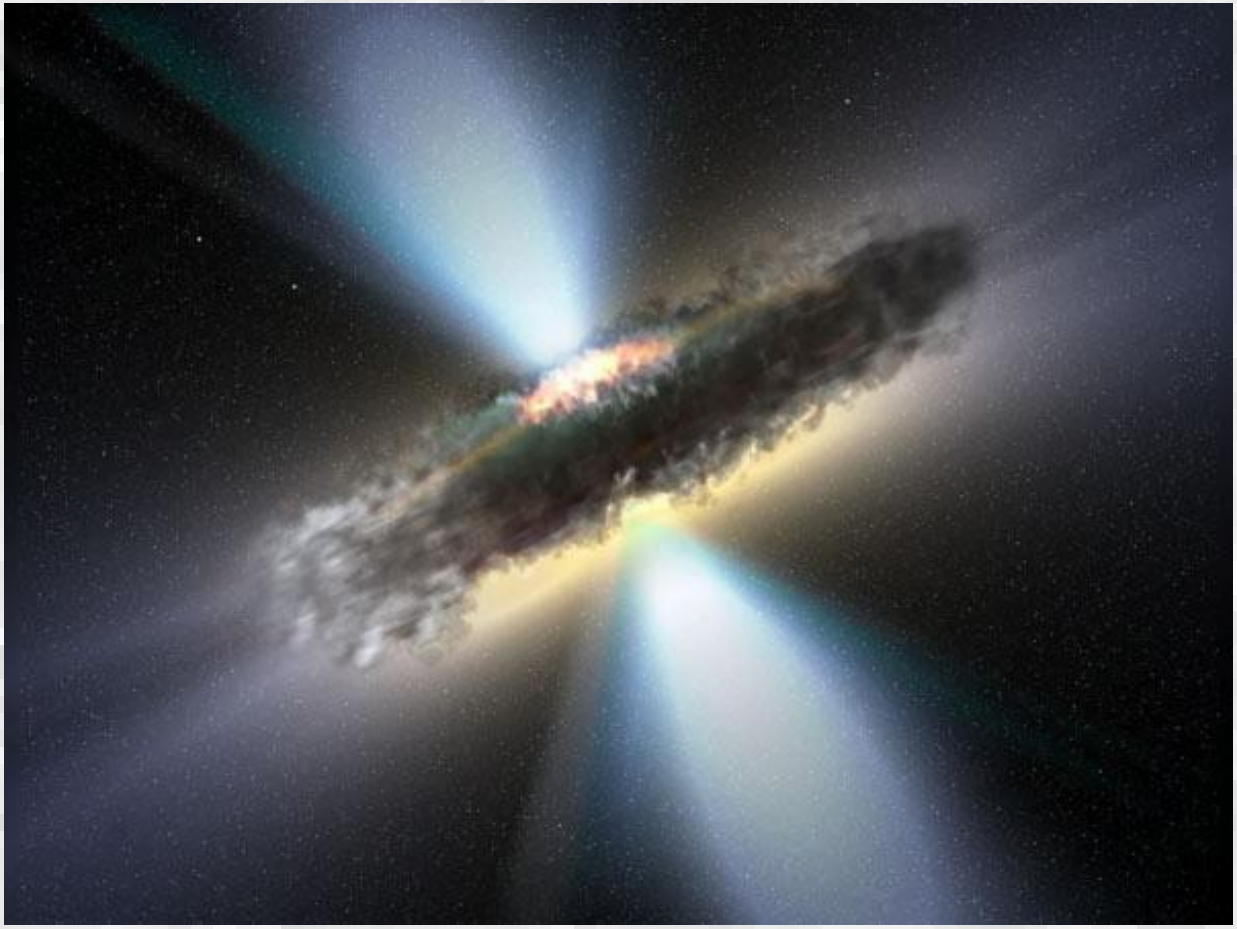
Using galaxy neighbours to probe the inner structure of AGN



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2012 preprint at arXiv:1211.0528

– Outline –

nature physics

LETTERS

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The different neighbours around Type-1 and Type-2 active galactic nuclei

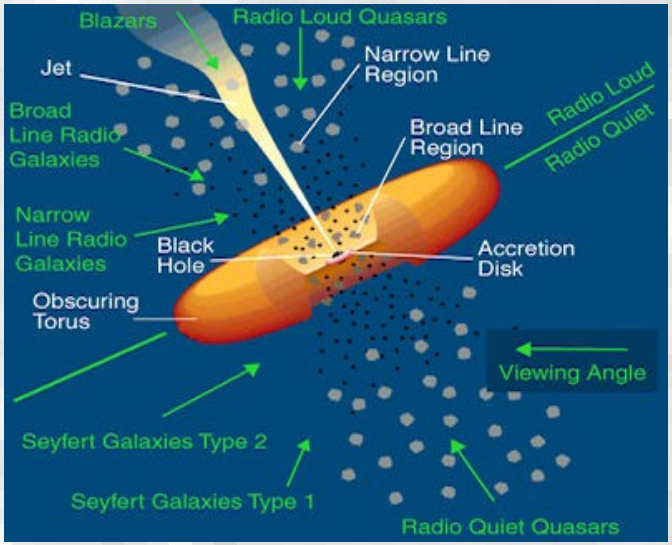
Beatriz Villarroel[1,2*] and Andreas J. Korn[1]

One of the most intriguing open issues in galaxy evolution is the structure and evolution of active galactic nuclei (AGN) that emit intense light believed to come from an accretion disk near a super massive black hole[1,2]. To understand the zoo of different AGN classes, it has been suggested that all AGN are the same type of object viewed from different angles[3]. This model—called AGN unification—has been successful in

So are Type-1 and Type-2 AGN truly representing the same kind of object?

The main idea of our hypothesis is that if Type-1 and Type-2 AGN are intrinsically the same objects, only viewed from different angles, their neighbours should, in a statistical sense, not differ systematically. On top of this, the AGN should interact in similar ways with them.

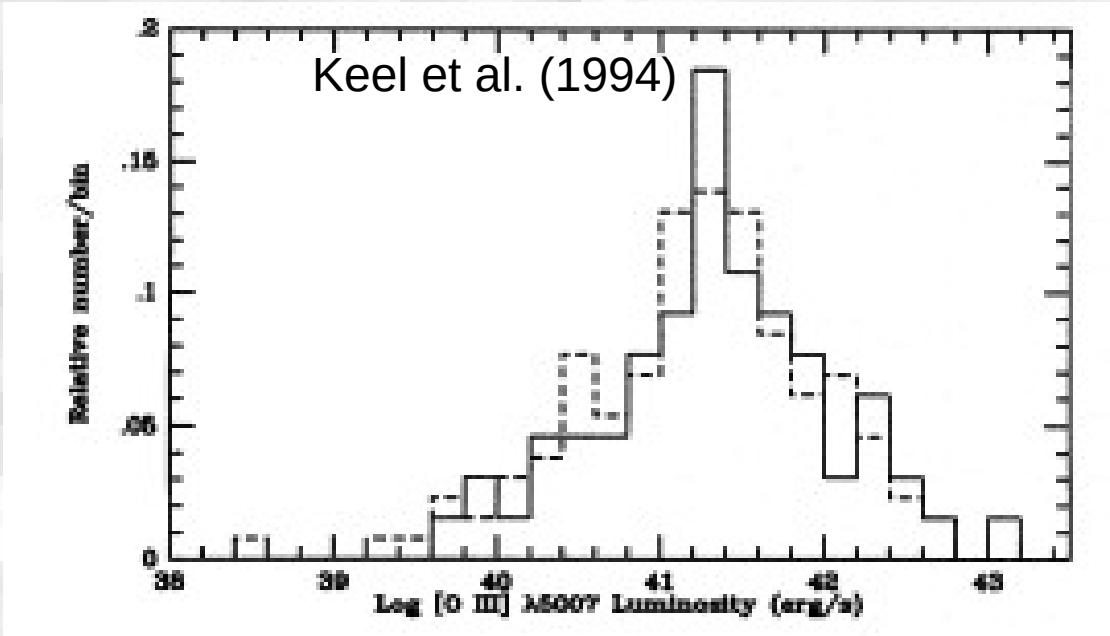
The viewing angle-dependent AGN unification



- Separate for radio-loud and radio-quiet.
- Successful predictions of polarized broad-line regions, ionization cones, high excitation lines, torus.
- Predicts that L[Oiii] is isotropic.

V1: "All Type-1 and Type-2 AGN are the same type of object just viewed from different angles through the dust torus."

V2: "A Type-2 AGN is a Type-1 AGN viewed through some dust."



What are the limitations of the AGN unification?

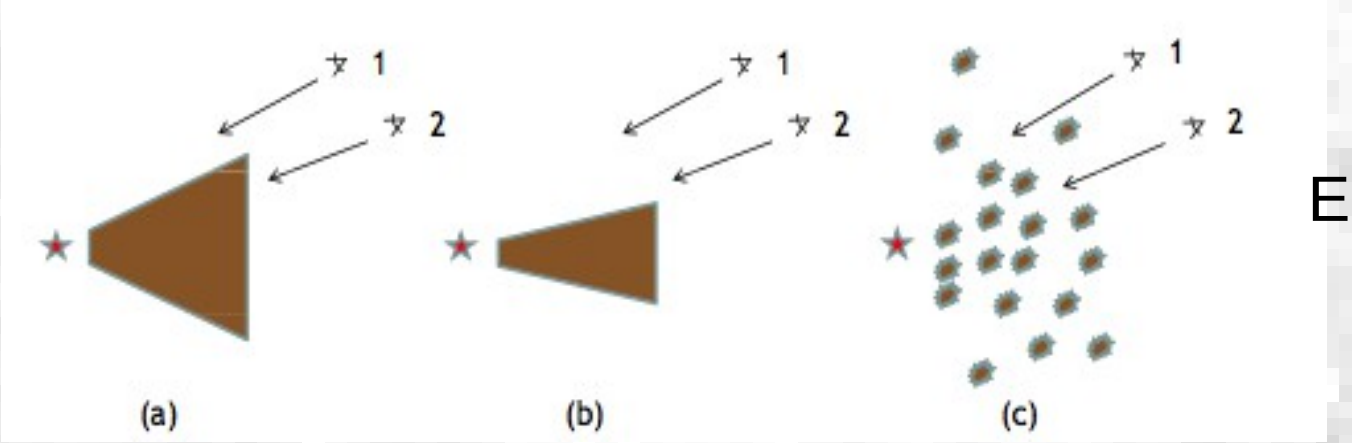
The model is a widely accepted assumption but some issues remain:

- -Clustering of satellites: the companion counts differ (Dahari 1984, Laurikainen & Salo 1995, Dultzin-Hacyan et al. 1999).
- -What about the 50% Type-2 AGN without hidden broad-line region? (Tran 2001, Tran 2003)
- -And the morphology-AGN type connection, variability, low-luminosity AGN, torus,...(fill in)

- Are Type-1 and Type-2 AGN fueled and formed the same way?

Complications of statistical tests

Clumpy torus. (e.g. Tristram et al. 2007)
Individual covering factors > selection biases in intrinsic properties.



Elitzur (2012)

See also review by Antonucci 1993, 2012

– The Three Commandments – for statistical tests of the AGN unification

1. *"Thou shalt not use the name of the Type-1 or Type-2 AGN in vain; thou shalt always have optical emission line classification for them."*

- Type-1 AGN are Unobscured

  Type-2 AGN are Obscured
- <u>BUT</u> Unobscured are NOT Type-1 AGN!

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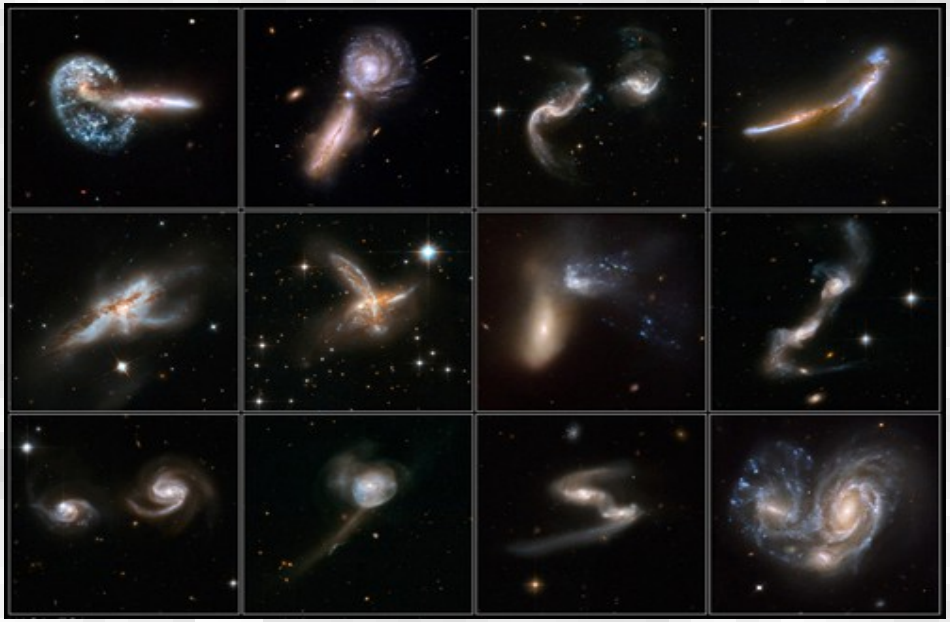
3. *"Remember the predicted L[OIII]5007 isotropy, to keep the narrow-line region holy."*

Method: statistics on neighbours instead!



Sloan Digital Sky Survey:

- AGN with at least one neighbour within projected distance of 350 kpc.
- Low redshift: $0.03 < z < 0.2$
- $|\Delta z|<0.001$, 0.006, 0.012 (spectroscopic-z) and $|\Delta z| < 0.03$ (photometric-z)

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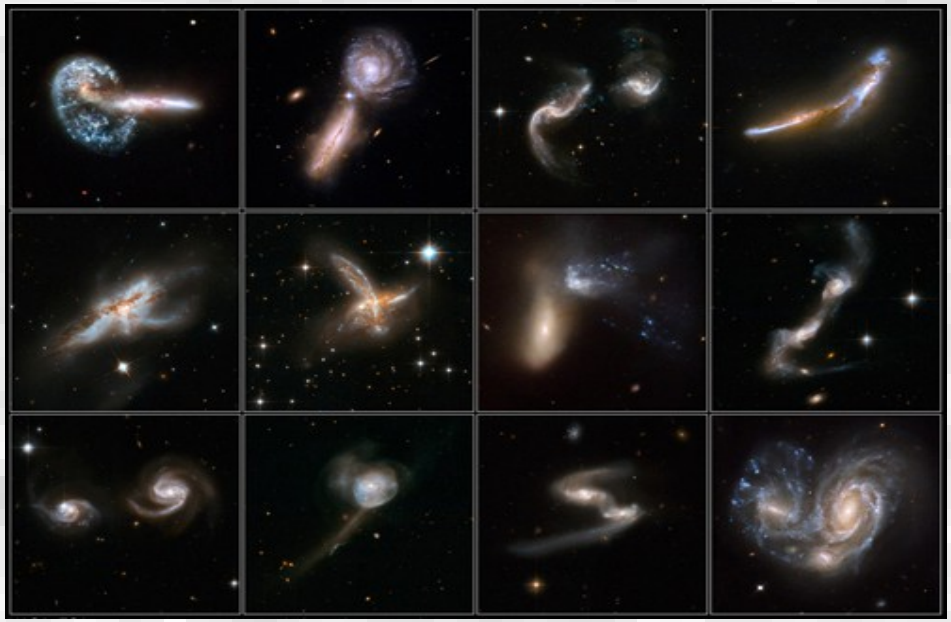

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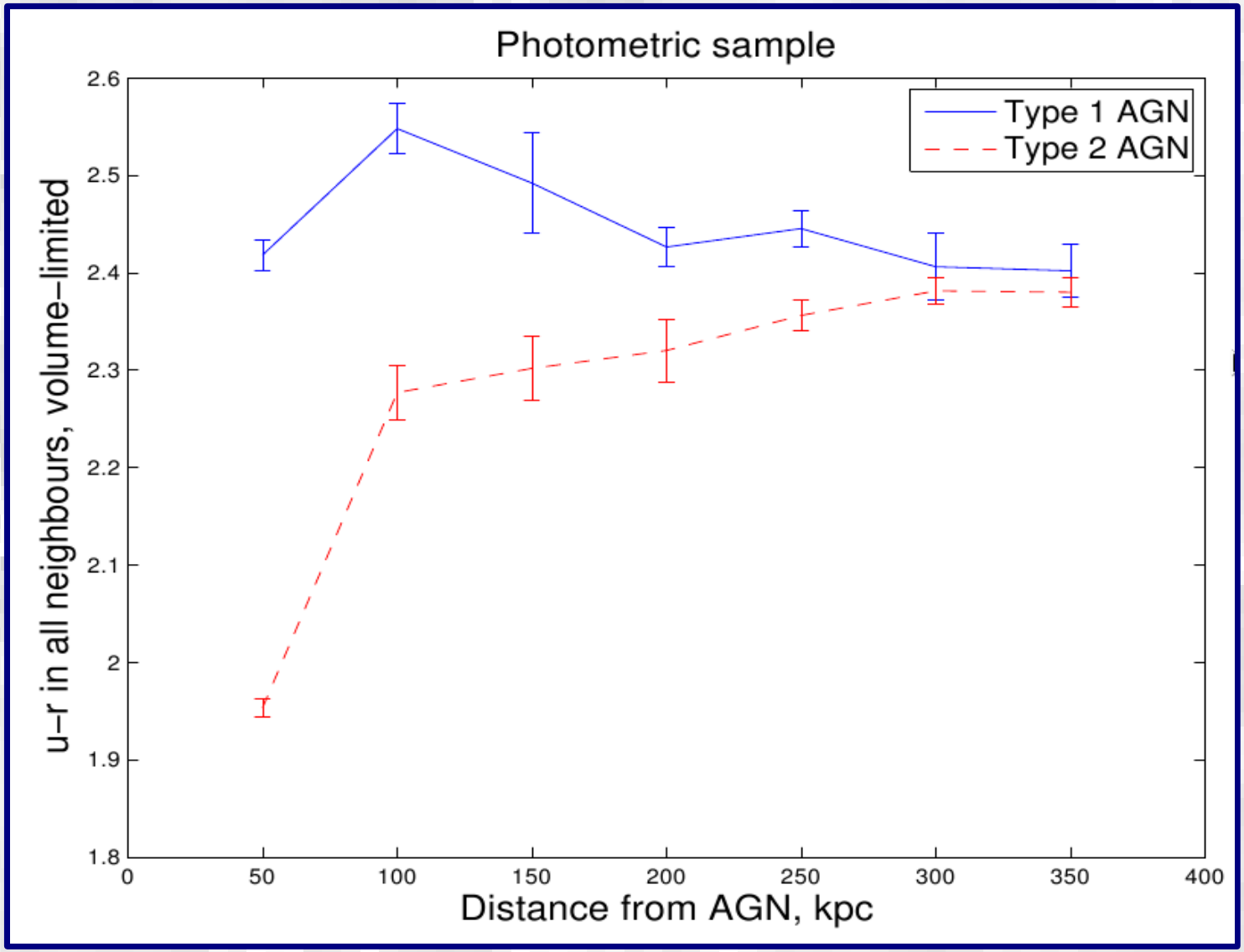
Spectroscopic pairs: 1658 Type 1 AGN-galaxy pairs; 5698 Type 2 AGN-galaxy pairs.

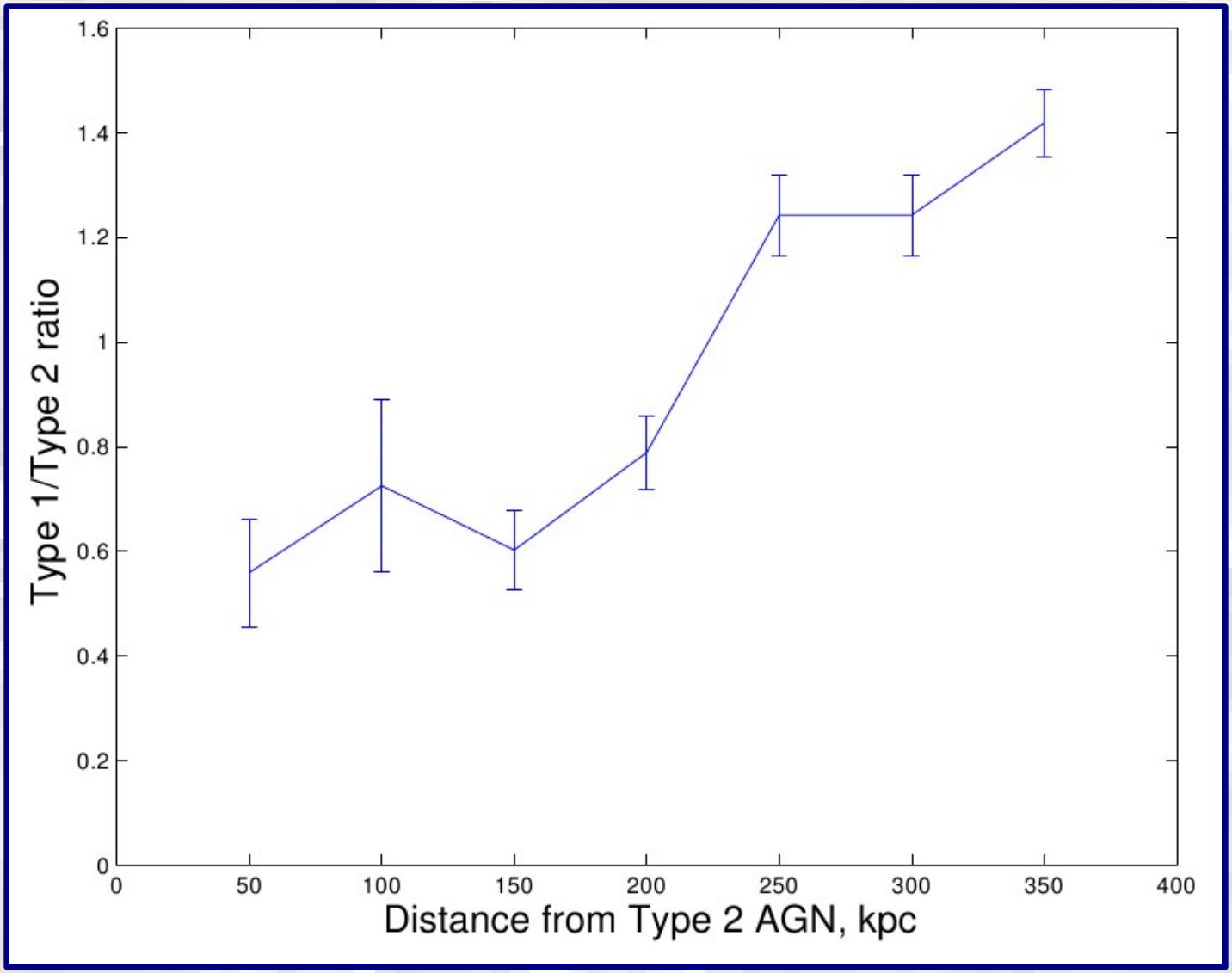
Photometric pairs: 13519 Type 1 AGN- galaxy pairs; 58743 Type 2 AGN-galaxy pairs.

Morphology of AGN host galaxies from the Galaxy Zoo project (Lintott et al. 2008, 2009, 2010, etc)

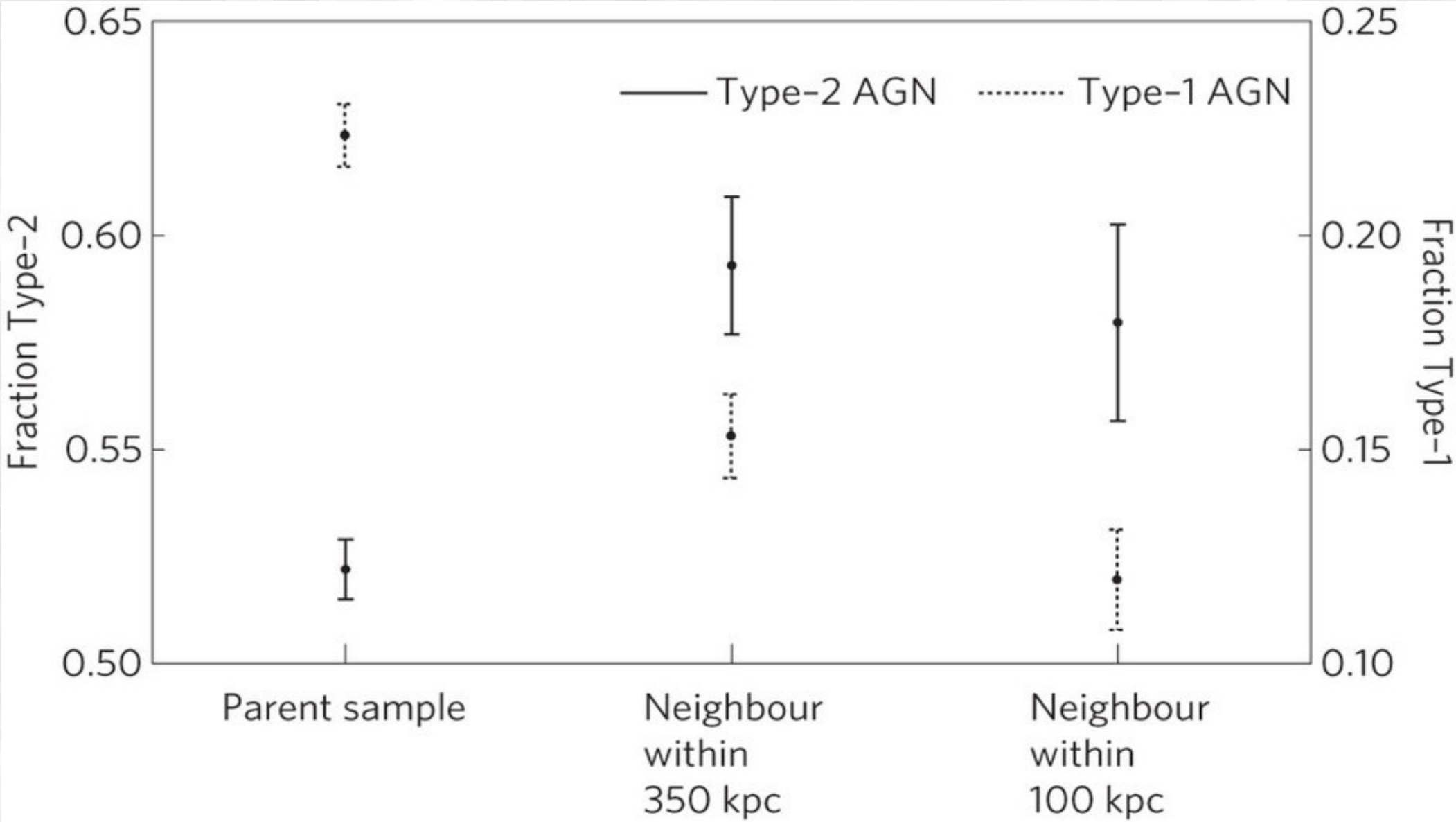
Color of neighbours



Number ratio of Type1/Type2-AGN neighbours to Type-2 AGN



Galaxy Zoo Morphologies



But hey!! Where the isotropy?

A Type-1 and Type-2 AGN at the same z, same host galaxy type and same L[OIII] must have the same mass.

1. Spiral (radio-quiet), face-on Type-1s and Type-2s.
2. For each Type-1, select the Type-2 with most similar redshift z and L[OIII]5007.
3. How are the neighbours now?

Type-1s and Type-2s have different neighbours – exactly as before.

Formulations: the viewing-angle dependent AGN Unification

1. “All Type-1 and Type-2 AGN are the same type of object just viewed from different angles through the dust torus.”

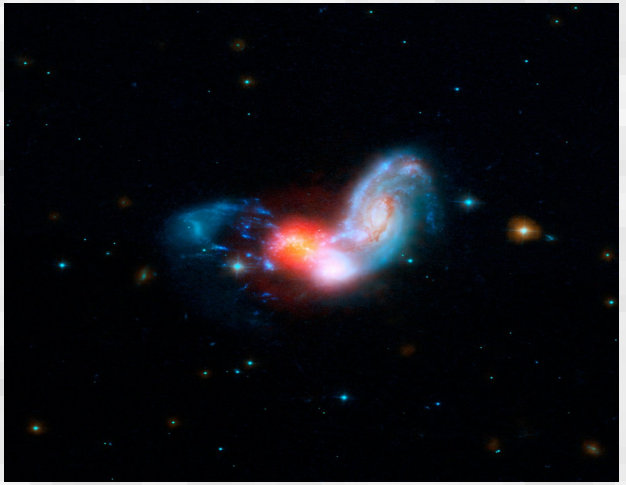
2. “A Type-2 AGN is a Type-1 AGN viewed through some dust.”

3. “A Type-1 AGN obscured by dust might look like a Type-2 AGN.”

– Or none of the above –

1. Pair of interacting/merging galaxies

2. Gasflows towards center: starburst ignition



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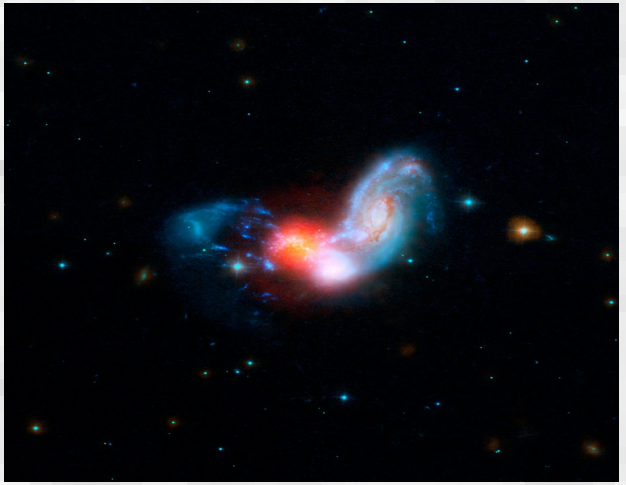

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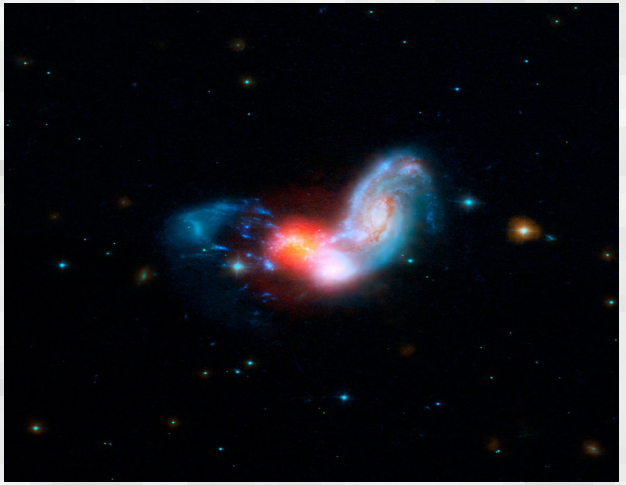

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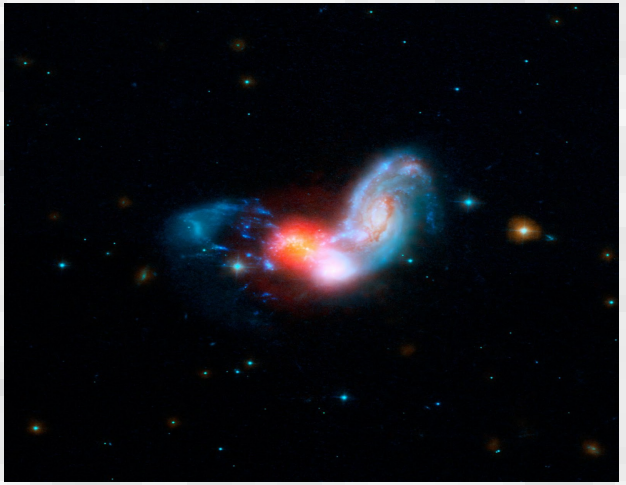

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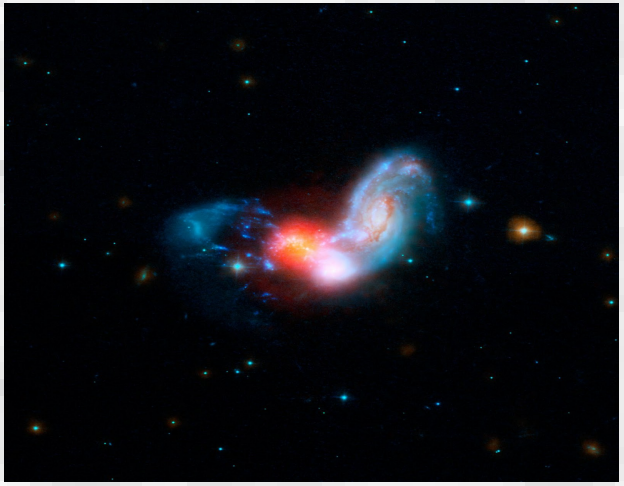

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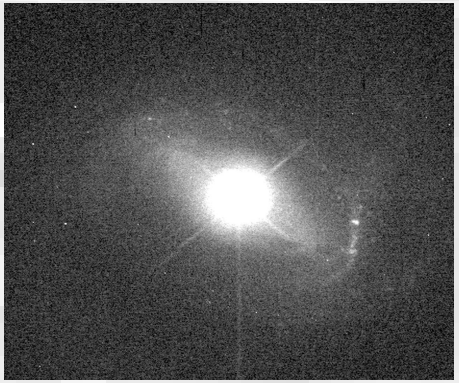

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6. Broad-line AGN with fewer gas-rich neighbours.

Summary

- Type-2 AGN “fragile” state?
  - The lack of Type-2 AGN in elliptical host galaxies.
- Type-2 AGN have many more gas-rich companions!
- Viewing angle, different covering factor, luminosity-bias from clumpy dust torus, bad measurements of emission line or morphology-dependence is not sufficient explanation to lack of statistical support for purely geometric AGN unification...or a mass bias **not** from the covering factor.

Thanks for your attention!!

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The hypothetical luminosity test 1

What luminosity bias is needed to reproduce the same neighbour colour distributions?

1. Assume geometric AGN unification and Gaussian distribution of the covering factor of the torus.

2. Define luminosity displacement E_dis=Mr,intrinsic- Mr,observed for Type-2 AGN.

3. What luminosity displacement in Type-2 AGN is needed to reproduce the following two properties:

   1) Same average color plus same color-distance dependence as

   Type-1 AGN with neighbours.

   2) Same morphology distributions as Type-1 AGN and reaction to nearby neighbour.

4. Do this for two extreme cases of broadening of the luminosity distribution (none and infinite).

The hypothetical luminosity test 2

5. Calculate the median and standard error of colours of the original volume-limited Type-1-galaxy pairs.

6. Iterate the “new” Mr for Type-2 AGN with a varying luminosity displacement for the previously mentioned two cases.

7. Does there exist any luminosity displacement E_dis where Type-1 and Type-2 have similar neighbour populations and reproduce the same morphological behavior?