Support for an Evolutionary Model of AGN

Deborah Dultzin, Yair Krongold, Sandro Mendoza-Castrejon,
Francisco Hernandez-Ibarra, Theodoros Bitsakis

Instituto de Astronomia
Universidad Nacional Autonoma de Mexico

In 2002 Krongold, Dultzin-Hacyan & Marziani
proposed an

EVOLUTIONARY MODEL FOR SEYFERT GALAXIES

in order to explain the difference they found between the close environment of Seyfert 1 and Seyfert 2 galaxies

Dultzin-Hacyan+ 99

(see also e. g. Laurikainen & Salo 95, Koulouridis+ 06, 13,14)
recently confirmed for a large sample by Villarroel & Korn 14)

In the initial stage the perturbation of a close companion induces gas and dust to fall and form a circumnuclear Starburst (SB) As the SB dies off, the dust distribution flattens out to configurate a torus → an initial composite Sy2 + SB nucleus then **evolves**
into an obscured Seyfert, which may be seen as Sy1 or Sy2 depending on the covering factor of the dust and/or orientation (UM). Notice that there are also “true” Sy2s (no BLR).
At this stage the perturber may be still present

In the final stages of the evolution most of the dust in the circumnuclear region is either destroyed or swept away by the winds of massive stars and the AGN itself, and a naked Sy1 nucleus can be observed. At this time the flyby or a traceless merger is completed, and the perturber is no longer present
(details & timescales: *Krongold+ 02*)

Induced nuclear activity in galaxy pairs with different morphologies (E+E), (E+S) and (S+S)

Hernandez-Ibarra, Krongold, Dultzin, del Olmo, Perea, Gonzalez, Mendosa-Castrejon, Bitsakis 15 (submitted)

Evidence of Tidal triggering of activity in pairs

e.g. Rogers+09, Ellison+11, Liu+12 **BUT** no one differentiates Sy1 from Sy2

This work: 385 galactic spectra from SDSS-DR7 that belong to the catalog of *isolated* pairs of galaxies by Karachentsev (CPG). The spectra correspond to local ($z \leq 0.05$) close pairs of galaxies with Similar mass galaxies. $\Delta V \leq 1200$ Km/s and pair separation ≤100kpc.

We search for the incidence of nuclear activity taking into account different pair molrpholologies and different types of activity (SB, LINERs and Seyfert's **separating types1 from 2**)

For Optical **Activity Type** classification we extracted **nuclear spectra *only* ,** meassured flux ratios from emission lines, and built Diagnostic Diagrams

Masses from 2MASS K band fluxes (u'-r' colors from SDSS) using Bell+ 03

Morphological classification from NED and **our own visual inspection**. In case of doubt we compared also with HYPERLEDA and Galaxy-Zoo

we compare with our own sample of "ISOLATED GALAXIES" (notice → not the same as "Field Galaxies") with matching properties *(Hernandez Ibarra+ 13).*
Data analisis was processed in both samples in the same way and thus is fully compatible

Main Results

The frequency of Incidence of AGN Activity is the same (within errors) in members of S+S pairs and E+E compared to isolated *(Hernandez-Ibarra+ 13)* galaxies with the same morphology

The Incidence of activity is enhanced by ~10% in the early S (Sa, Sb) member of E+S pairs compared to isolated Sa, Sb galaxies

ONLY 4 objects, ~1% of 385 galaxies (compared to 4% in isolated and 20% & in field –same morphology and z distributions) ARE TYPE1 AGN This result does NOT seem to support the UM at least in its simpler version.

In the context of evolution → In pairs we see initial approach and not enough time (~1Gyr according to Krongold+ 02) has elapsed for a Sy1 to appear after the interaction. Consistent alsowith idea that BLR can only be formed at higher accretion rates

Take into account also that we are talking of LLAGN

MIR spectroscopic study of Seyfert 1 and Seyfert 2 Galaxies, Isolated and in Interaction

Mendoza-Castrejon, Dultzin, Krongold, Gonzalez & Elitzur 15

The presence of a close neighbour produces a steady inflow of gas and dust into the nuclear region, and a smooth dust distribution is expected.

In the final stages, the perturber is probably gone or merged . Much of the dust nearest to the nuclear region has been destroyed and/or swept away by the winds of massive stars and the AGN itself. Further out, the dust cools and clumps. A Sy1 nucleus may be observed (depending on orientation (UM) and accretion rate) a clumpy dust distribution is expected.

Sample

19 Seyfert 1 (redshift 0.007 ≤ z ≤ 0.034)
20 Seyfert 2 (0.007 ≤ z ≤ 0.020)
From Dultzin-Hacyan+ 99
With Spitzer Spectra

We cosider three characteristic classes of spectra that require modification of the fitting intervals *(following Siroky+ 08):*

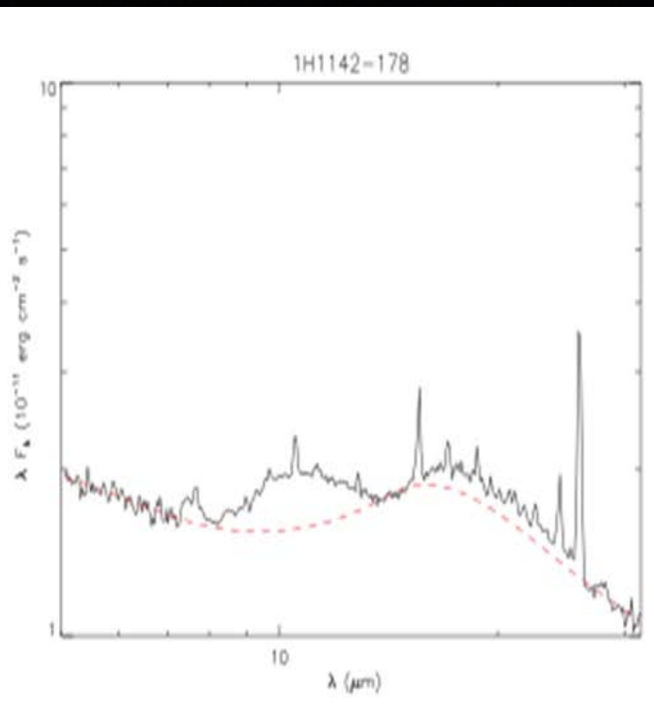
"Continuum-dominated spectra": 5-7,13.8-14.2 & 26.5-31.5 μm.

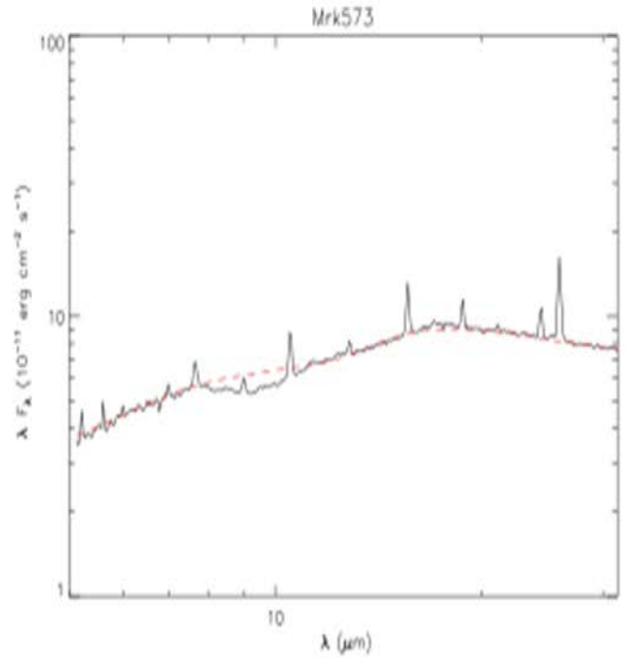
"Absorption-dominated spectrum": 5.2-5.6, at 7.8, 13.2-14.5 & 26.5-31.5 μm.

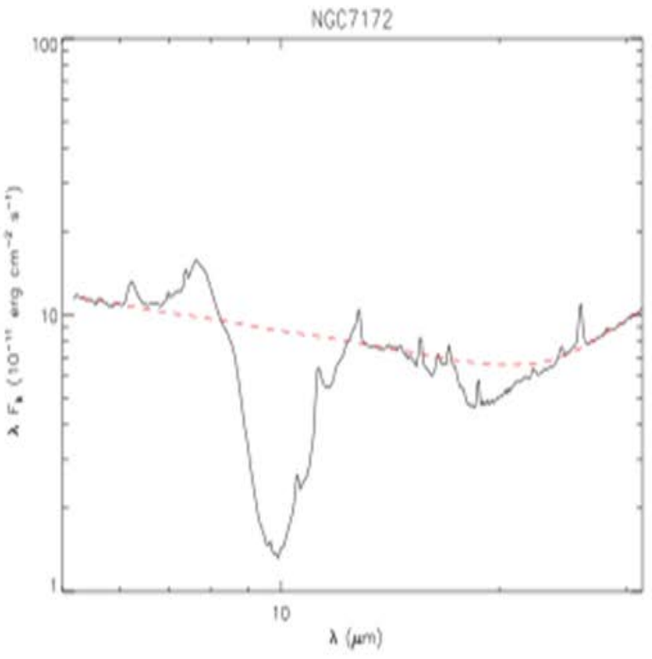
"PAH-dominated spectra": 5.3-5.7, 14-15 & 26.5-31.5 μm.

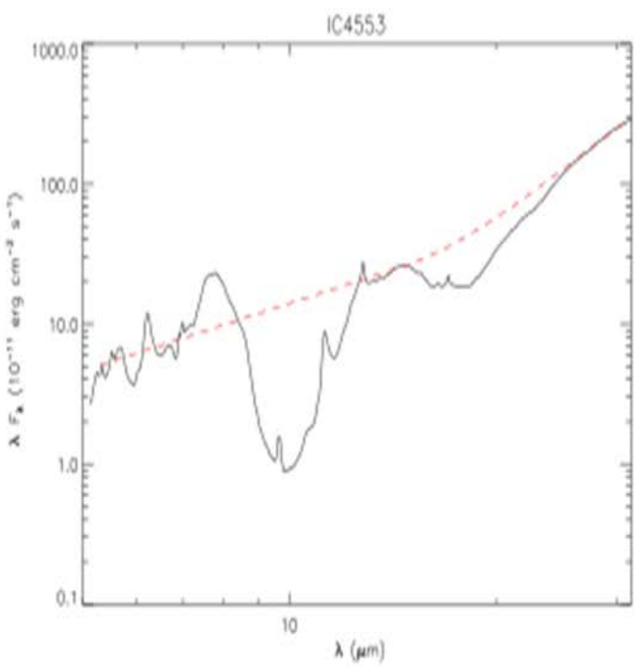
The presence of PAH is linked with higher Star Formation

Fitting the continua: Seyfert1 Seyfert2

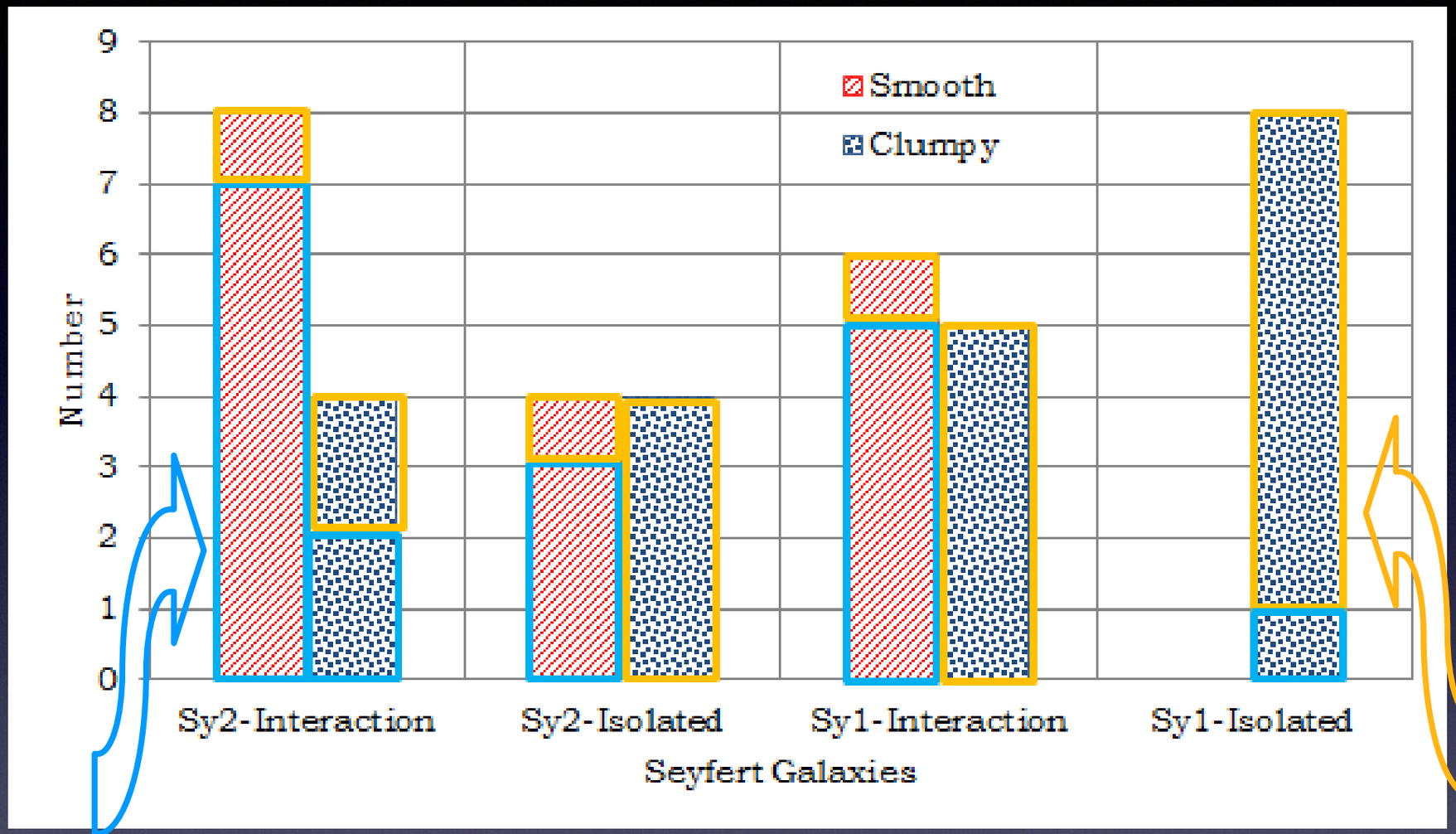








our results (albait preliminar) support the EVOlUTIONAY MODEL



PAH-Dominated spectra

Time

Continuum-Dominated spectra

$$Interacción \Rightarrow Starburst \rightarrow Seyfert\ 2 \rightarrow Seyfert\ 1$$

Studying the evolution of galaxies in compact groups over the past 3 Gyr – I. Nuclear activity

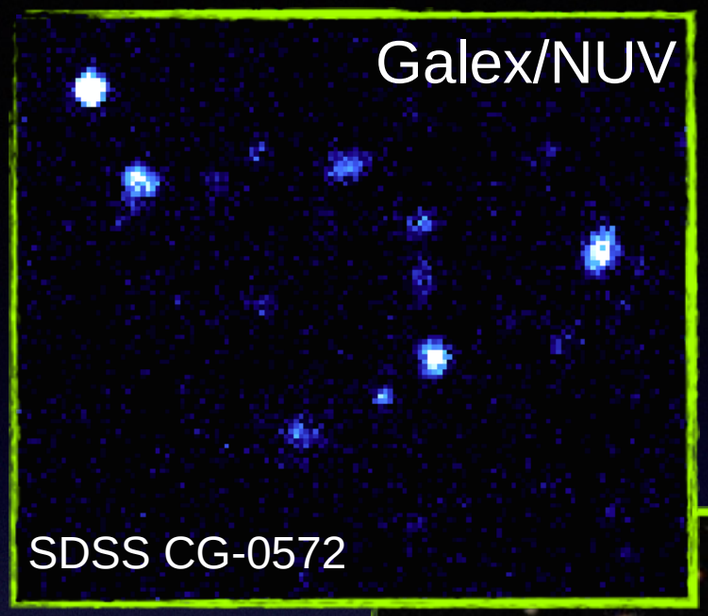
Bitsakis, Dultzin, Ciesla, Krongold, Charmandaris, Zezas 2015

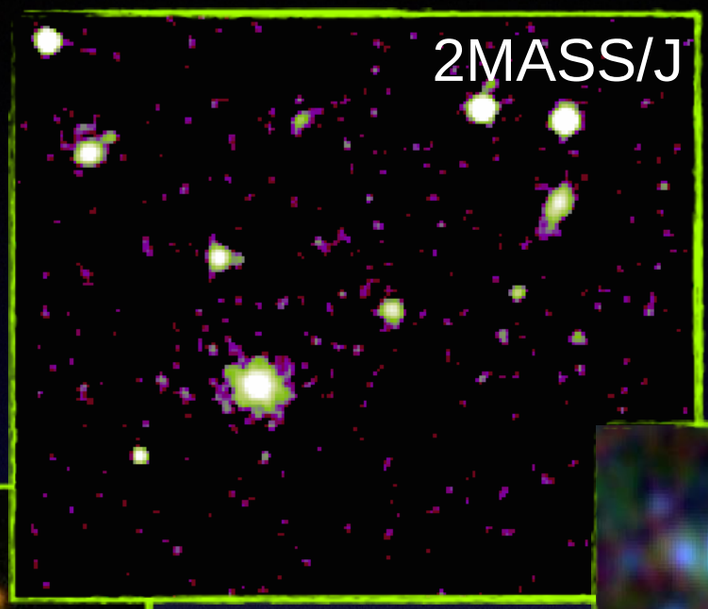
previous studies only z<0.05

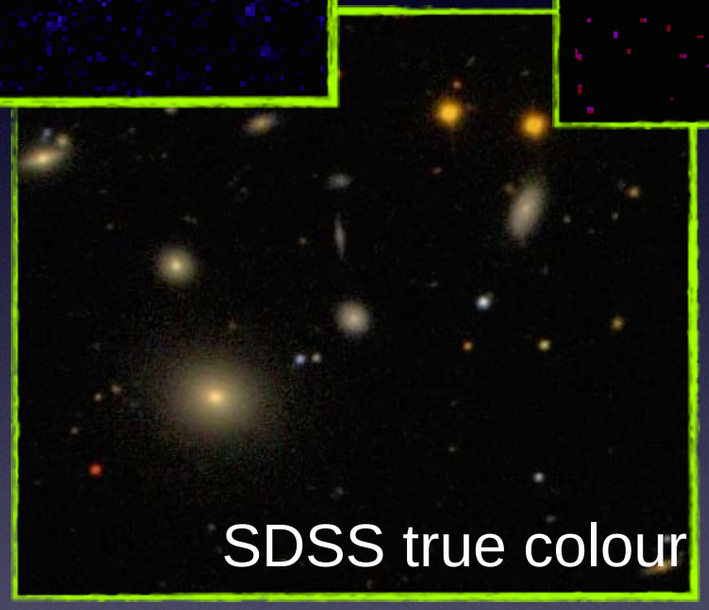
40-45% of HCG galaxies contain AGN (mostly low-luminosity AGN; LLAGN) (Shimada+00, Martinez+10)

The new sample should cover a wide range of z's (for HCGs was <0.03) McConnachie+09 dapted Hickson's criteria to the whole SDSS-DR7 database and compiled a sample of 2,297 groups. We selected 1770 groups (7417 galaxies) using multifrequency data in the range z<0.01<0-25

SAMPLE SELECTION



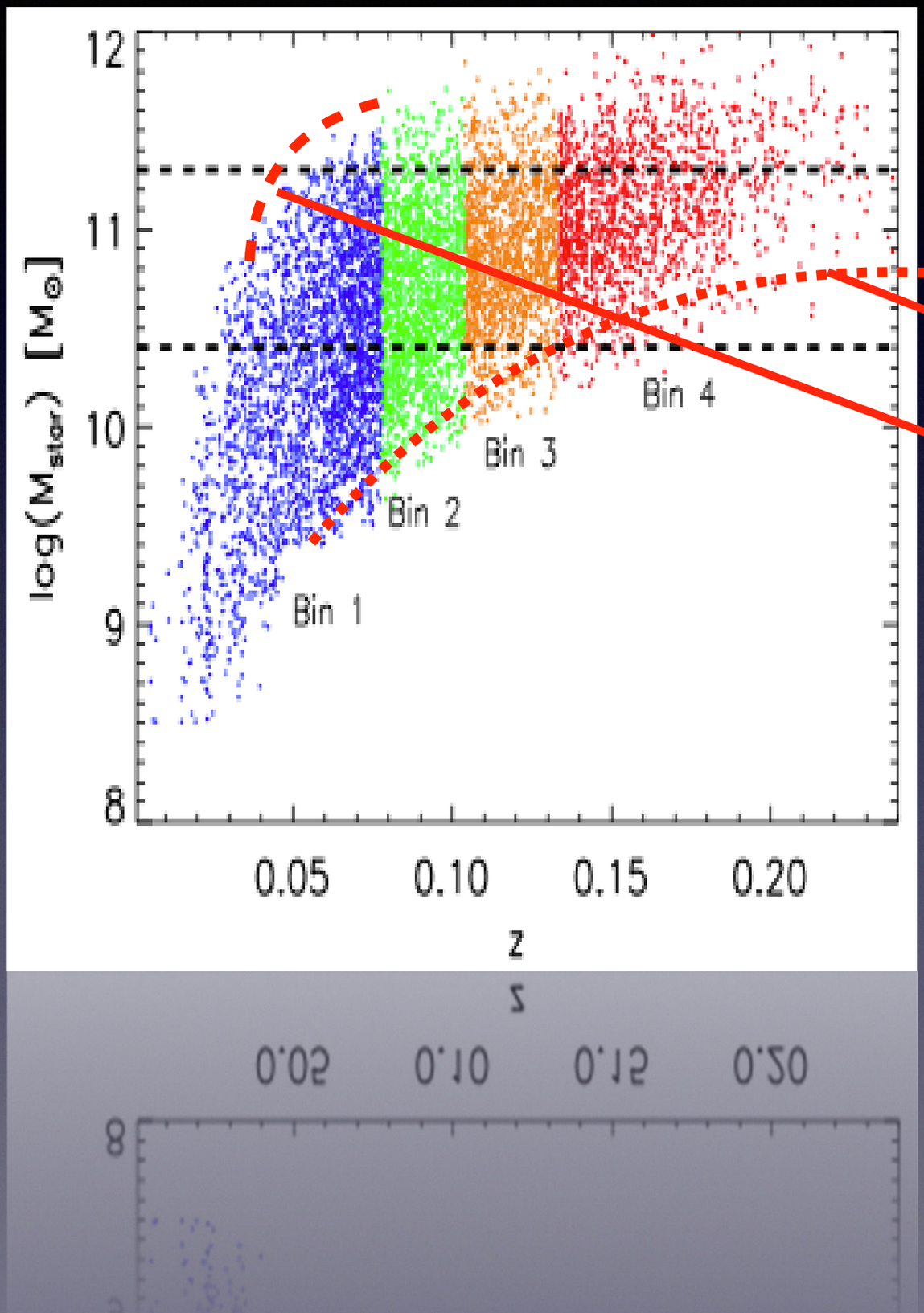




LARGEST MULTI-WAVELENGTH CG SAMPLE to-date…

- Need of a **multi-wavelength** sample (**14 bands**) to probe the various properties of galaxies
- Available **optical spectroscopy** for 4,208 of the galaxies

Avoiding SELECTION BIASES



- For the purposes of comparison **we split our sample into 4 bins**
- Our sample can be subject of two selection biases

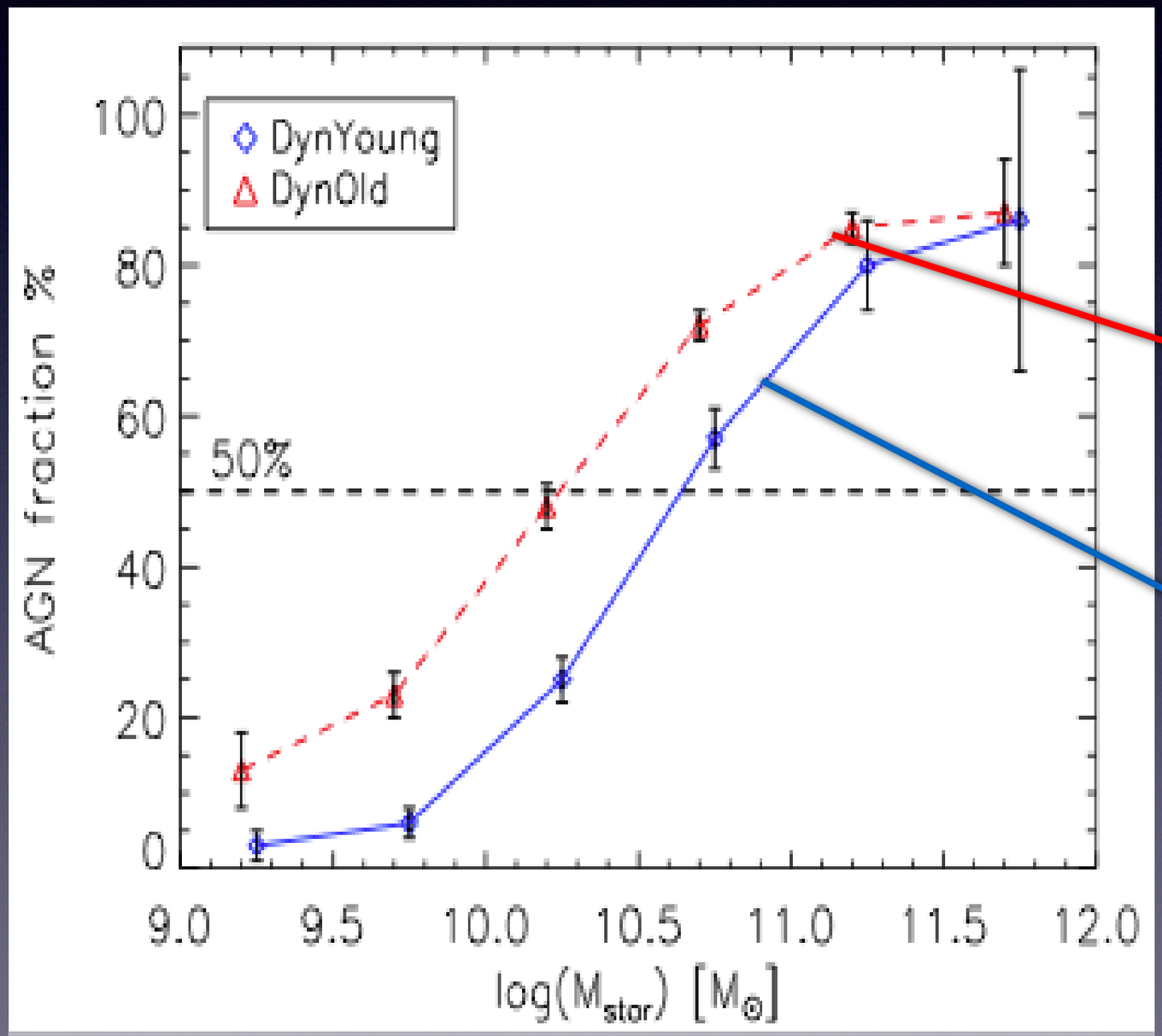
Malmquist bias

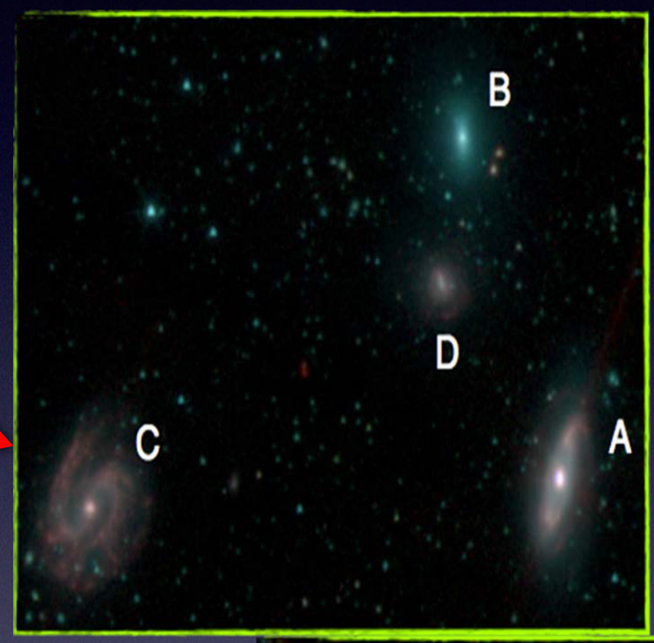
Upper limit cut-of

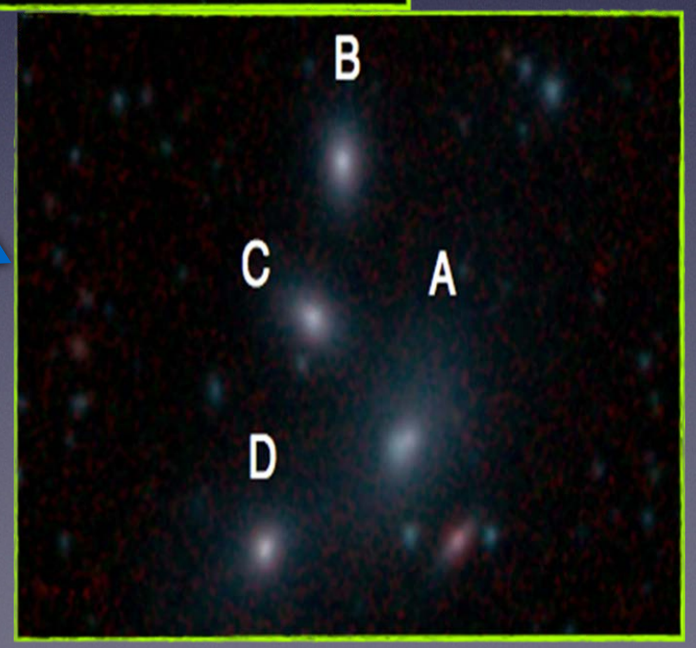
- We compare galaxies within the range $10.4 < \log M < 11.3\ M_{solar}$

AGN activity in young and old groups

- Galaxies in **dynamically** old groups are more likely to host AGN at any given M_{star}. No enhancement in dynamically young







Looking for **Sy-1 AGN** (from opt. Diag Diagr.) **we find < 1%**

- **Could they be dust obscured? NO:**
  - We showed that MIR WISE colour diagnostics < 0.5%
  - SED fitting gives also negligible AGN contribution in IR bands

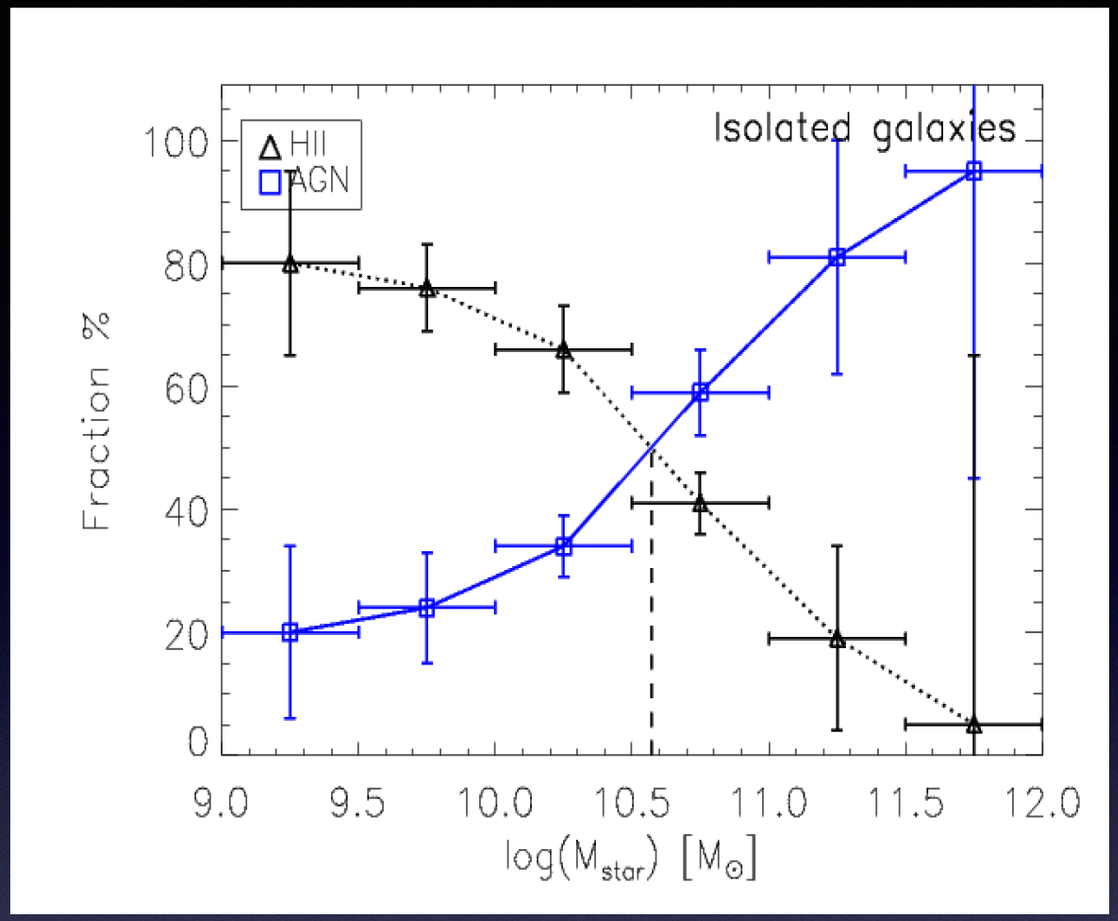
If orientation + obscuration only (UM) ⟶ we should find Sy1 more often ***(~20% local Universe Ho+ 97)***

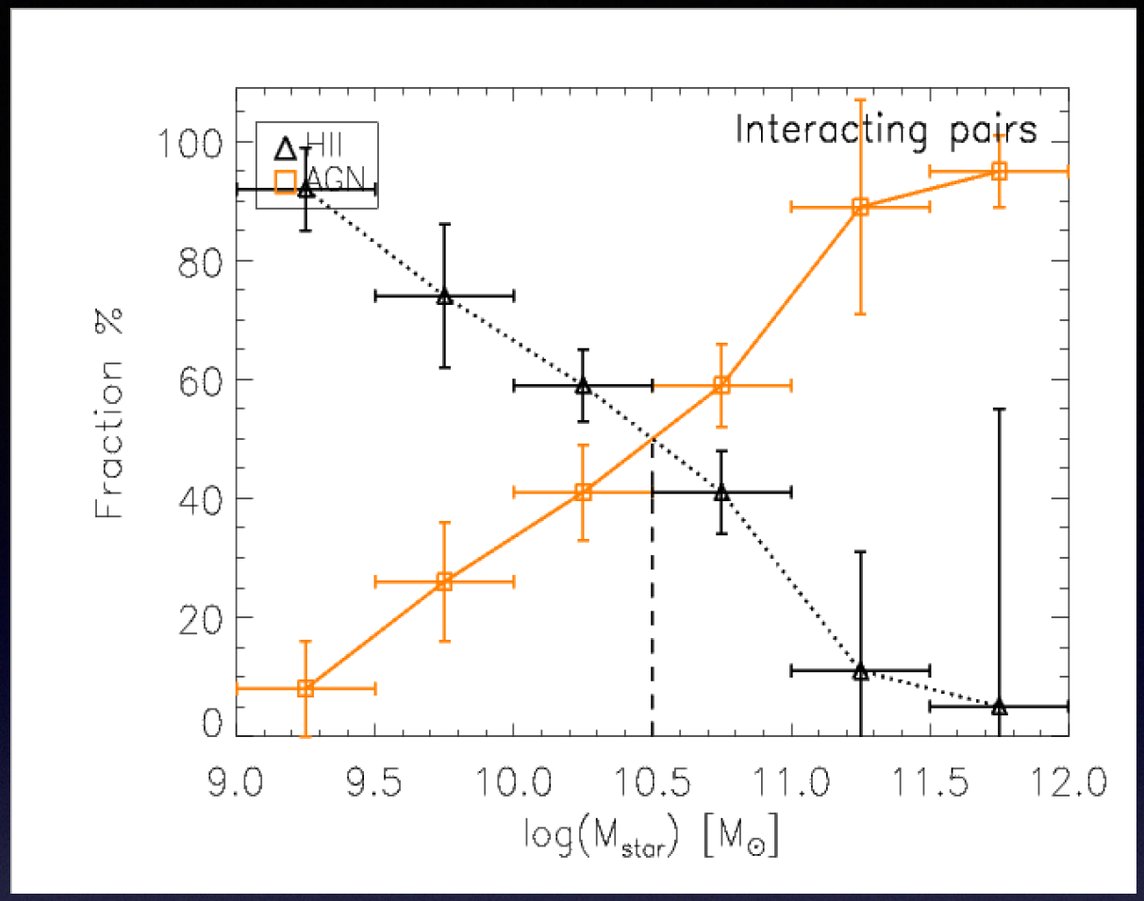
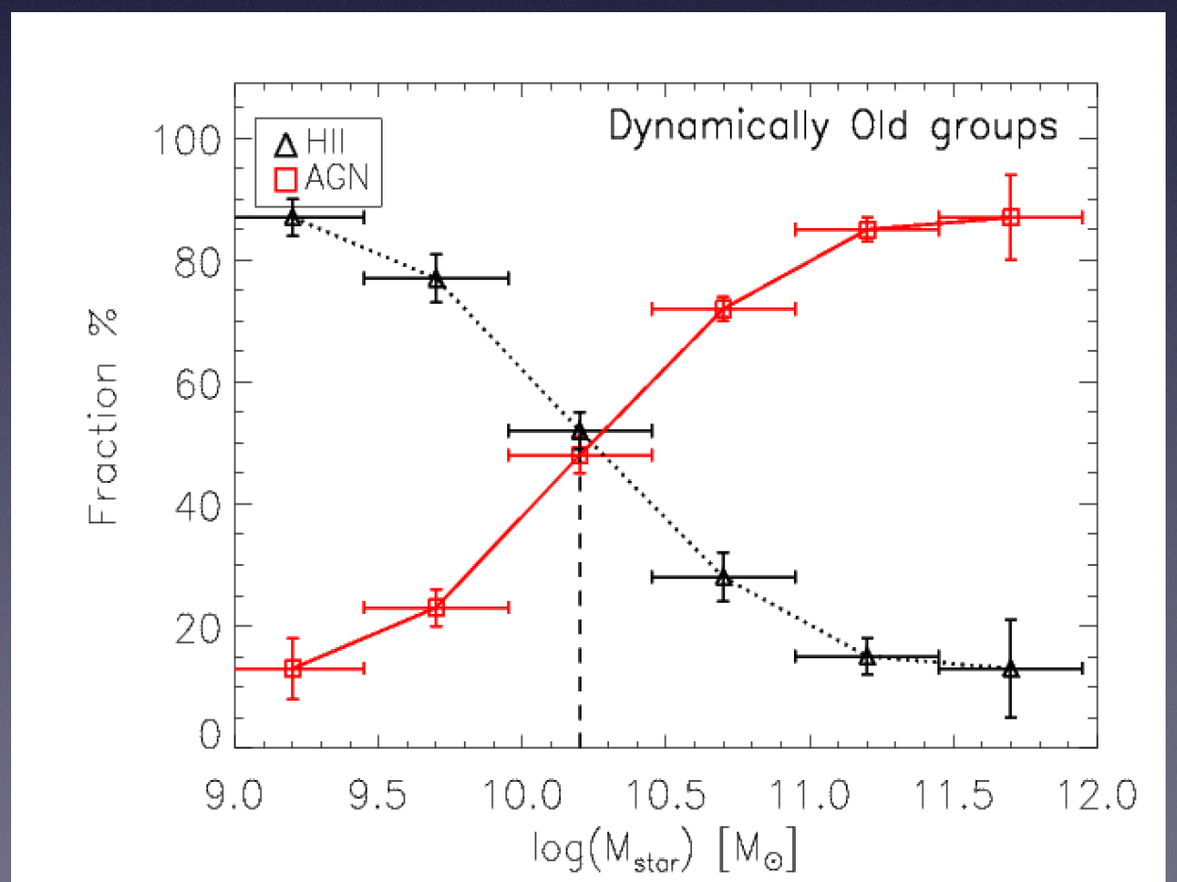
Again UM not enough (at least in simpler version)

It has been proposed that low accretion leads to the absence of a Sy-1 sources (e.g. Nicastro+00, Elitzur+06). HCG host only LLAGN

Gas depletion due to past SF and tidal interaction may lead to lower accretion rates at lower-z's

At low z the fraction of AGN increases but their overall activity drops…





The **incidence of AGN** is linked to Galactic Star **Mass** starting from a different threshold depending on the close **environment**