Elusive dual AGN revealed by WISE

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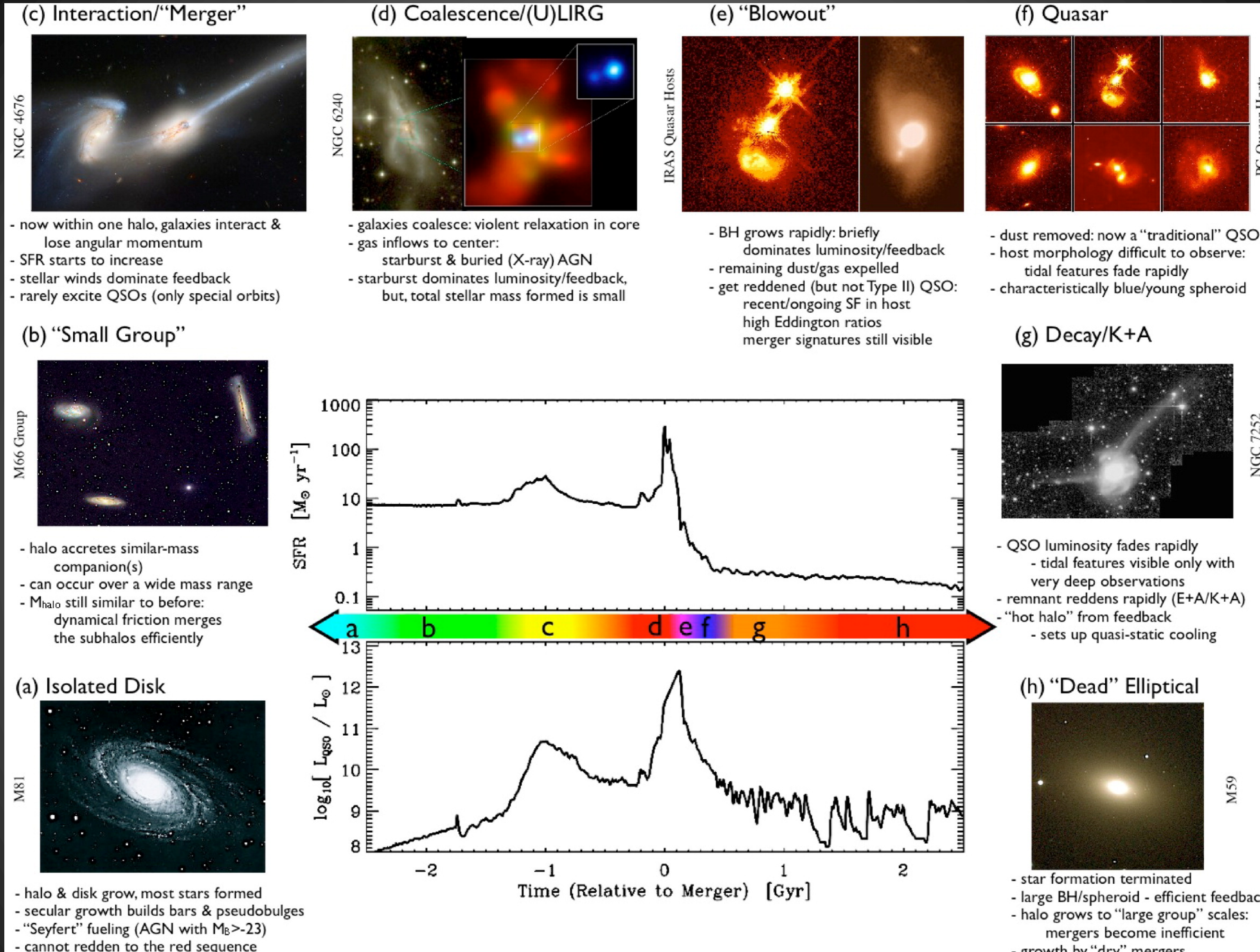


Hopkins et al. (2008)

Recent challenges to the picture that mergers can trigger AGN, even at the highest luminosities.

THE BULK OF THE BLACK HOLE GROWTH SINCE $z \sim 1$ OCCURS IN A SECULAR UNIVERSE: NO MAJOR MERGER–AGN CONNECTION*

Mauricio Cisternas[1,20], Knud Jahnke[1], Katherine J. Inskip[1], Jeyhan Kartaltepe[2], Anton M. Koekemoer[3], Thorsten Lisker[4], Aday R. Robaina[1,5], Marco Scodeggio[6], Kartik Sheth[7,8], Jonathan R. Trump[9], René Andrae[1], Takamitsu Miyaji[10,11], Elisabeta Lusso[12], Marcella Brusa[13], Peter Capak[7], Nico Cappelluti[13], Francesca Civano[14], Olivier Ilbert[15], Chris D. Impey[9], Alexie Leauthaud[16], Simon J. Lilly[17], Mara Salvato[18], Nick Z. Scoville[7], and Yoshi Taniguchi[19]

Cisternas et al. (2011)

Schawinski et al. (2012)

Heavily obscured quasar host galaxies at $z \sim 2$ are discs, not major mergers★

Kevin Schawinski,[1,2]†‡ Brooke D. Simmons,[2,3] C. Megan Urry,[1,2,3] Ezequiel Treister[4] and Eilat Glikman[2,3]§

Morphologies of $z \sim 0.7$ AGN host galaxies in CANDELS: no trend of merger incidence with AGN luminosity

C. Villforth,[1,2]★ F. Hamann,[1] D. J. Rosario,[3] P. Santini,[4] E. J. McGrath,[5] A. van der Wel,[6] Y. Y. Chang,[6] Y. Guo,[7] T. Dahlen,[8] E. F. Bell,[9] C. J. Conselice,[10] D. Croton,[11] A. Dekel,[12] S. M. Faber,[7] N. Grogin,[8] T. Hamilton,[13] P. F. Hopkins,[14,15] S. Juneau,[16] J. Kartaltepe,[17] D. Kocevski,[18] A. Koekemoer,[8] D. C. Koo,[7] J. Lotz,[8] D. McIntosh,[19] M. Mozena,[7] R. Somerville[20] and V. Wild[2]

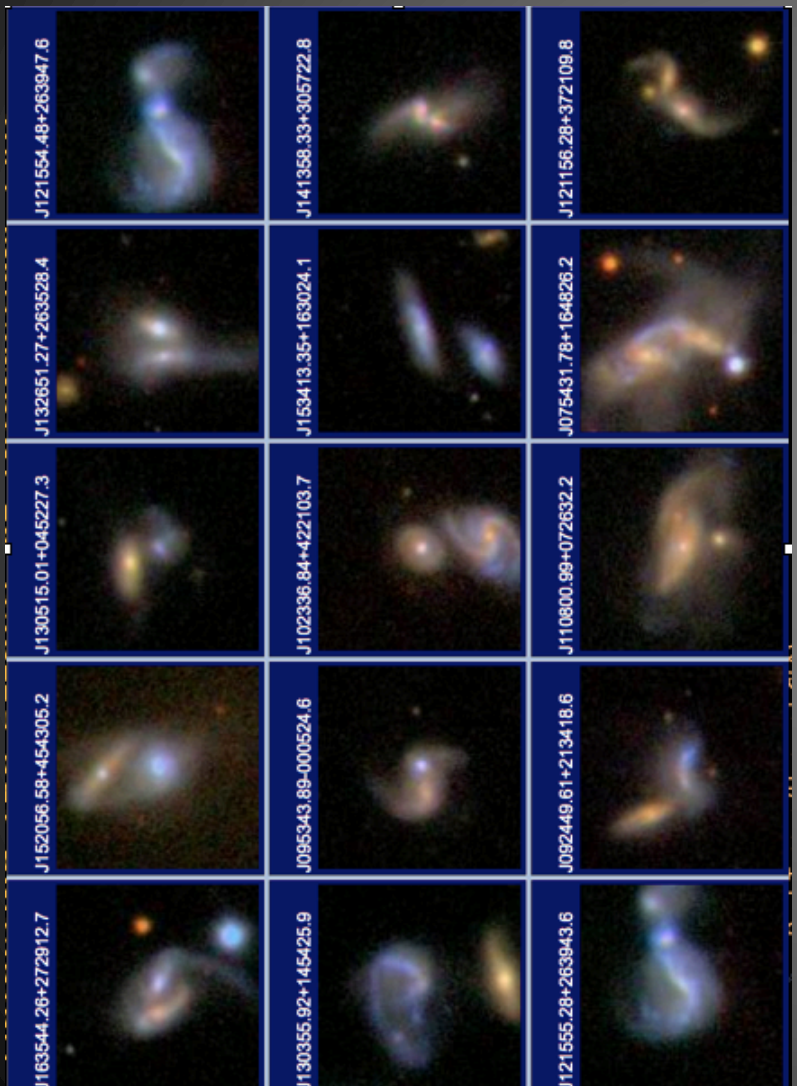
Villforth et al. (2014)

Host galaxies of luminous z∼0.6 quasars: Major mergers are not prevalent at the highest AGN luminosities ⋆

C. Villforth[1,2], T. Hamilton[3], M. M. Pawlik[2], T. Hewlett[2], K. Rowlands[2], H. Herbst[4], F. Shankar[5], A. Fontana[6], F. Hamann[4,8], A. Koekemoer[7], J. Pforr[9,10], J. Trump[11,12], S. Wuyts[1]

Villforth et al. (2017)

Observational tests of merger induced transformations: Galaxy pairs in the SDSS

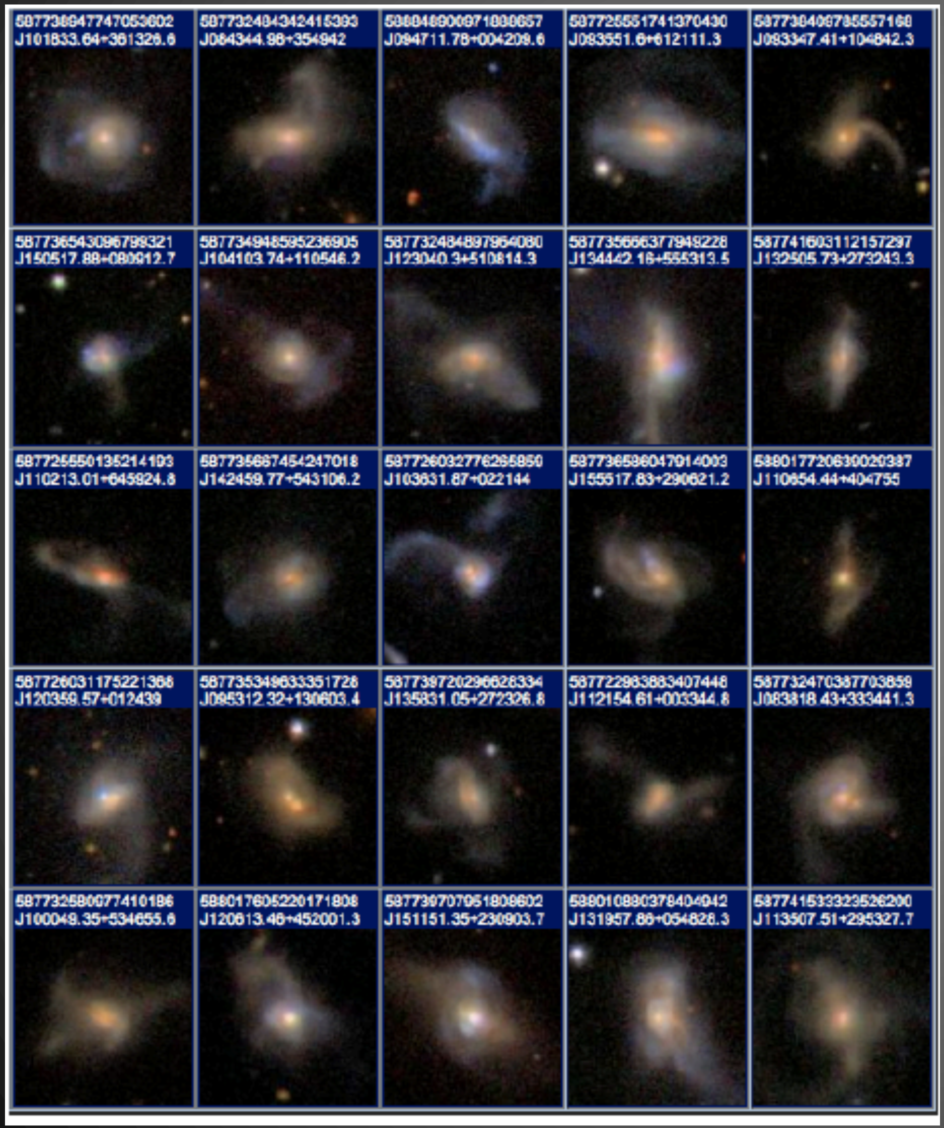


DR7 pairs sample:
Projected separation <80 kpc
ΔV <300 km/s
Mass ratio 0.1 - 10

Yields: ~14,000 galaxies in pairs.

Construct control samples that are matched in mass, redshift and environment: typically 100s control galaxies per pair.

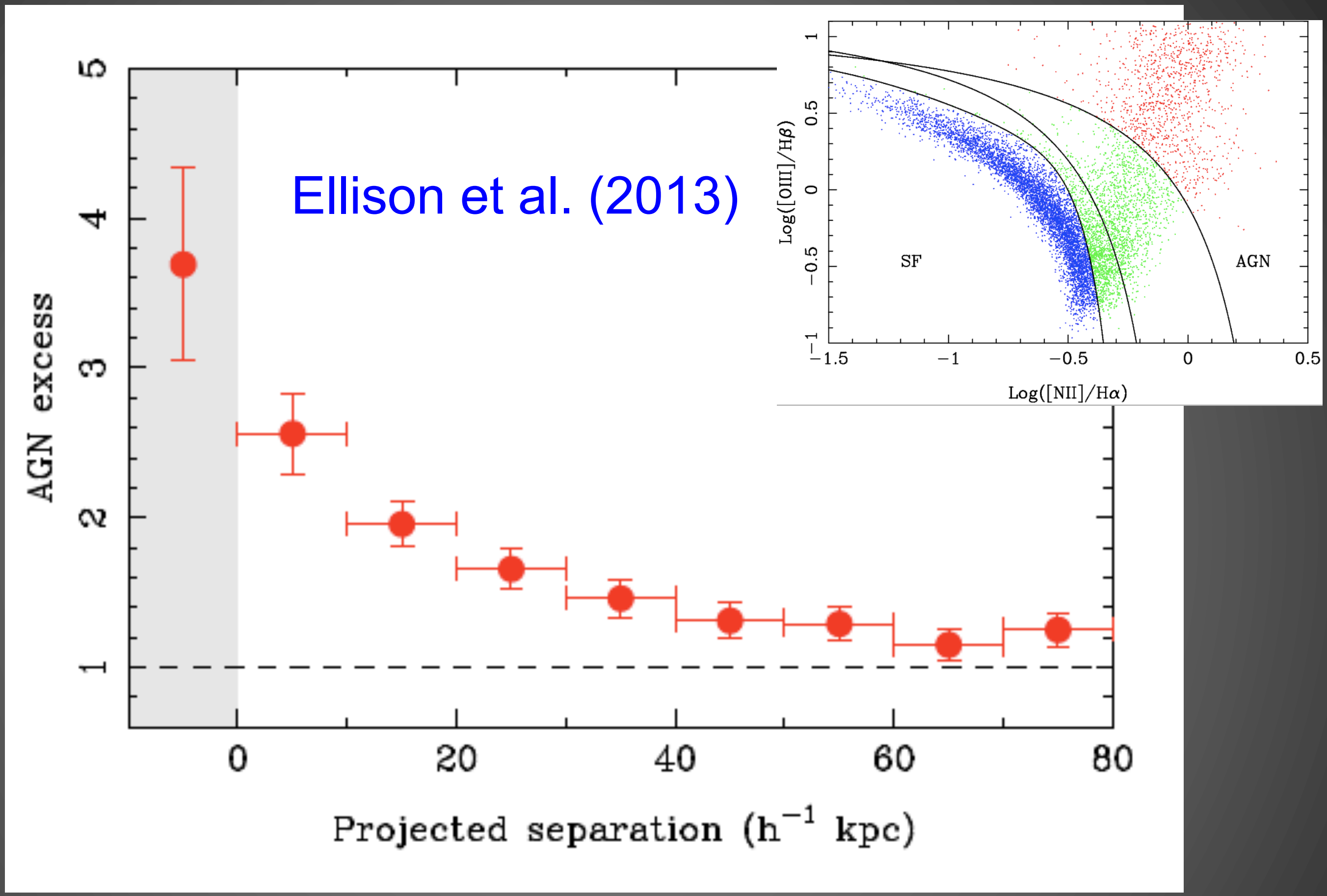
Post-merger sample



97 visually selected post-mergers from Galaxy Zoo.

Control matching and analysis done exactly same as for pairs.

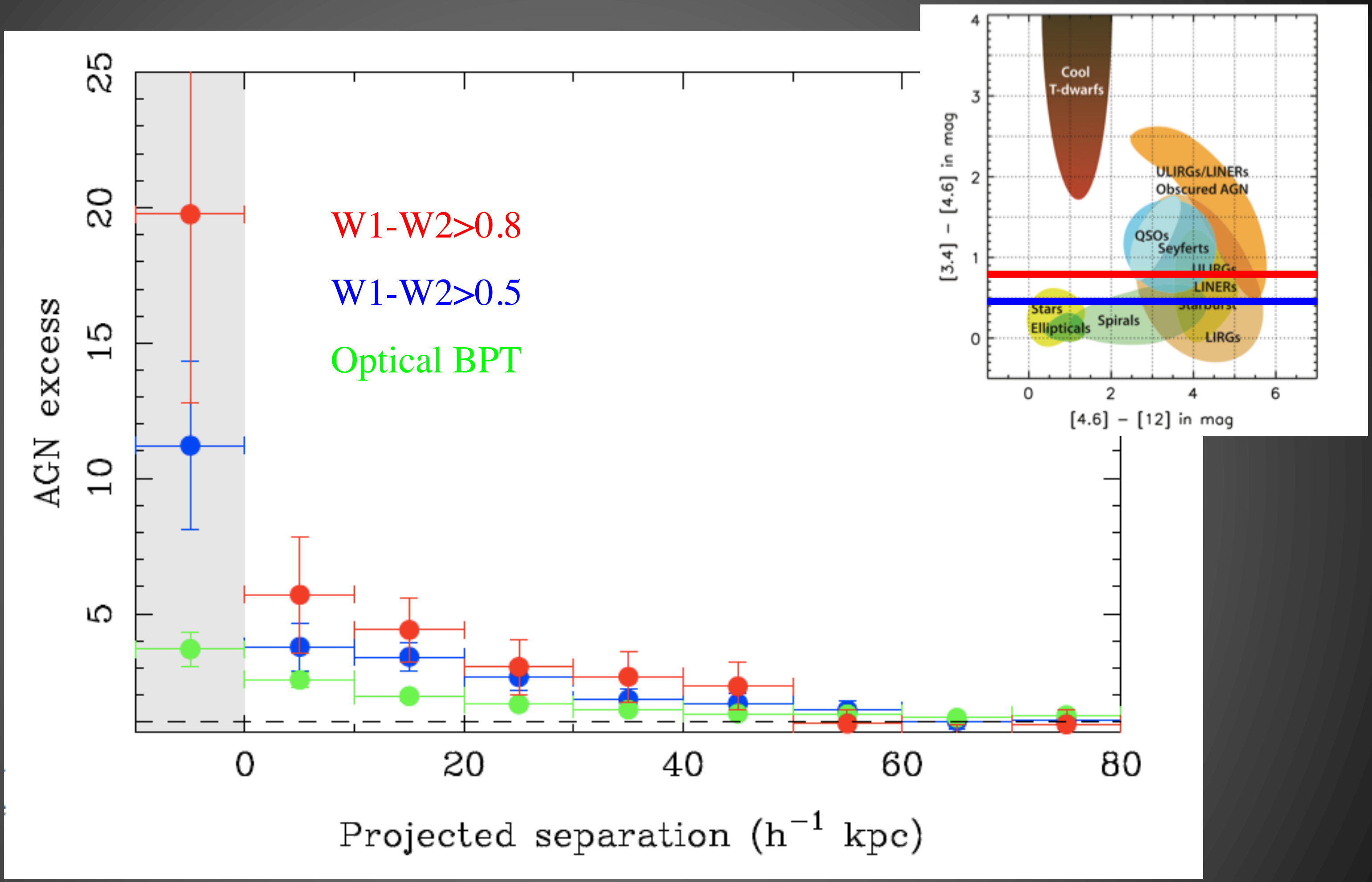
AGN frequency: from optical emission lines



Although AGN *may* be triggered by first pass, fraction increases most strongly after coalescence

See also Ellison et al. (2011), Khabiboulline et al. (2014)

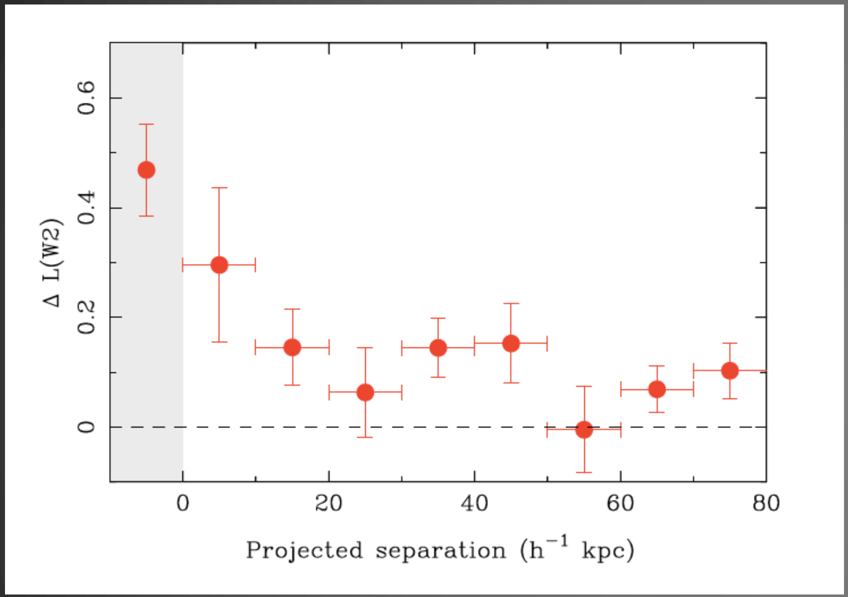
AGN frequency: from mid-IR colours

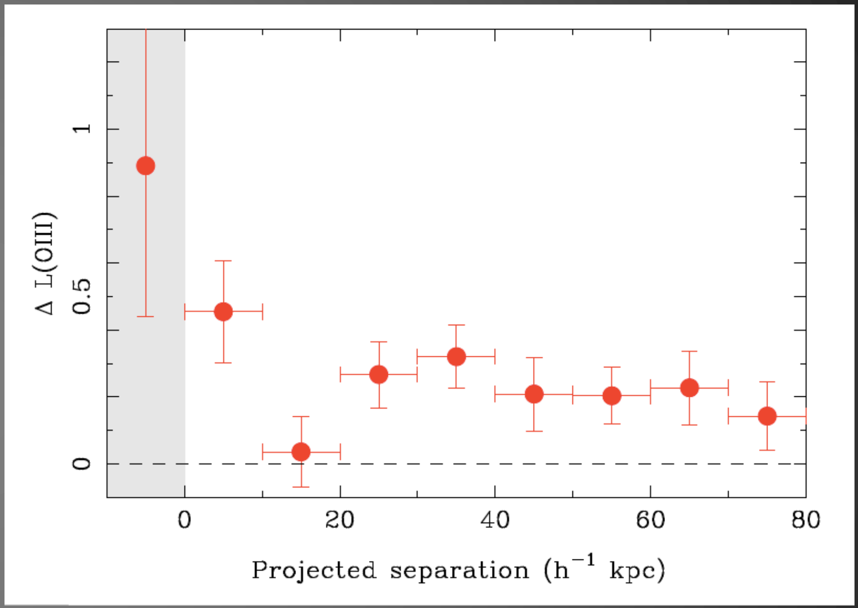


Significant fraction of merger triggered AGN are dust obscured and not seen as AGN in optical.

Satyapal et al. (2014)

Increase in AGN luminosity at smaller separations.

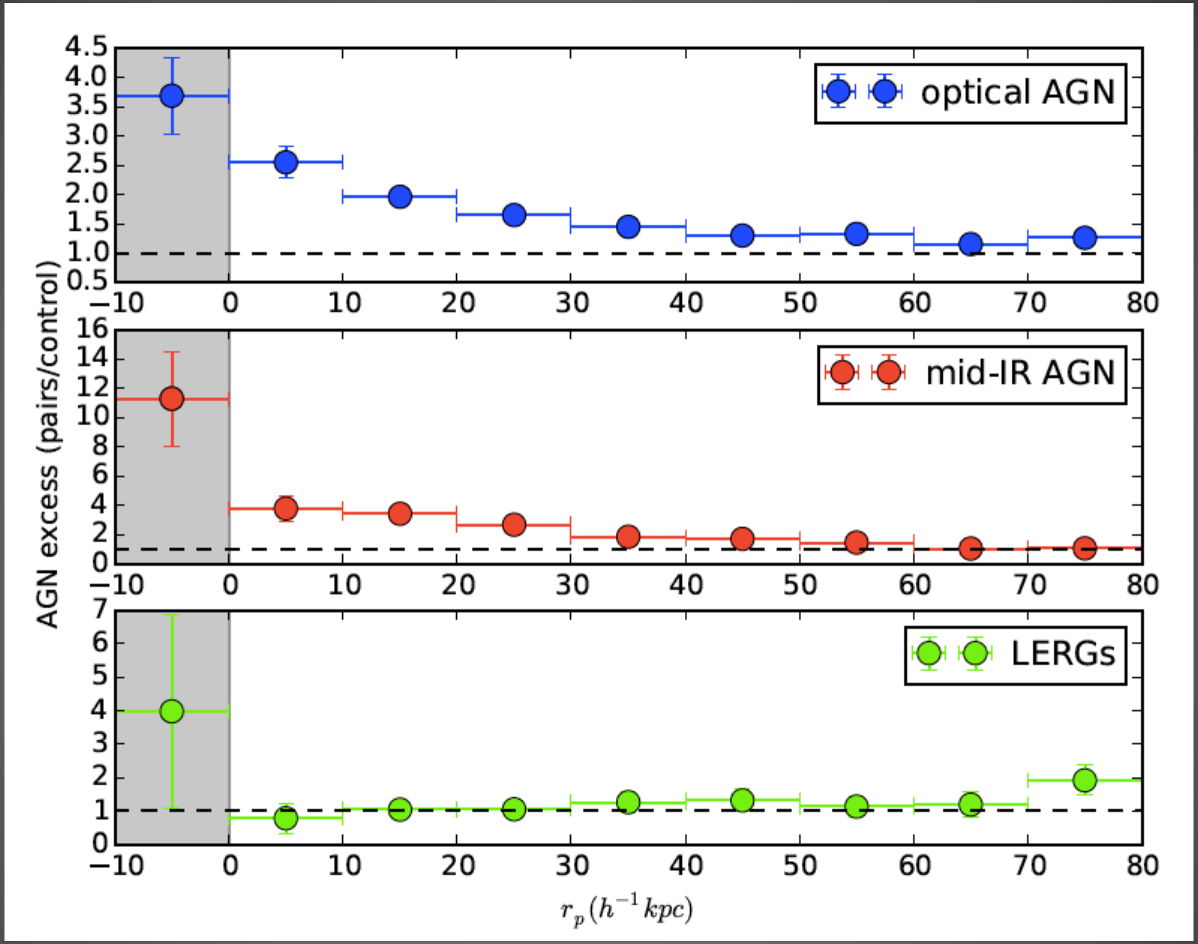




Measured in the mid-IR with WISE: Satyapal et al. (2014)

Measured in the optical with [OIII]: Ellison et al. (2013)

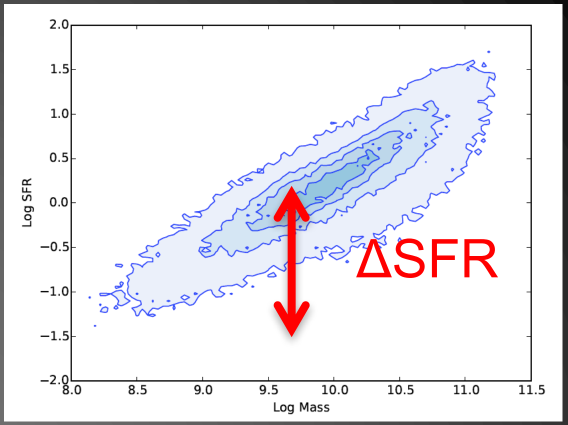
AGN excess depends on selection technique

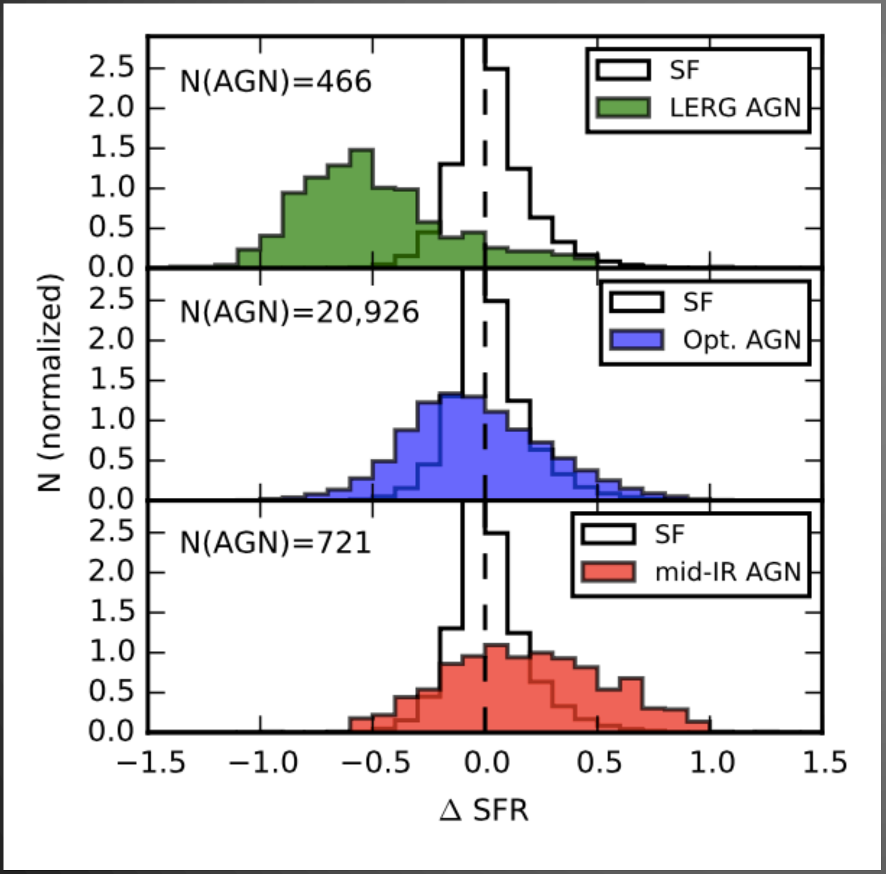


Low excitation radio galaxies – not triggered by mergers

Ellison, Patton & Hickox 2015

More evidence that not all AGN exhibit same galaxy host properties: star formation rates.





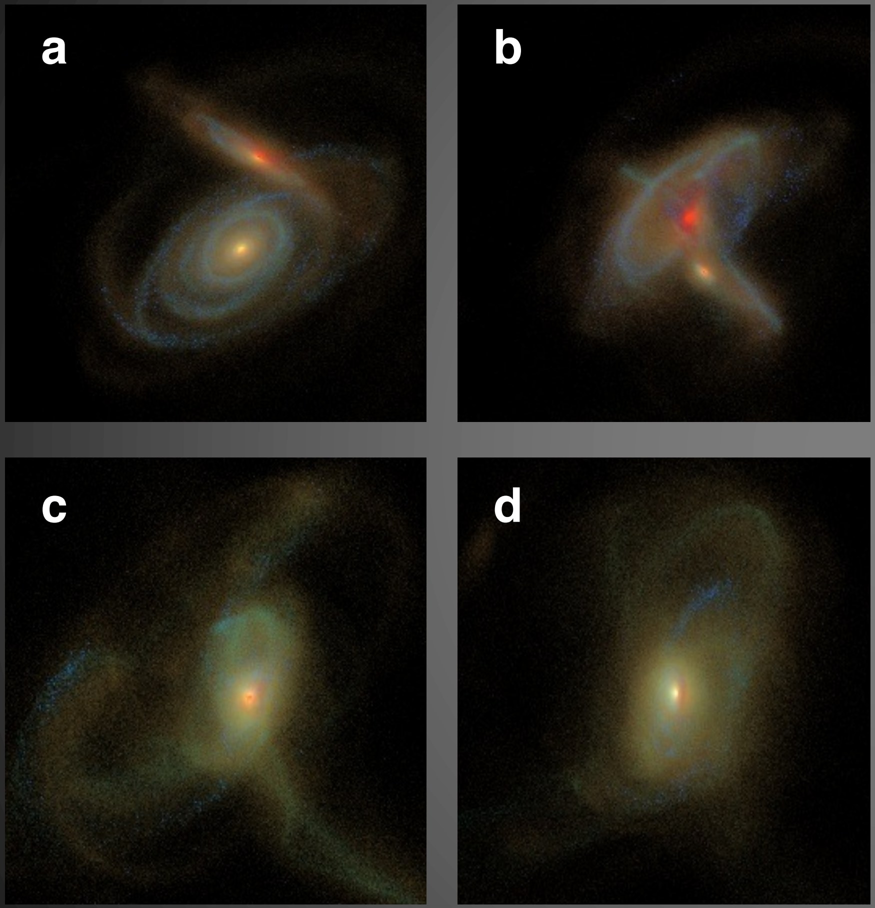
Radio-selected AGN (LERGs) are strongly UNDER star forming

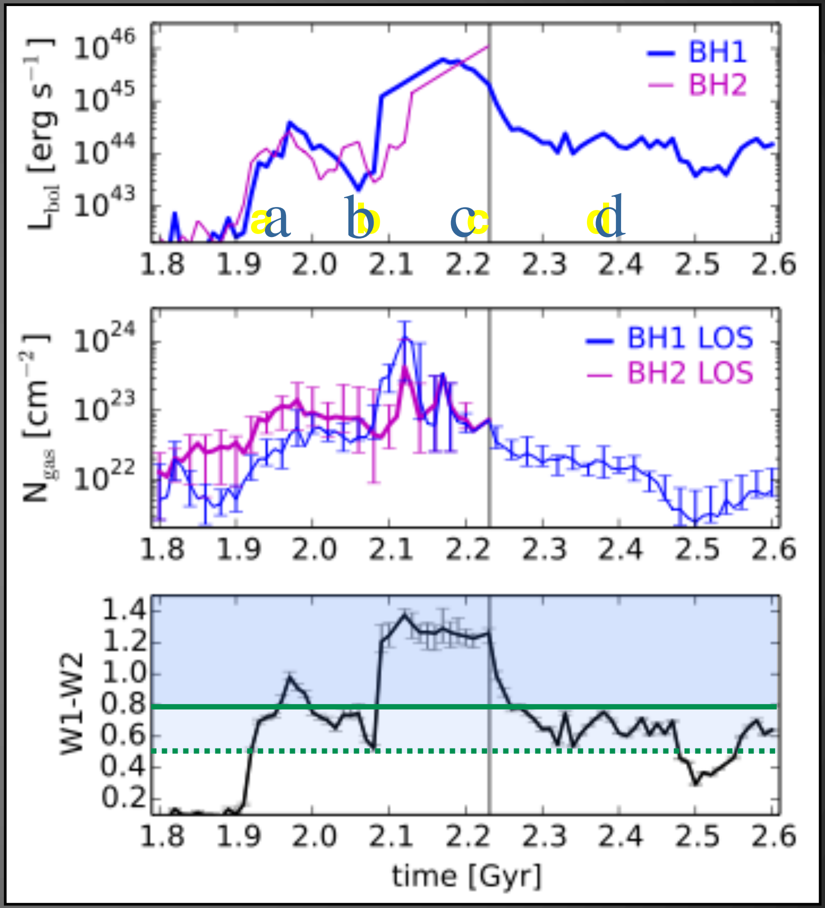
Optically-selected AGN are slightly UNDER star forming

mid-IR-selected AGN are OVER star forming

Ellison et al. (2016)

Mergers preferentially related to obscured AGN: simulations





Blecha et al. (in prep)

Growing supermassive black holes in the late stages of galaxy mergers are heavily obscured

C. Ricci[1,2,3★], F. E. Bauer[1,2,4,5], E. Treister[1,2], K. Schawinski[6], G. C. Privon[1,2], L. Blecha[7], P. Arevalo[8], L. Armus[9], F. Harrison[10], L. C. Ho[3,11], K. Iwasawa[12,13], D. B. Sanders[14], D. Stern[15]

ARE COMPTON-THICK AGN THE MISSING LINK BETWEEN MERGERS AND BLACK HOLE GROWTH?

Dale D. Kocevski[1], Murray Brightman[2], Kirpal Nandra[3], Anton M. Koekemoer[4], Mara Salvato[3], James Aird[5], Eric F. Bell[6], Li-Ting Hsu[3], Jeyhan S. Kartaltepe[7], David C. Koo[8], Jennifer M. Lotz[4], Daniel H. McIntosh[9], Mark Mozena[8], David Rosario[3], Jonathan R. Trump[10]
Department of Physics and Astronomy, Colby College, Waterville, ME 04961

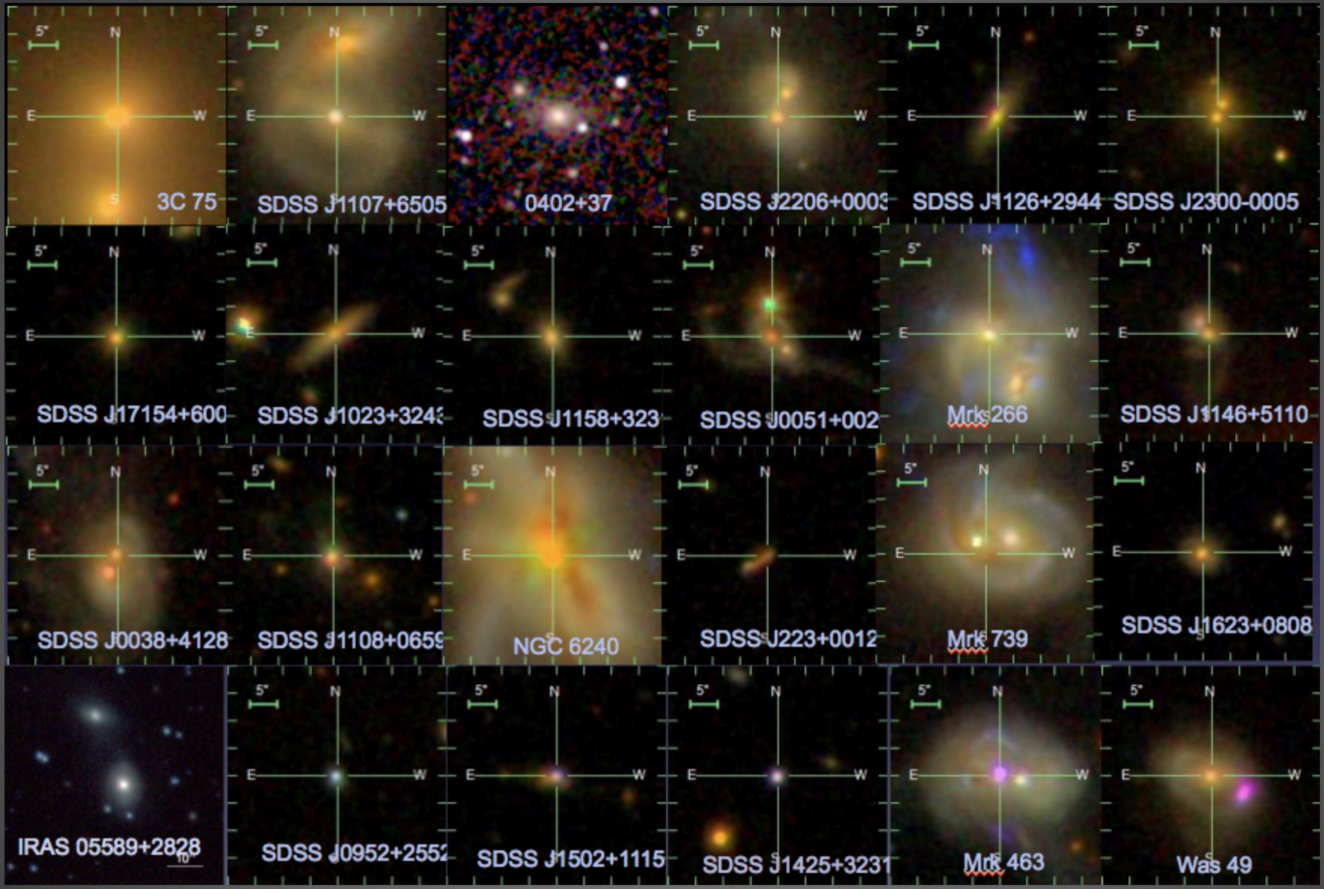
Draft version September 15, 2015

A NEW POPULATION OF COMPTON-THICK AGN IDENTIFIED USING THE SPECTRAL CURVATURE ABOVE 10 KEV

Michael J. Koss[1,2,18], R. Assef[3], M. Baloković[4], D. Stern[5], P. Gandhi[6], I. Lamperti[1], D. M. Alexander[7], D. R. Ballantyne [8], F.E. Bauer[9,10], S. Berney[1], W. N. Brandt[11,12,13], A. Comastri[14], N. Gehrels[15], F. A. Harrison[4], G. Lansbury[7], C. Markwardt[15], C. Ricci[9], E. Rivers[4], K. Schawinski[1], E. Treister[16], C. Megan Urry [17]

Draft version April 28, 2016

The final stages of the merger sequence: the hunt for dual AGN



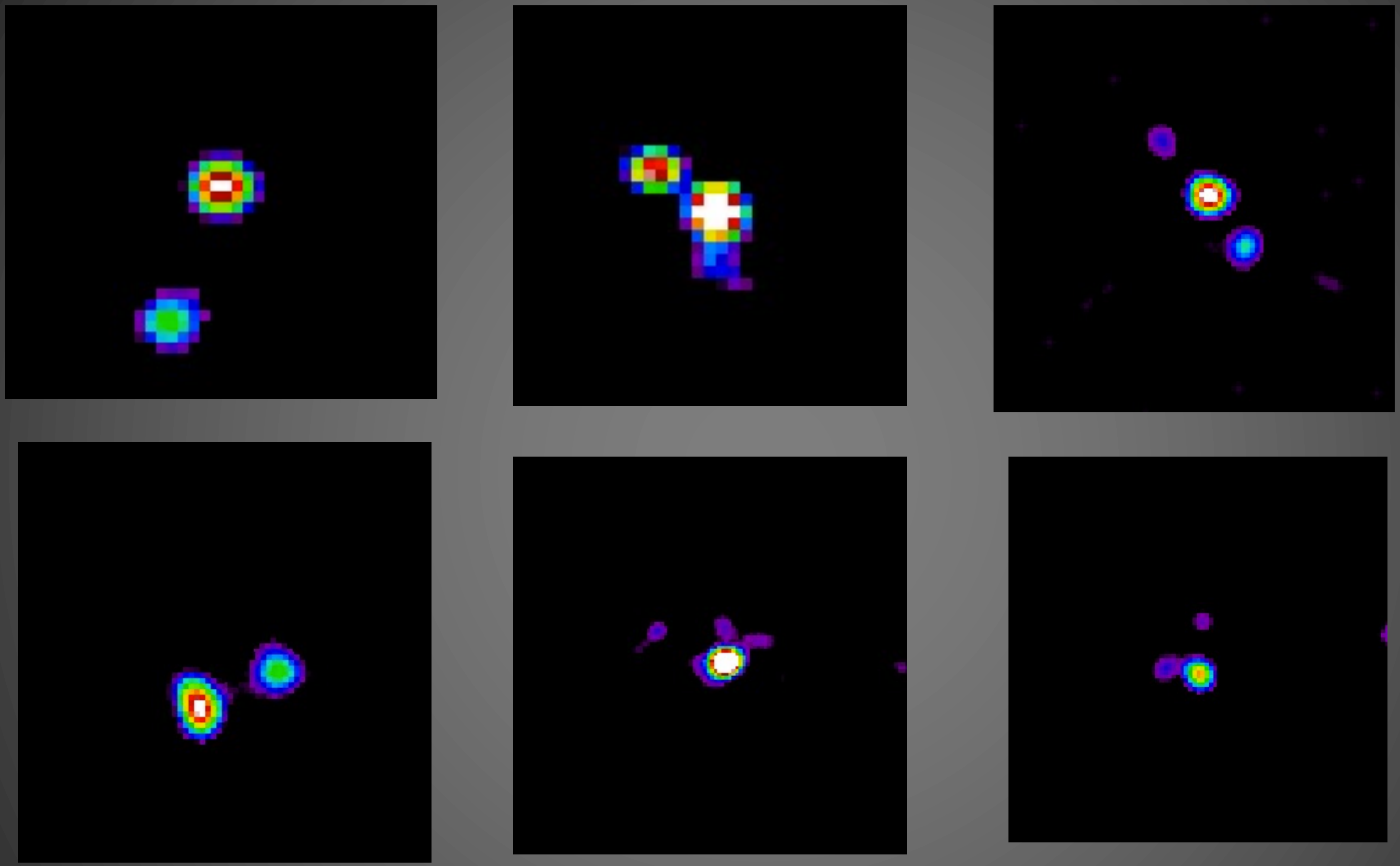
Small number of dual (r<10 kpc) AGN known. Most discovered serendipitously in X-rays or radio. Targeted searches (e.g. dual peak emission lines) largely unsuccessful.

The search for binary AGN: a pilot study with Chandra

6 mergers from SDSS selected to have red WISE colour: W1-W2>0.5.
All are classified as SF or composite on BPT diagram.

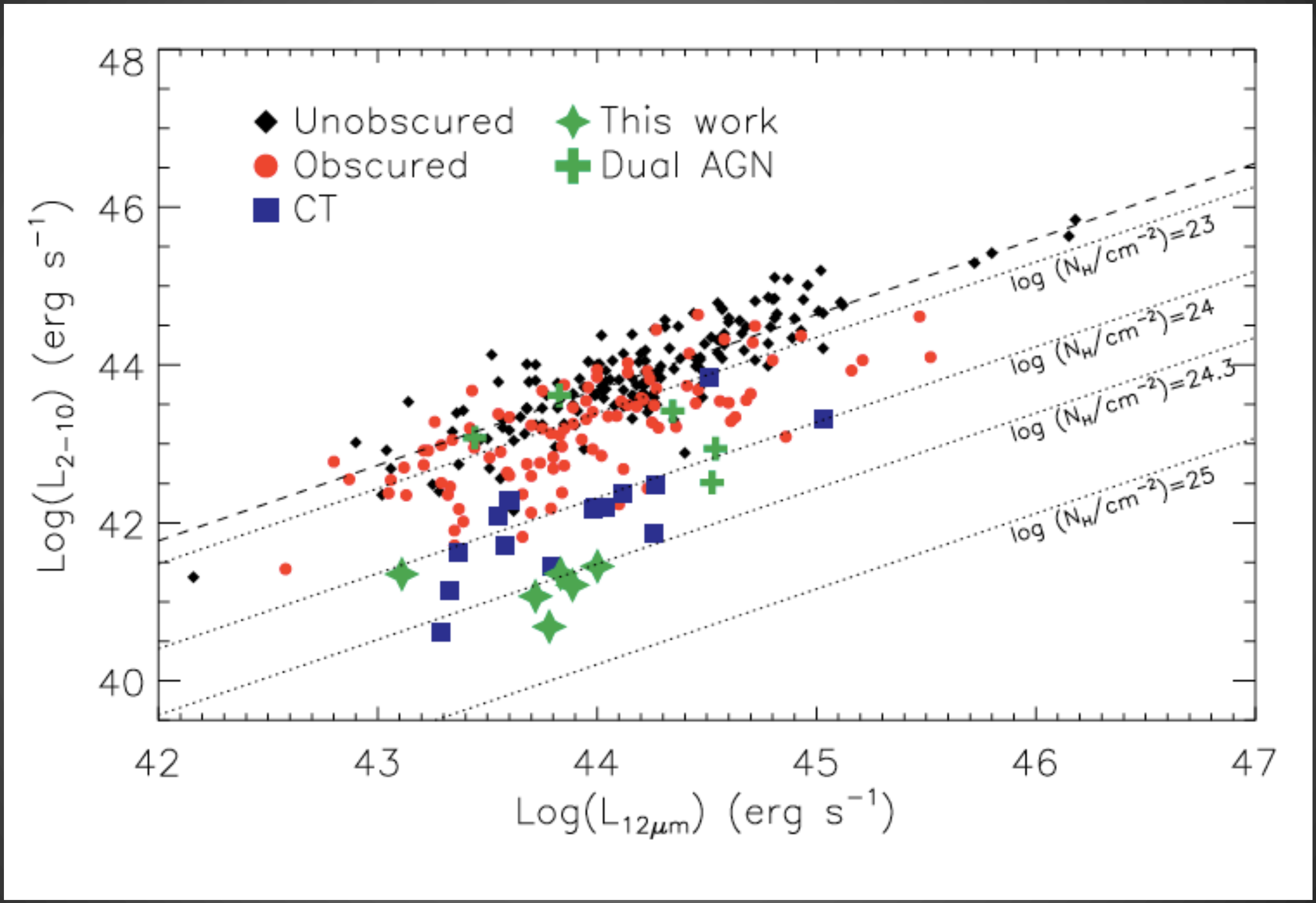
The search for binary AGN: a pilot study with Chandra

Satyapal, Secrest, Ricci, Ellison et al. (2017, submitted)



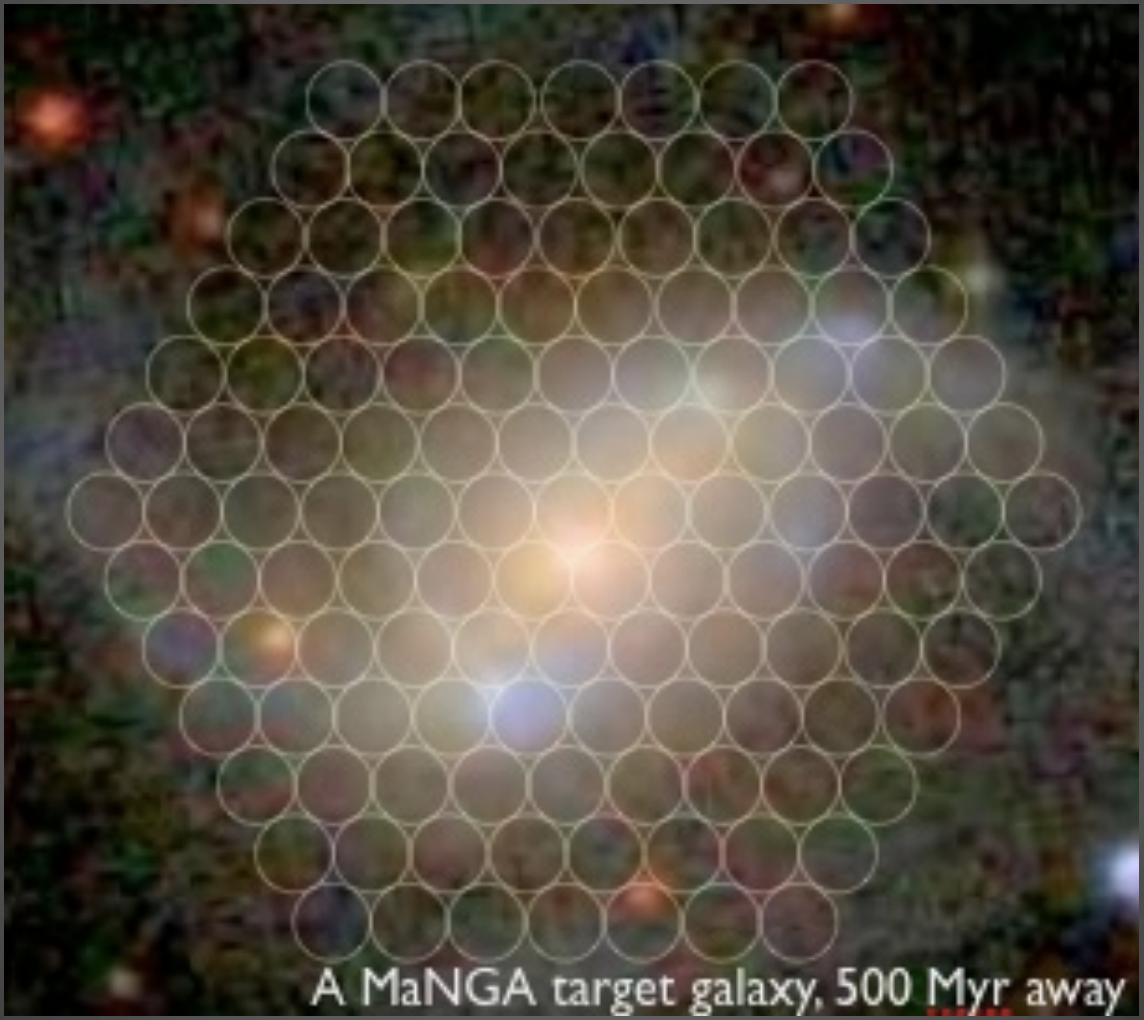
4/6 mergers (r_p <10 kpc) with WISE AGN colours identified as dual AGN candidates with Chandra, increase number of close dual AGN confirmed in X-rays by 50%.

WISE mid-IR selected duals tend to be highly absorbed

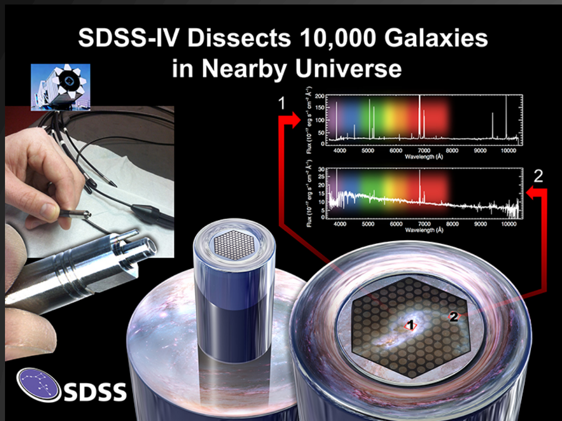


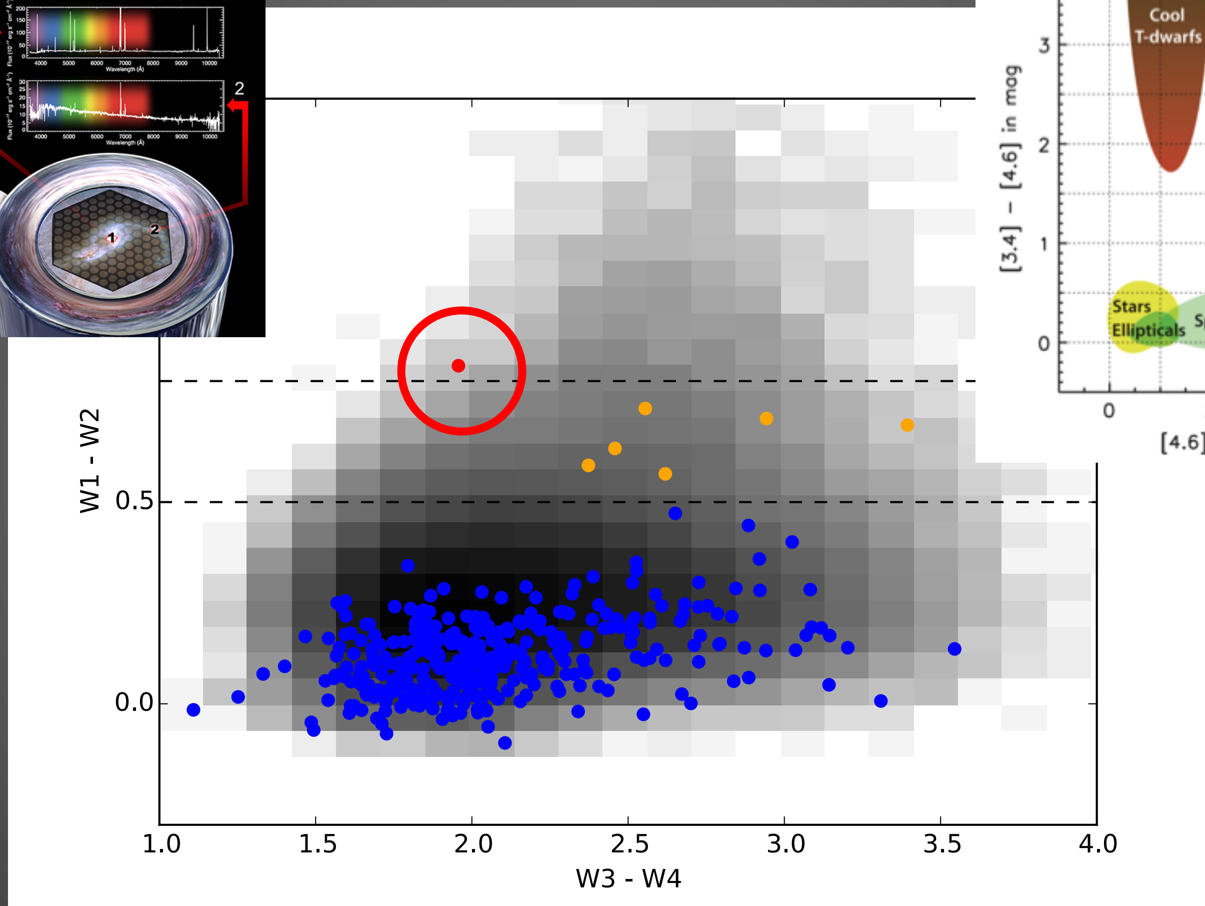
Satyapal, Secrest, Ricci, Ellison et al. (2017, submitted)

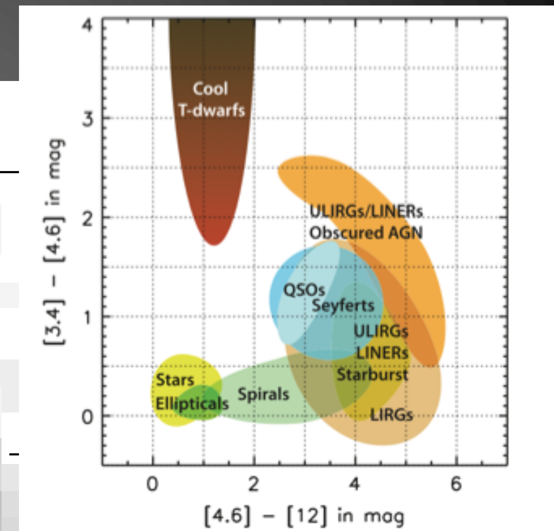
Finding dual AGN with IFU spectroscopy.



Combining MaNGA (SDSS-IV) with WISE

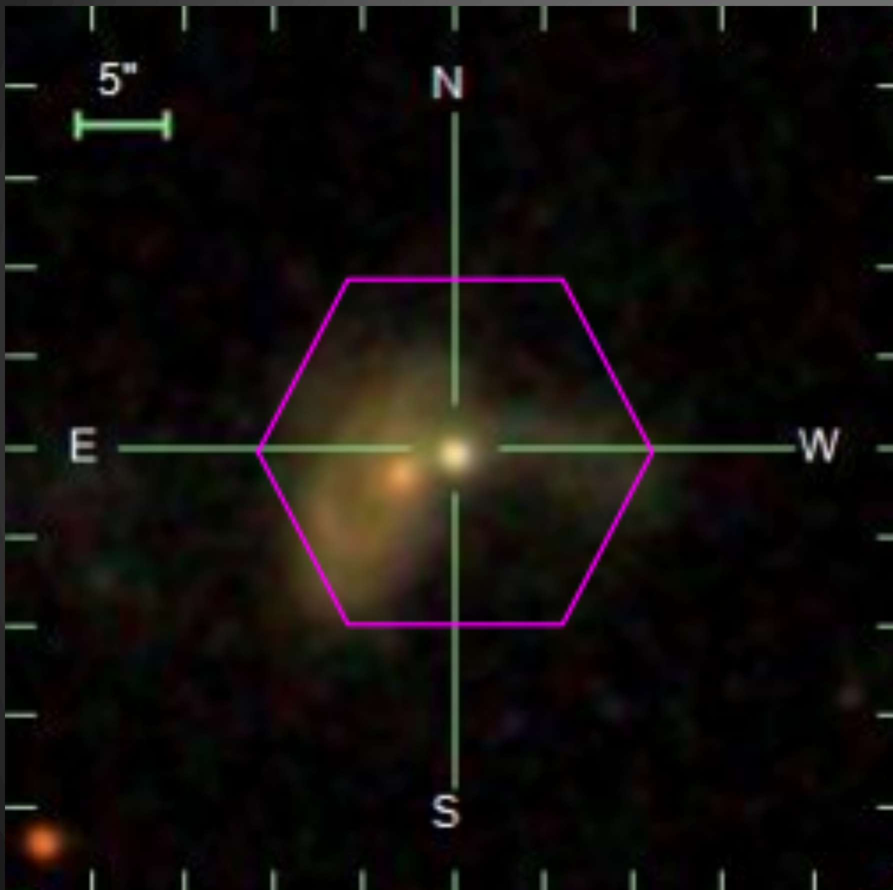


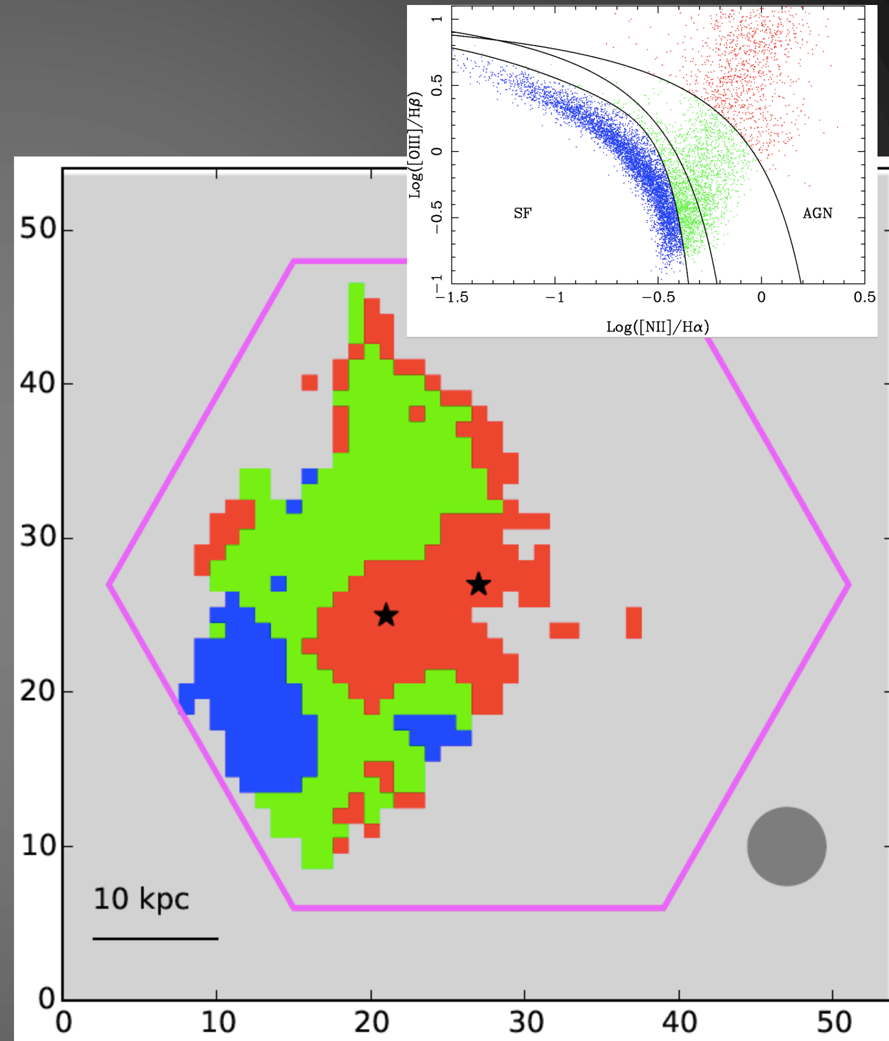




First public release of MaNGA data in July 2016, as part of SDSS IV DR13 ~ 1400 galaxies.

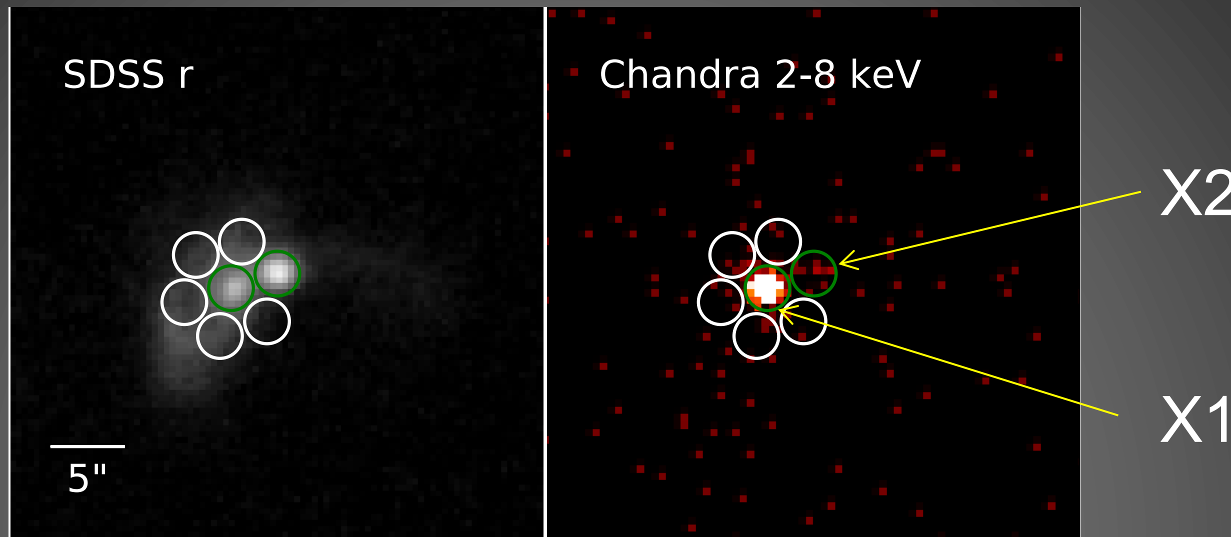
Combining MaNGA (SDSS-IV) with WISE





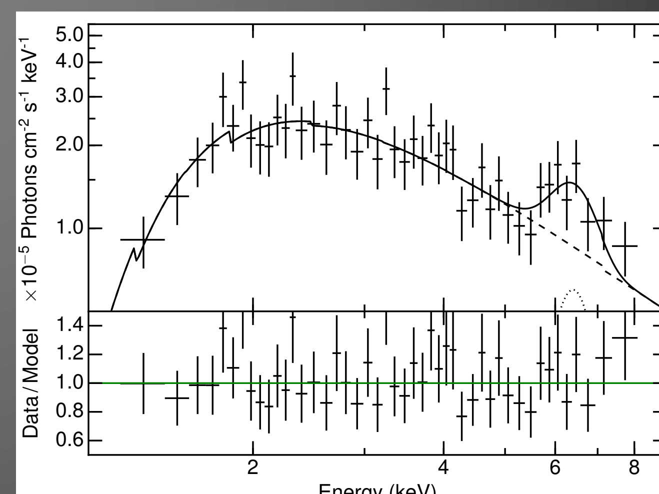
Ellison et al. (2017)

Dual AGN with 8 kpc separation confirmed with 30 ks of Chandra DDT time.



X1: Log L_X = 4×10^{43} erg/s
X2: Log L_X = 4×10^{41} erg/s

X1 fit: Gamma = 1.6,Log N_H = 2×10^{22} cm^{-2}



Ellison et al. (2017)

Summary

- Mergers can trigger AGN, and enhance their accretion rate. Ellison et al. (2011, 2013).

- IR selected AGN more prevalent in mergers than optically selected AGN – mergers more frequently to lead to obscured AGN. Satyapal et al. (2014)

- Mergers are ***not*** responsible for most low excitation (low luminosity) RL-AGN Ellison, Patton & Hickox (2015).

- AGN host galaxies have different star formation rates depending on their selection technique. Ellison et al. (2016)

- IR selection very effective for finding dual AGN (which are often highly obscured). We have increased the number of X-ray confirmed dual AGN by over 50%: Satyapal et al. (2017), Ellison et al. (2017).