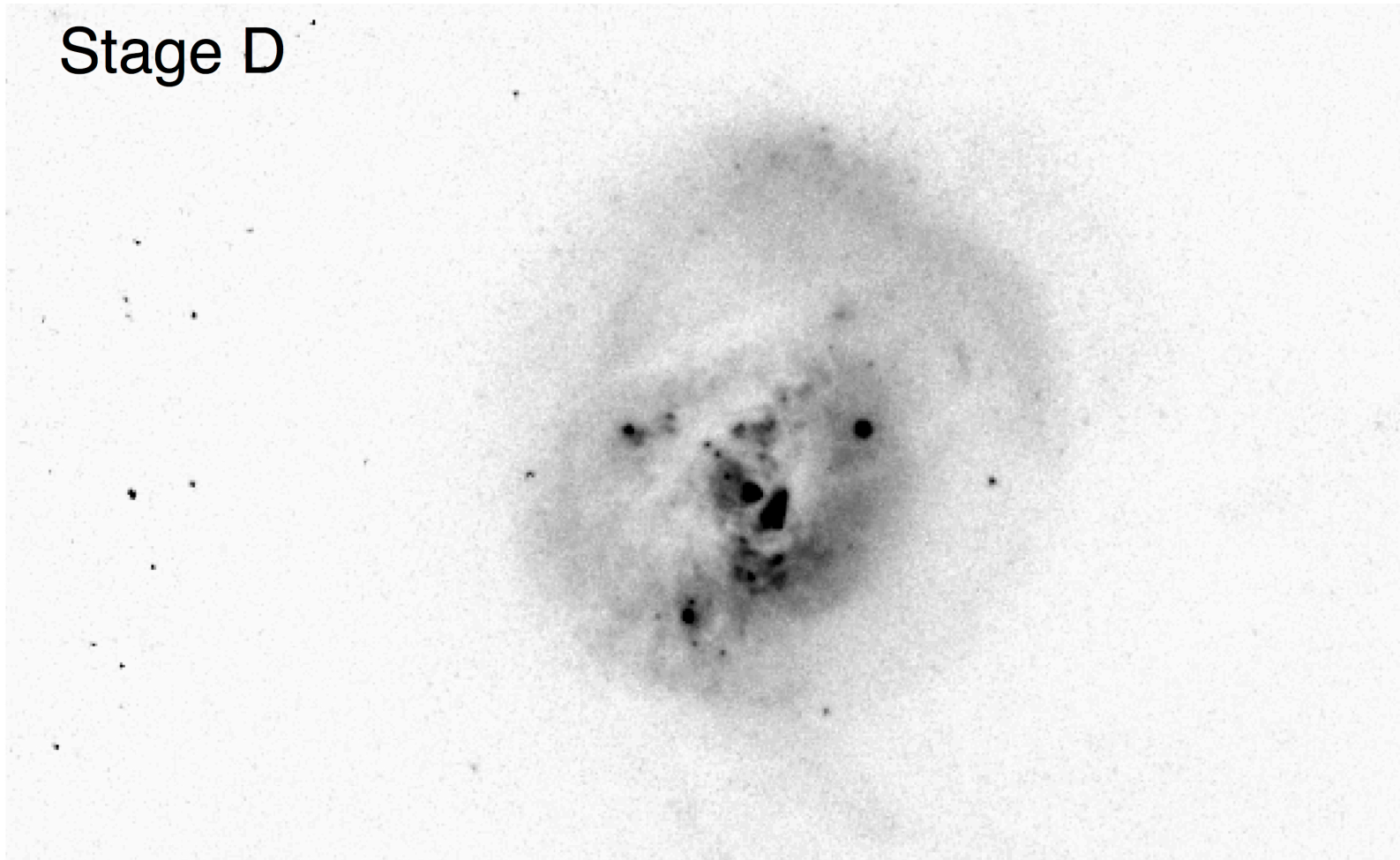
Stage C



Stage D

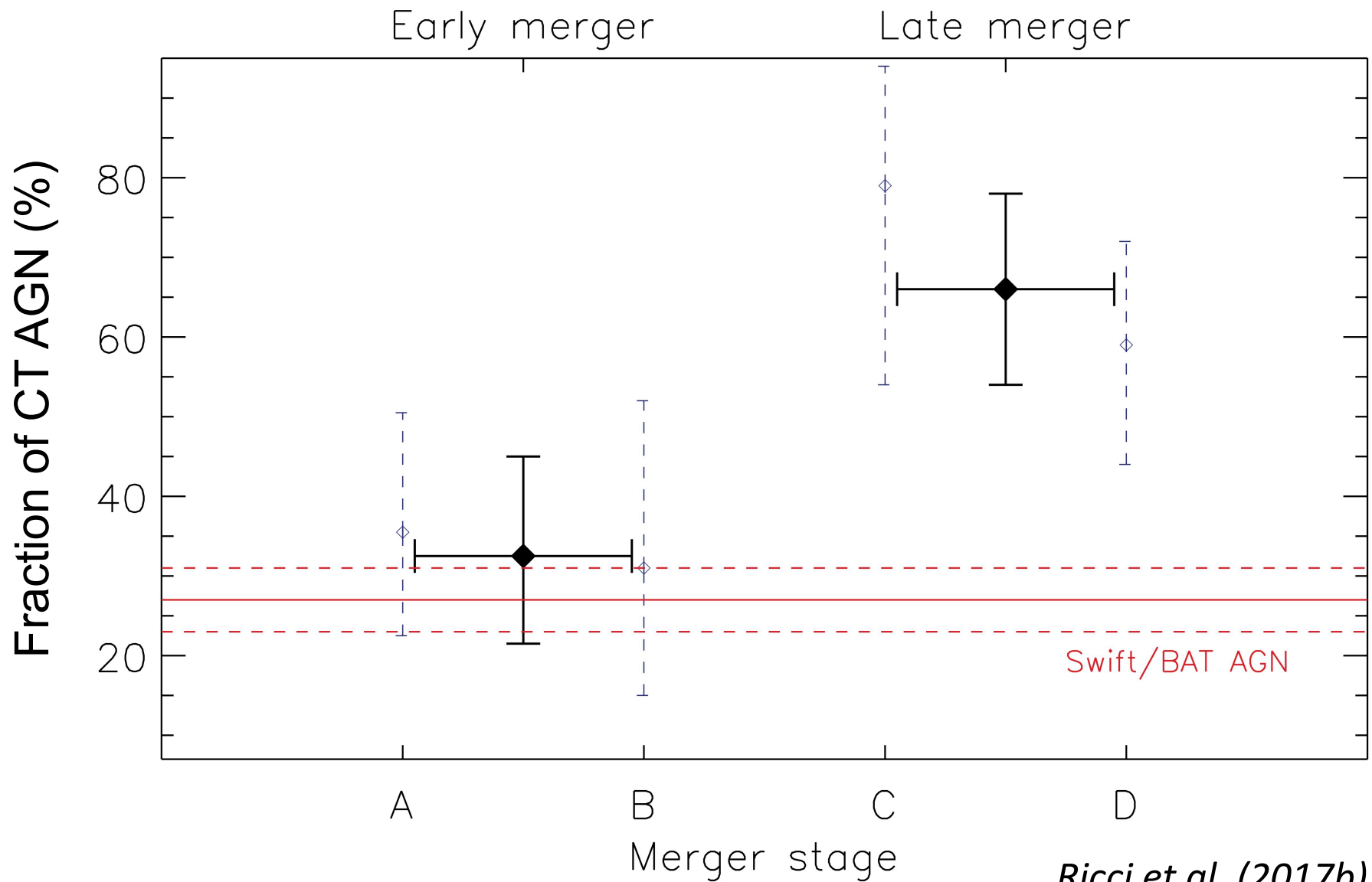
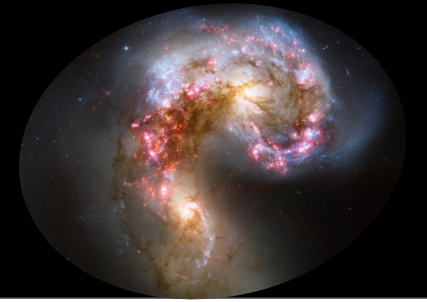


Stage D



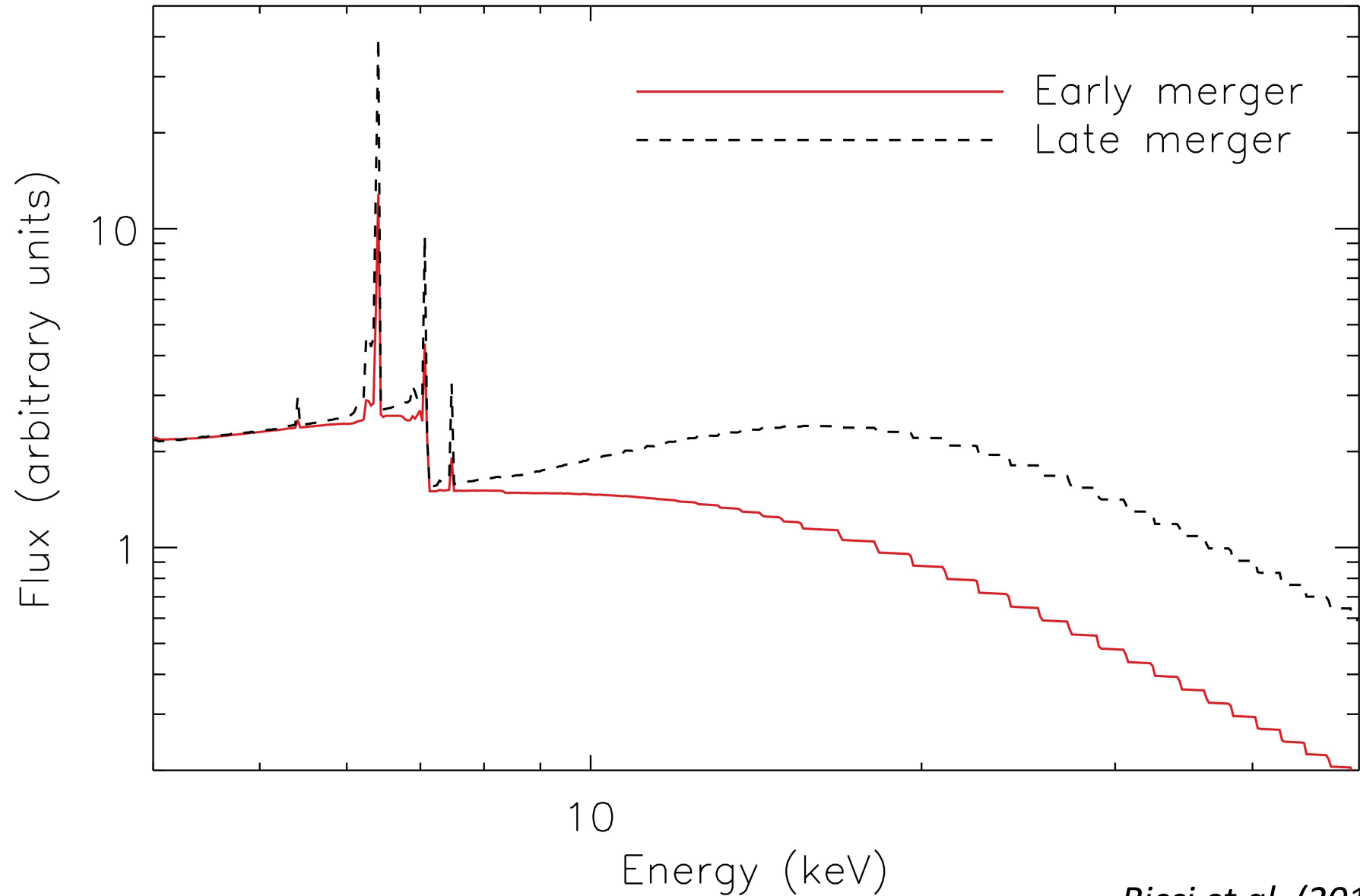
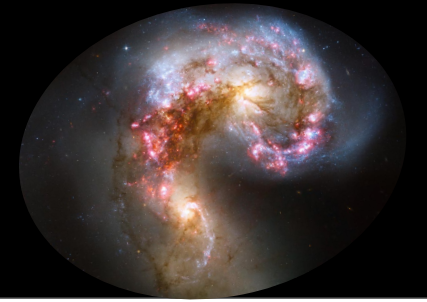
Late stages of mergers

Obscuration properties of mergers



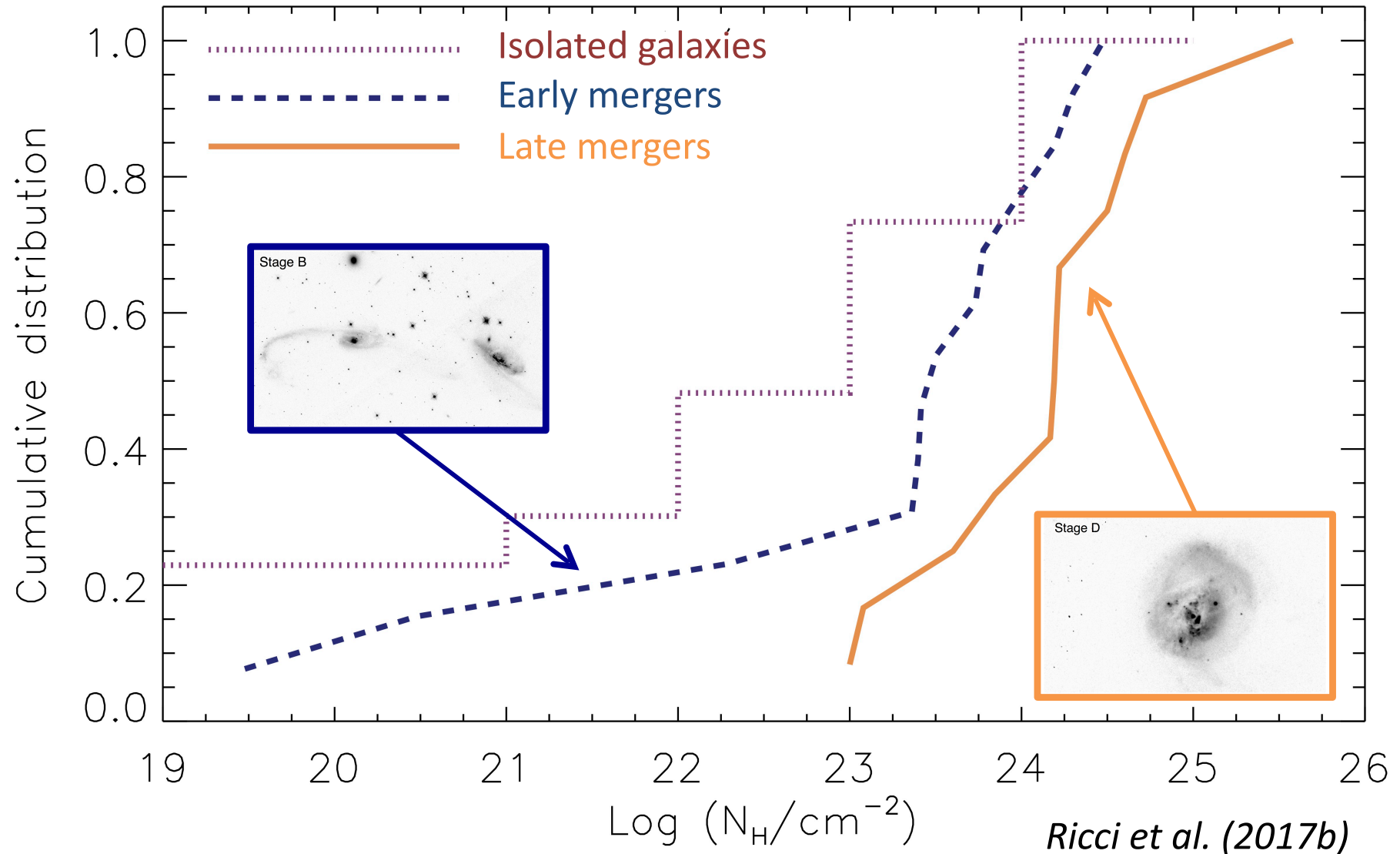
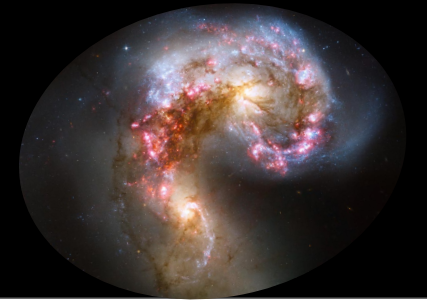
Ricci et al. (2017b)

Average broad-band X-ray spectra



Ricci et al. (2017b)

Obscuration properties of mergers

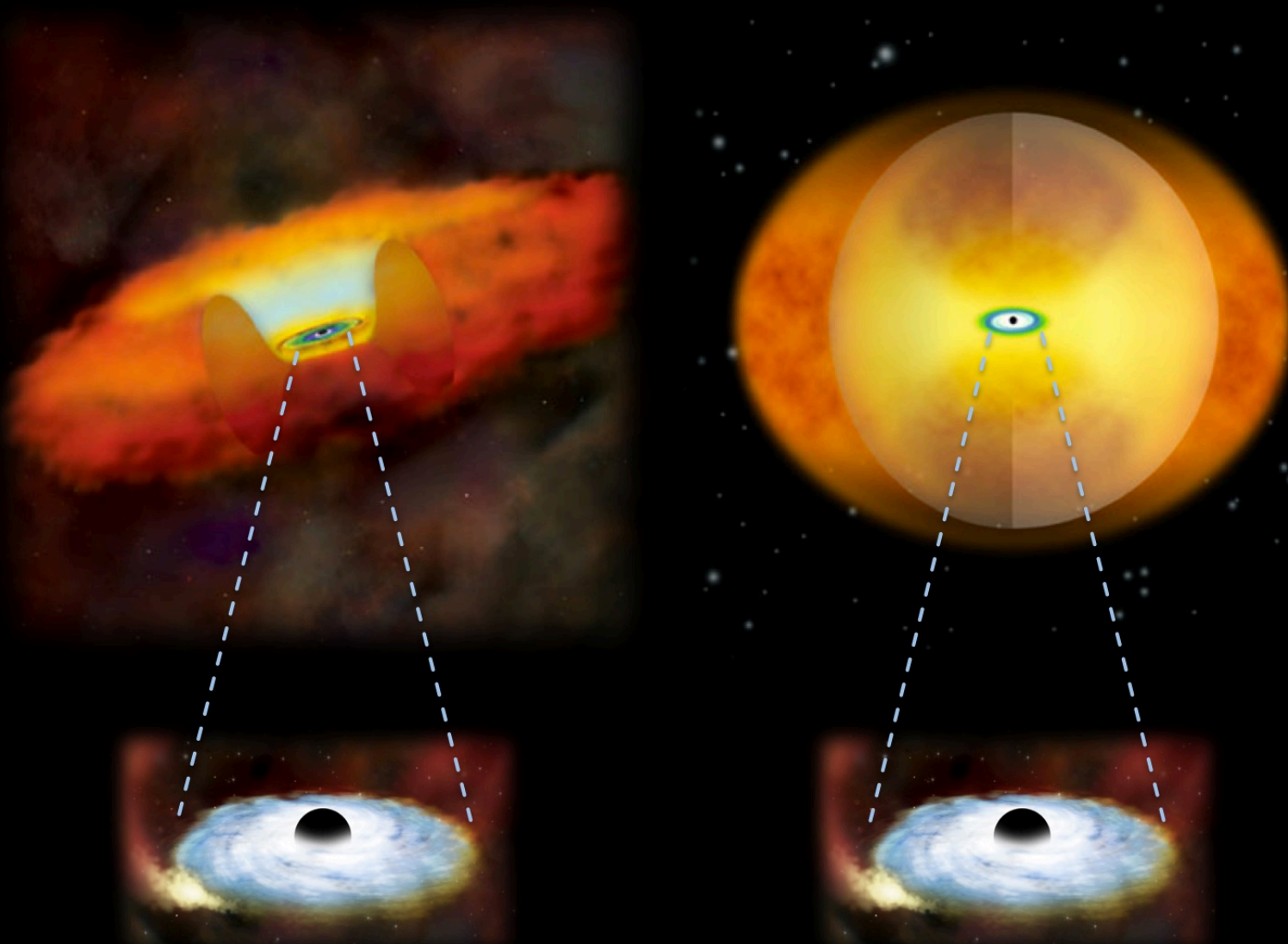


Isolated galaxies

Log $N_{\text{H}} > 23$ $52 \pm 4\%$
Log $N_{\text{H}} > 24$ $27 \pm 4\%$

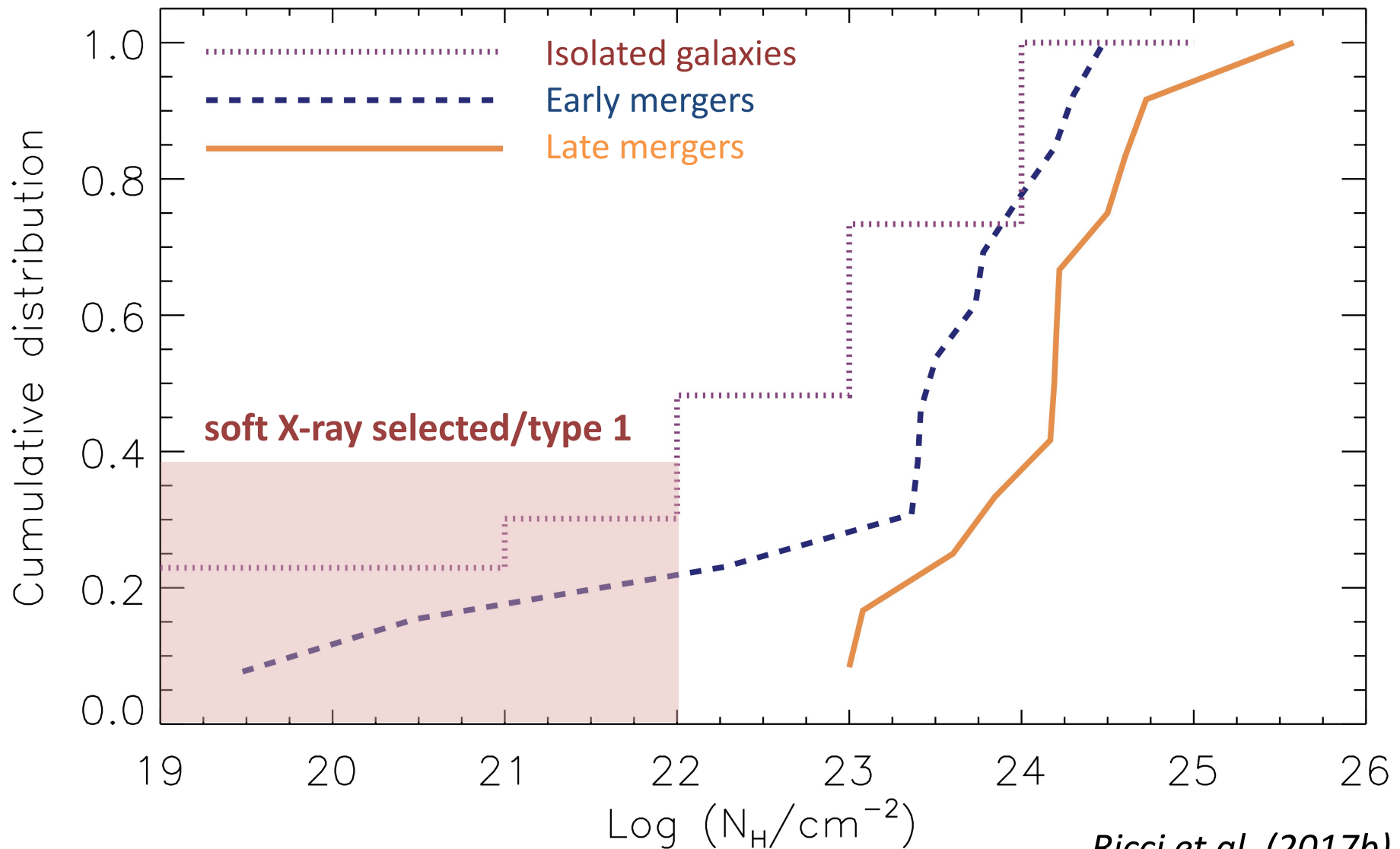
Late stages of merger

$95 \pm 5\%$
 $65 \pm 12\%$



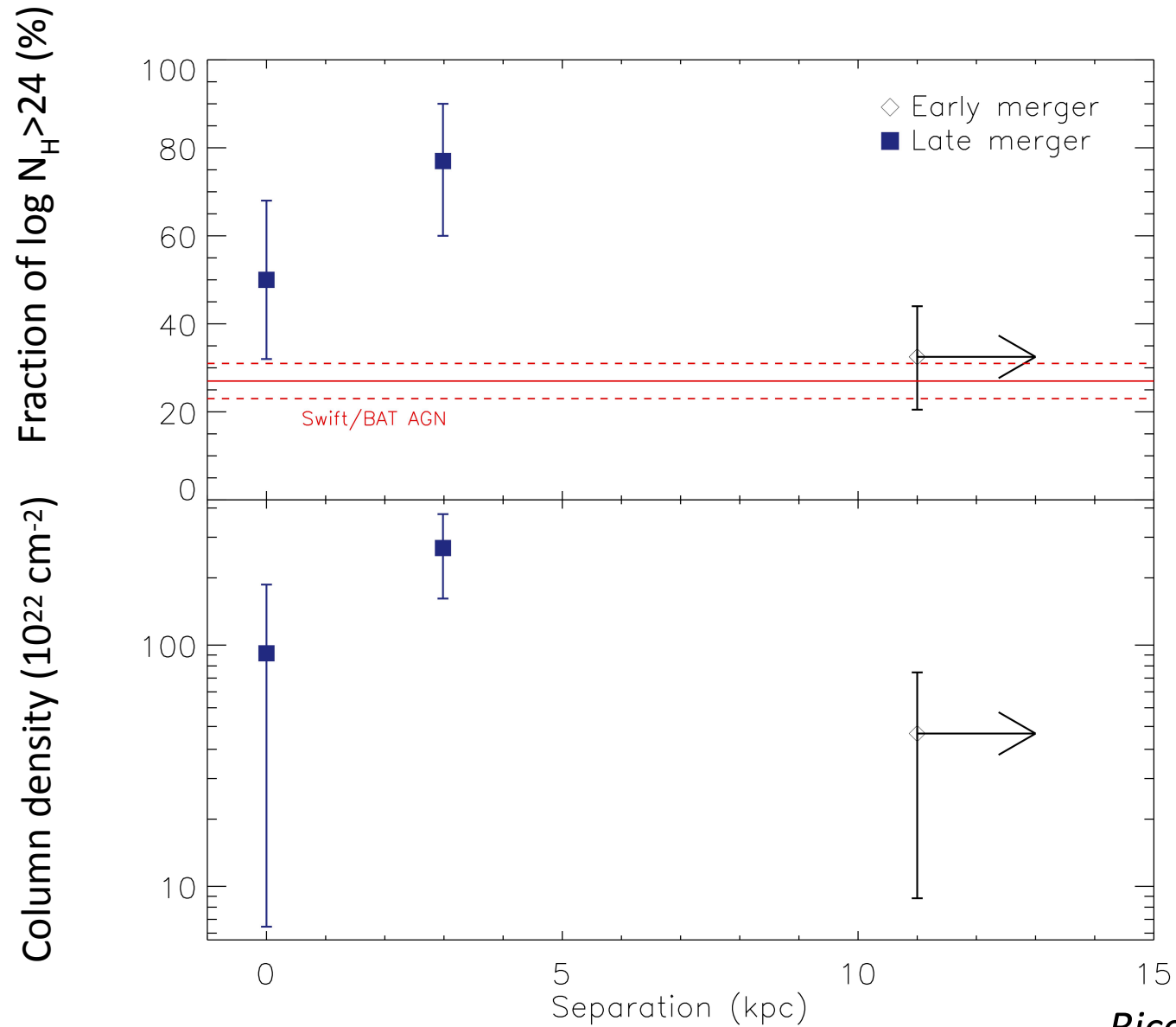
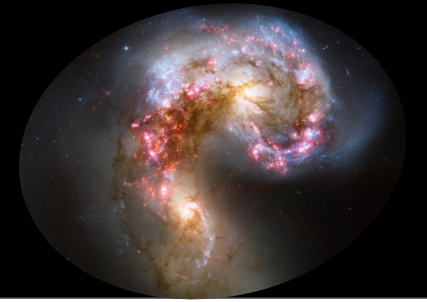
From the NASA press release; Credits: NAOJ/NASA/CXC/M. Weiss

The importance of selection



Ricci et al. (2017b)

Obscuration properties of mergers

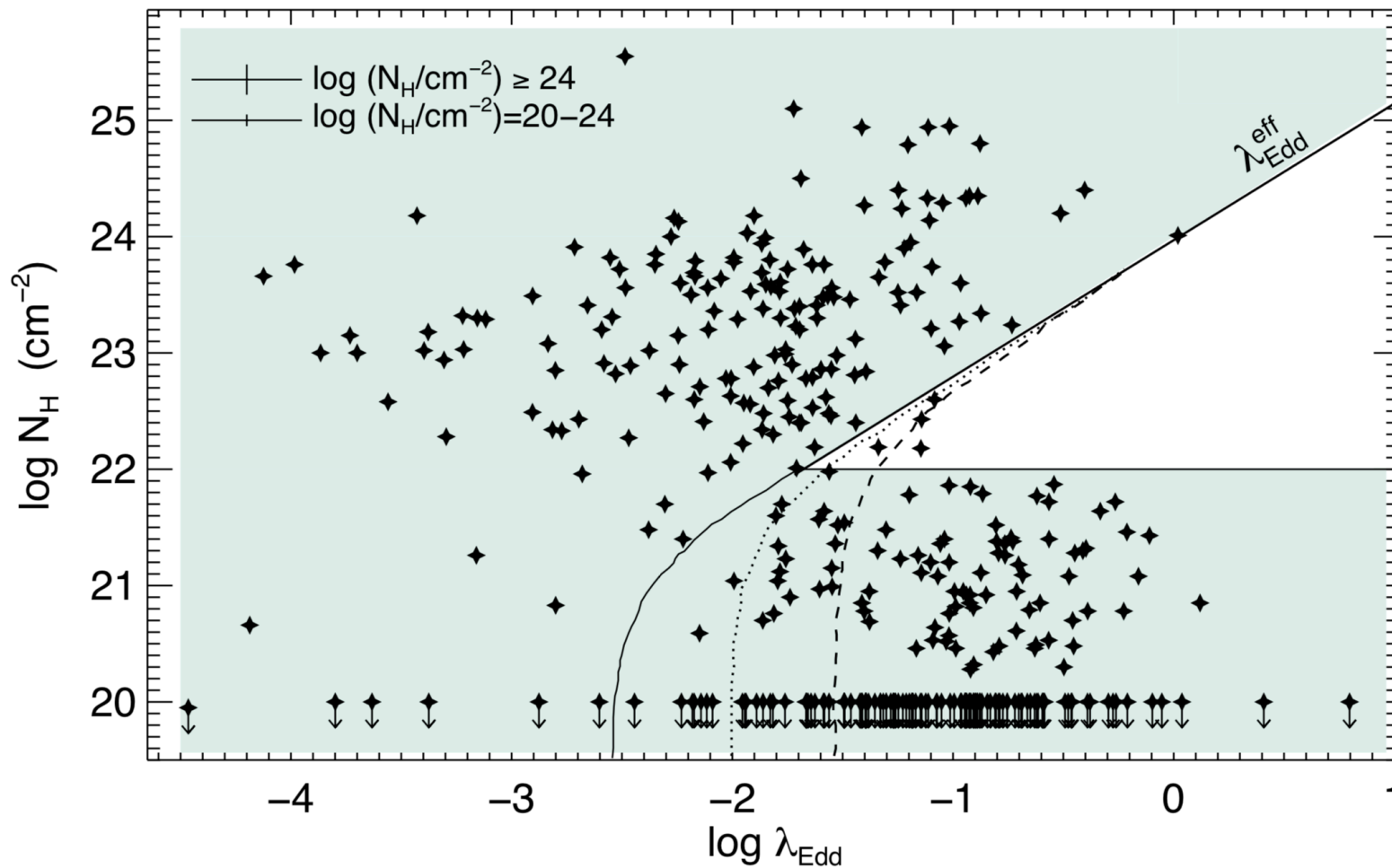


Ricci et al. (2017b)

Radiation pressure on dusty gas

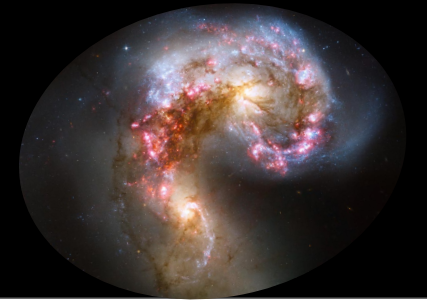


Effective Eddington limit $\lambda_{\text{Edd}}^{\text{eff}} = \sigma_T / \sigma_i(N_H; \xi)$

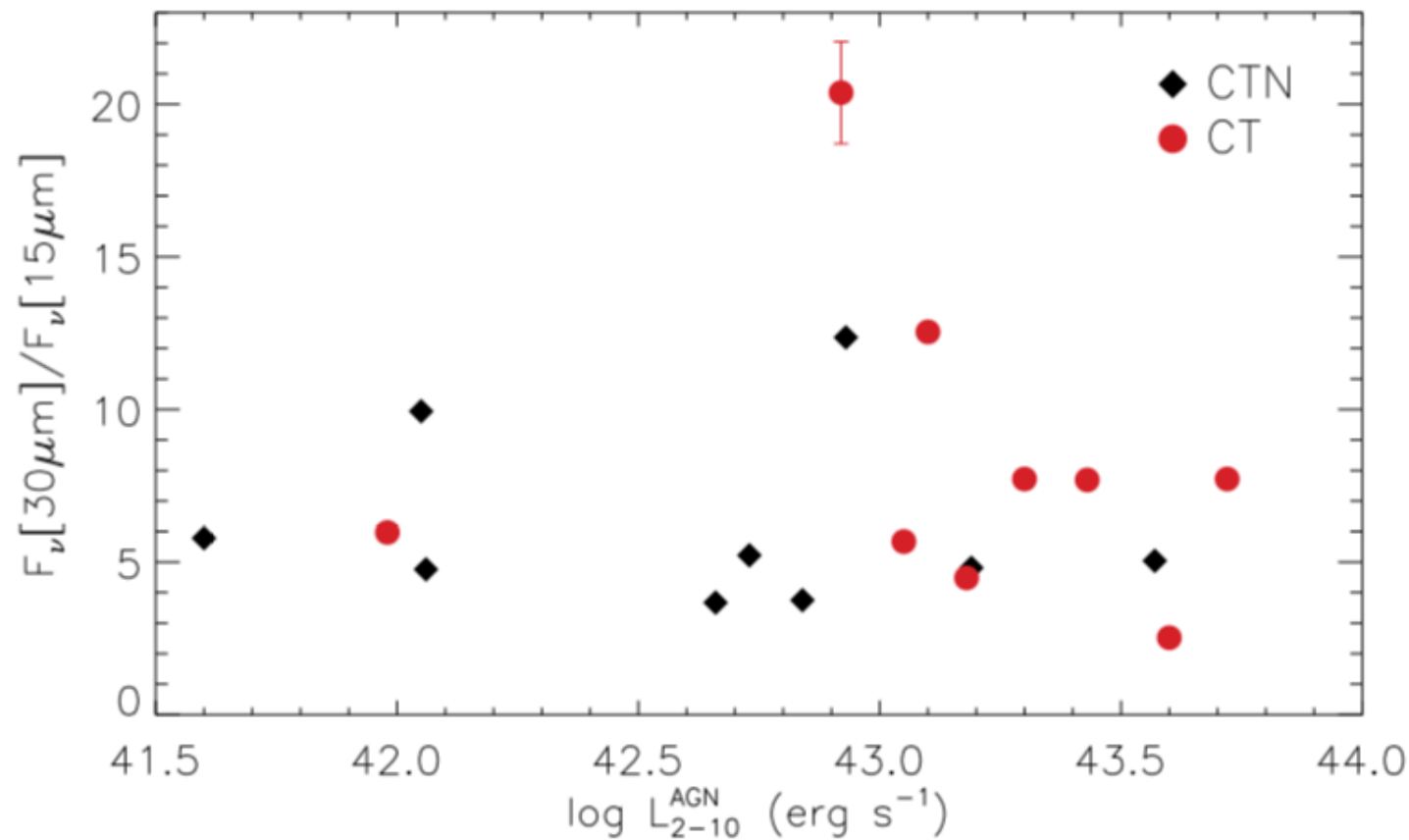


Ricci et al. (2017c, Nature); See talk by L. Zappacosta

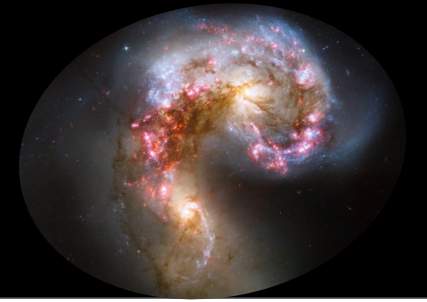
MW proxies of AGN activity



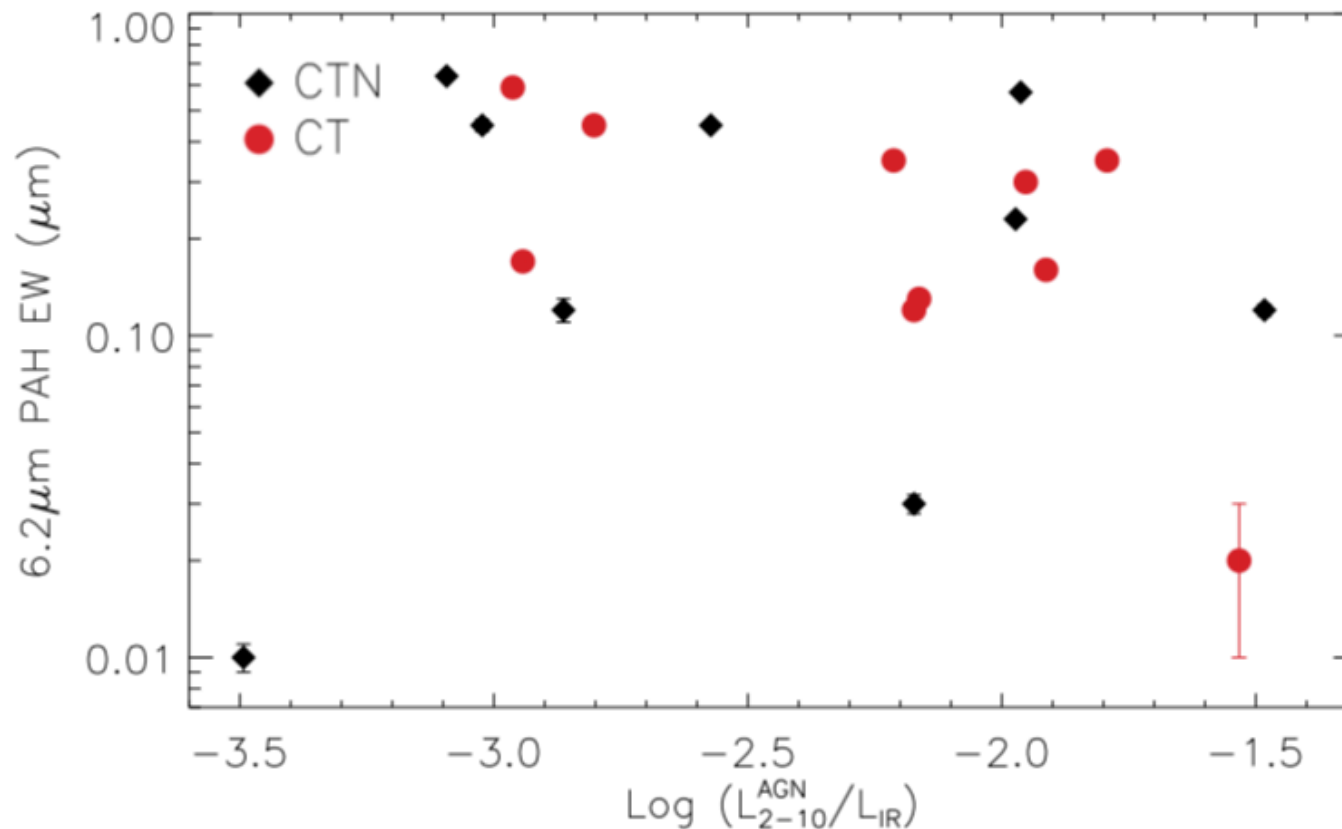
Extended sample: 51 GOALS U/LIRGs now observed with *NuSTAR*



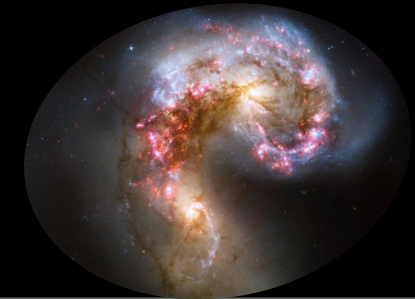
MW proxies of AGN activity



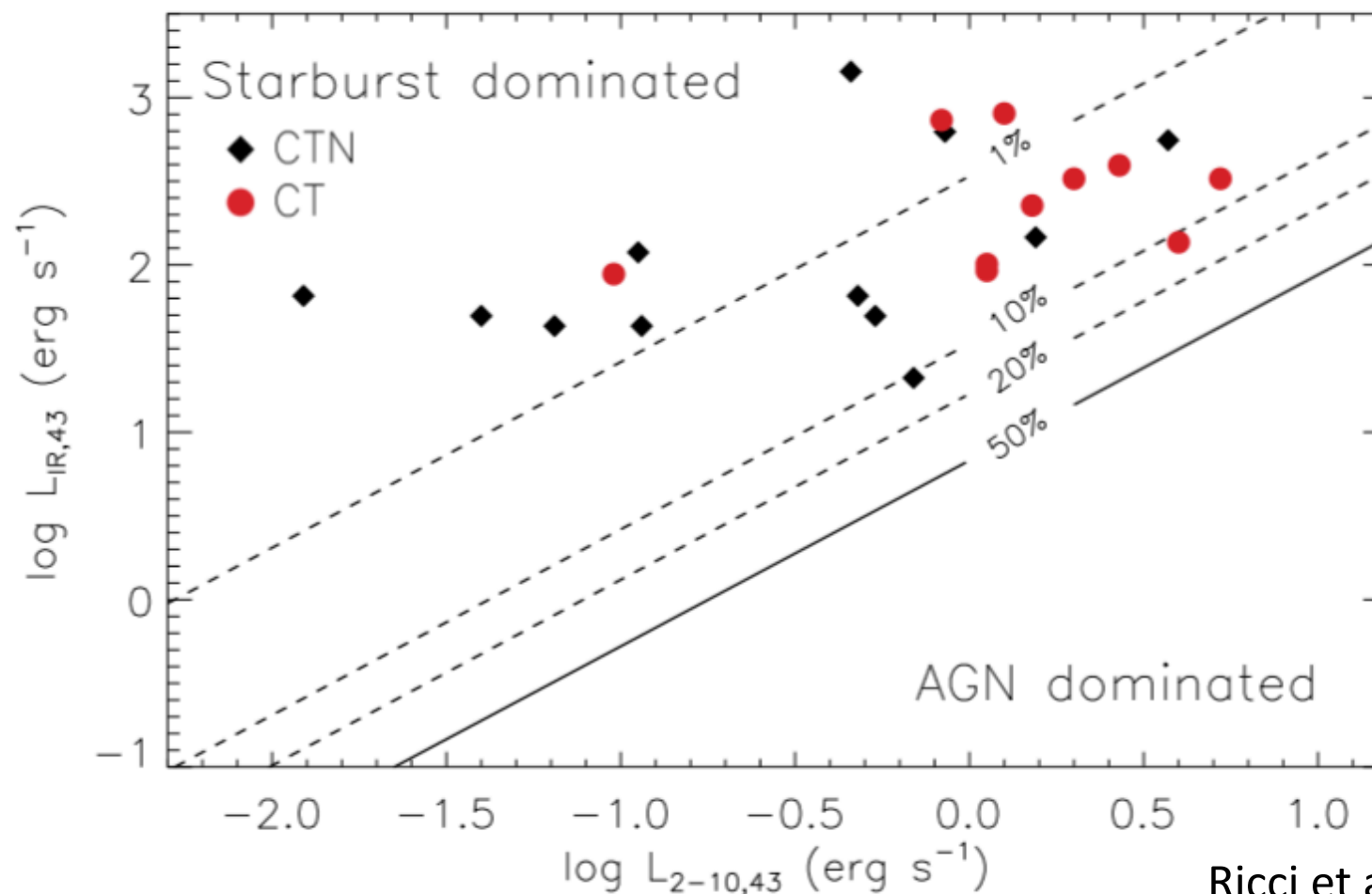
Extended sample: 51 GOALS U/LIRGs now observed with *NuSTAR*



MW proxies of AGN activity

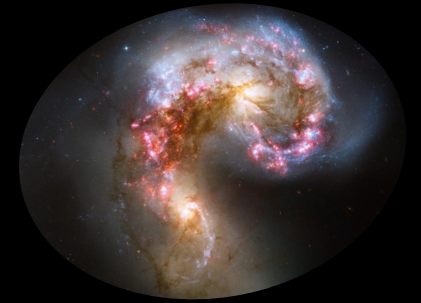


Extended sample: 51 GOALS U/LIRGs now observed with *NuSTAR*





Summary



- Accreting SMBHs in the late stages of mergers are heavily obscured
- Selection effects can be very important when looking at the fraction of AGN in mergers
- MW proxies of AGN activity in local U/LIRGs not always in agreement with hard X-ray observations