No merger-AGN connection since $z\sim1$

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Galaxy-Black Hole Coevolution

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0 summary

We are trying to solve the age-old question: what is the relevance of mergers and interactions as triggering mechanisms for AGN activity? For an answer we analyse the so far largest sample of 140 massive AGN host galaxies over z ~ 0.3-1.0 with high-resolution HST/ACS imaging (from the COSMOS field, Scoville et al. 2007). A visual analysis of their morphologies by 10 independent human classifiers yields a fraction of distortions as signs for recent mergers, potentially responsible to the AGN fueling/triggering. Comparing this distortion fraction to a matched control sample of inactive galaxies from the same dataset we find that (i) the majority (>80%) of AGN host galaxies is completely smooth/symmetric, and (ii) there is no significant difference in distortion fraction between AGN hosts and inactive galaxies. Our findings provide the best direct evidence that, since z~1, the bulk of the black hole accretion is occurring by secular triggers.

1 data

The COSMOS Survey features the largest contiguous area (2 deg^2) ever imaged with the HST, with a large complementary multiwavelength coverage from X-ray to radio. X-rays are one of the best ways to detect the emission of the accreting BHs. The XMM-COSMOS Survey (Hasinger et al. 2007) is the prime source for ~1000 AGN, 140 at z<1.0 and with $M_* \leq 10^{11.5}$ M_{SUN}, subsequently confirmed as type-1/2 from spectroscopic surveys and SED fitting.

2 our approach

Our analysis can be decomposed in 2 main aspects:

I) Comparison Sample

Studying distortions as signs for merger triggering AGN needs a direct comparison sample of inactive galaxies. Relevant is the enhancement of distortions for AGN, not the absolute fraction. Our study is unique in this respect, since we can draw ~10 inactive galaxies for each AGN host galaxy from the same HST dataset, matched in redshift and brightness. Only this allows comparing apples to apples.

II) Visual Classification

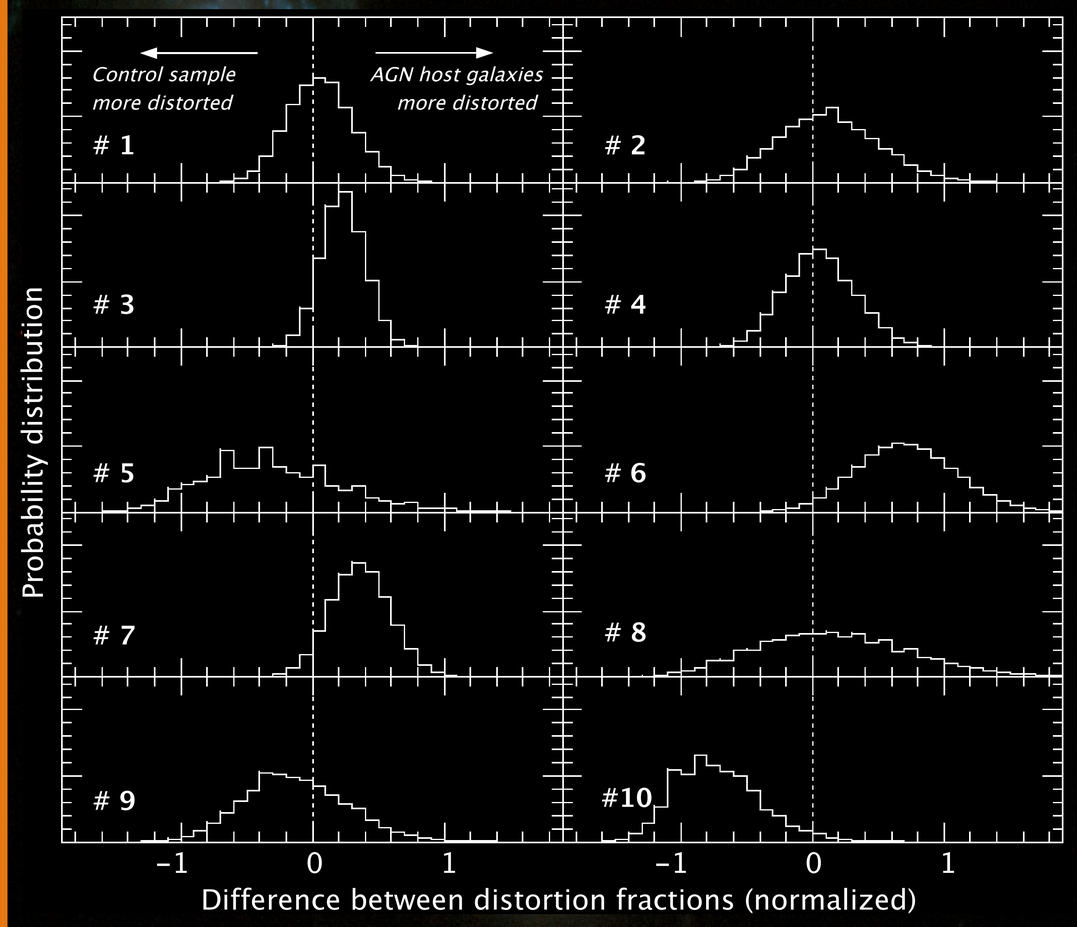
We inspect the morphologies of our AGN and inactive galaxies visually, for robustness by 10 people†, searching distortions, merger signatures, and interacting systems. This is done as a blind study, mixing AGN hosts and inactive galaxies, to avoid biases.

† besides the authors (MC, KJ, KI), the other classifiers are:
J. Kartaltepe (NOAO), M. Scodeggio (INAF IASF Milano), J.T. Trump (Steward Observatory), T. Lisker (ARI Heideberg), A.R. Robaina (MPIA), A.M. Koekemoer (STScI), and K. Sheth (Caltech).

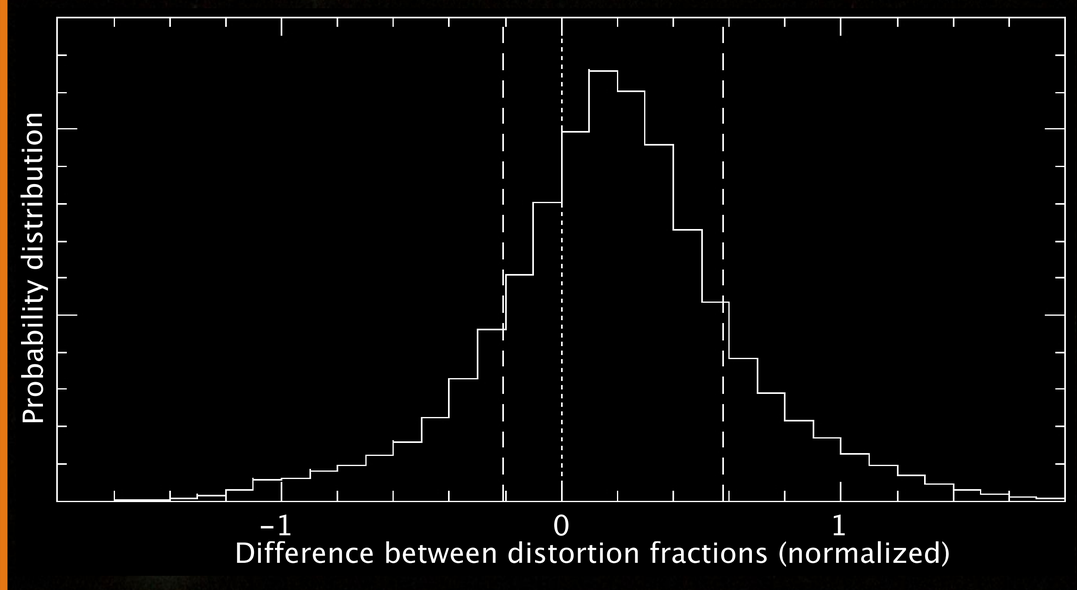
3 results & discussion

As expected, the absolute merger fractions vary from person to person, due to differences in internal calibration, but this has no effect on the main question, whether AGN have a higher distortion fraction compared to inactive galaxies.

Below we show the difference in distortion fractions between AGN hosts and inactives, normalized by the mean distortion fraction, for each classifier. These probability distributions were computed by randomly sampling the (binomial) error distributions for distortion fractions in both samples each 1 million times. Here "0", marked with a vertical dotted line, means no difference in distortion fraction, "+1" that AGN have a twice higher distortion fraction.



The (Bayesian) combined probability distribution is a coaddition of the 10 measurements:



As we can see, the histogram is consistent with zero difference between the fractions. The central 68% confidence level is marked with vertical dashed lines.

Our result of zero enhancement in distortions shows that merging is not the dominant AGN triggering mechanism since z~1 at stellar masses up to $10^{11.5}$ M_{SUN} since it occurs as frequently as in normal galaxies. Our work provides direct evidence for the scenario suggested by Hasinger (2008). Here, the major merger-driven evolution could dominate early in the universe, producing the bulk of the brightest quasars at z~2-3. However, around z~1, secular evolution and minor interactions take the lead, becoming the main fueling mechanisms.

references

- Hasinger et al. 2007, ApJS, 172, 29
- Hasinger 2008, A&A, 490, 905
- Scoville et al. ApJS, 172, 38

acknowledgements

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