

Unveiling Multiple AGN activity with multi wavelength observations

Alessandra De Rosa INAF/IAPS & MAGNA team

Stefano Bianchi, Tamara Bogdanovic, Jochen Heidt Ruben Herrero-Illana, Bernd Husemann, Stefanie Komossa, Nora Loiseau, Matteo Guainazzi, Zsolt Paragi, Miguel Pérez-Torres, Enrico Piconcelli, Cristian Vignali

AGN13: Beauty and the Beast - Milano 9-12 Ottobre 2018

rationale

BIG QUESTIONS: THE ROLE OF MERGERS TRIGGERING AGN ACTIVITY AND STAR FORMING ARE QUASARS MERGERS OF TWO RICH-GAS GALAXIES?

QUASAR PAIRS ARE IDEAL PROBES OF THE LARGE-SCALE ENVIRONMENT, MERGERS ARE MORE LIKELY TO OCCUR Tremaine+2002, Volonteri+2003 Di Matteo+2005, Hopkins+2006, Mayer2013, Djorgovski +2006, Liu+2011, Farina+13 Hennawi+2015

background

- strong interactions are not more common in AGN with respect to normal galaxies (Cisternas+2011, Gabor+2009,)
- No trend of merger incidence with AGN luminosity(CANDELS) Villforth+014,+2016
- Heavily obscured quasar z=2 are disk not mergers (Schawinski+2012)
- AGN fraction in close pairs increases with decreasing separation (Ellison+11, Silverman+11, Koss+10, Satyapal+14)
- heavily obscured or reddened AGN have very high incidences of merger features (Kocevski+2015, Weston+2017, Urrutia+2008, Fan+2016, Ricci+17)
- galaxies with enhanced sSFR have a higher obscured AGN fraction: evolutionary phase in gas-rich mergers? (Juneau+2013)

Q: which merger increases AGN activity?

Idealized simulations



✓ not all AGN activity is merger driven, however the merger stage enhances the AGN activity
 ✓ AGN trigger strongly depends on how effective physical processes are in inducing the gas to lose angular momentum

Idealized simulations: Fraction of dual AGN Capelo+15

AGN when log Lx>42.2

20-30 % in major mergers, 1-10 % in minor mergers

smaller galaxy responds more strongly (i.e. in terms of Edd. enhancement) than bigger galaxy

gas obscuration changes the dual AGN lifetime by at most a factor of two



Cosmological simulations. Merger fraction



lack the required resolution to reliably follow the dynamics and accretion of BHs below kpc scales. Comparison between AGN and non-active pairs

Cosmological & Idealized simulations agree on:

- The probability of dual AGN increases with decreasing BH separation
- The BH mass ratio changes significantly during the merger: very unequal BH pairs, with an initial q ≤ 0.25, tend to evolve towards higher q, whereas pairs with an initial q > 0.25 tend to increase the BH mass contrast.
- Dual AGN require large gas reservoir

Optical selection (Yan+11, Ellison +11,13): AGN emission lines often hidden by star formation or dust. Requires high SNR optical spectra to subtract host galaxy light





Mid-IR selection (Satyapal+14) Interlopers include other luminous IR galaxies, hi-z galaxies Gas-rich mergers more likely to be strong IR emitters

X-rays < 10 keV. AGN population lost due to heavy absorption. Ultra-hard x-rays (14-194 keV) (Koss+12) Unbiased sample of local AGNs, but limited to z < 0.1 Still misses the truly Compton-thick AGNs



How can we convincingly identify a dual AGN system?

MAGNA

observation of SMBHs during different stage of merging is challenging

Objective: MAGNA goal is the first systematic study of a well defined sample of multiple SMBHs using multiband information

http://www.issibern.ch/teams/agnactivity/Home.html

small questions

What is our current understanding of candidate selection methods and their reliability to pick up true (confirmed) dual AGN?

How many of the dual AGN are subject to multiple observational tests, and how many of those pass or fail?

Ubiquity of AGN in interacting galaxies.

Possible indicators to predict detections, even for weak or obscured AGN.

dual AGN (candidate) - selection

1286 AGN systems optically classified (SDSS, Liu+2011)
Sy-Sy systems through emitting line diagnostic - BPT diagram
Max proj. dist = 60 kpc (only interacting systems)
Final sample of 17 Systems: Proj. dist ≈ 10-60 kpc z≈0.03-0.17
Large separation systems ang sep. >10": XMM 5 systems (~200 ks) + 10 systems with VLA

Close separation systems ang sep. < 10" VLA (proposed); LBT: 8 sources (2 LBT+VLA, 1 Chandra + VLA + LBT)





De Rosa & MAGNA 2015

AGN fraction with logLx>42.2 is 60%, higher with respect to CG of similar stellar mass and MB (~20-40% Silverman+2011,2014)

MUSE-IRAM30m-VLA



Herrero-Illana & MAGNA in prep.



<u>A strong galactic wind in the ionized</u> gas perpendicular to the gal disk A prominent ionized gas region to the SW, possibly indicative of <u>a gas</u> <u>outflow</u> BPT: AGN-dominated region and the SW component in the <u>SFR</u> kinematic distortions in the ionized gas velocity field indicative of a recent merger

AGN jets on 1-100 pc scales / jet-induced star formation The HI content and kinematics in group members and intragroup medium (VLA) The amounts of neutral (VLA HI) and ionized (MUSE Ha & [O iii]) - feedback

Dual AGN: Absorption De Rosa & MAGNA+18

Four systems in earlymerging phase, galaxies separation 30-60 kpc observed with XMM and optically selected

comparison with dual/ multiple AGN systems with X-ray measurement of Nh

otpical/X-ray/IR selection

Guainazzi+05; Bianchi+08; Piconcelli+10; Liu+13; De Rosa+15; Koss+12, Ricci+17;



Fraction of AGN in dual/multiple systems with Nh>10²² cm⁻²

Average single AGN 46+-3% (Ricci+15)

dual/multiple 84+-4%

Nh values are in good agreement with numerical simulations (Capelo+17, Blecha+17) BUT their absorption resolution are at resolution of 50 pc scale (it should be considered a lower limit)



AGN-galaxy pairs: absorption properties

- ✓ Parent sample: SDSS AGN/no-AGN pairs (Liu+2011)
- ✓ Separation 5-100 kpc (≥15")
- ✓ Correlation with 3XMM: 55 sources
- ✓ ~0% are dual ~100% X-ray sources are the (SDSS-classified) AGN
 - Average single AGN 46+-3% dual/multiple 84+-4% galaxy-AGN: 52+-7%



dual AGN at close separation

Husemann & MAGNA in preparation



- ✓ larger SDSS fibers and the beam smearing of light due to seeing the fainter nucleus is contaminated by the primary
- ✓ MODS-LBT data high spatial resolution reveal/confirm dual AGN at closer separation (d- 3-10 kpc)
- ✓ AGN in the secondary nucleus, it is likely to be of much lower luminosity

summary

multiple observational tests needed to confirm dual/multiple AGN detections

- •the 'environment' of dual AGN systems is different wrt isolated AGN, namely more obscuring than that of isolated AGN
- •galaxy-AGN pairs have absorption properties simular to isolated AGN
- •simulation higher resolutions to map gas at smaller scales (pc separation from the BH)

Work in progress:

on-going VLA study of AGN pairs at very high angular resolution at 5 and 10 GHz: core-jet structures and environments

chandra data for systems at closer separation (<10") + LBT MODS

"Remark: galaxy spectra are not power-laws with emission lines on top!" optical astronomer's cit.