Active Galactic Nuclei

- The discovery of BH - galaxy coevolution has changed our view of AGN
- AGN are not only sources to study *extreme physics* but also *key actors in galaxy evolution*.
- AGN studies are now located to the framework of galaxy formation and evolution.
- AGN studies includes also studies on supermassive Black Holes even when they *quiescent*.

Active Galactic Nuclei @ Arcetri

STAFF

- Leslie Hunt
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- Guido Risaliti
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- Marco Salvati
- Guidetta Torricelli
- Paolo Tozzi
- Stefano Zibetti

POSTDOCs & STUDENTS

- Eleonora Sani
- Mauro Sirigu (UniFI)
- Stefano Carniani (UniFI)

MAIN RESEARCH LINES

- physical processes close to the BH
- radiative processes
- BH masses
- BH-galaxy relations
- AGN feedback
- cosmological evolution of BH and AGN

FUNDING (in the last few years)

- INAF, ASI, PRIN-MIUR, NASA

Projects & Highlights

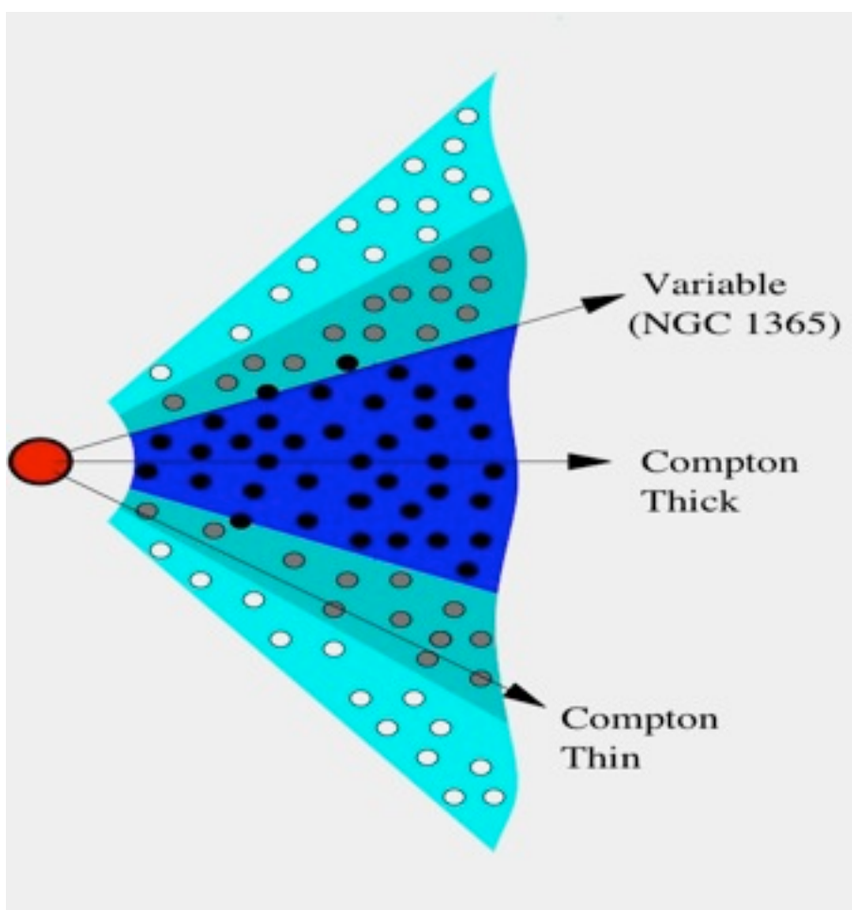
Absorption Variability in AGNs

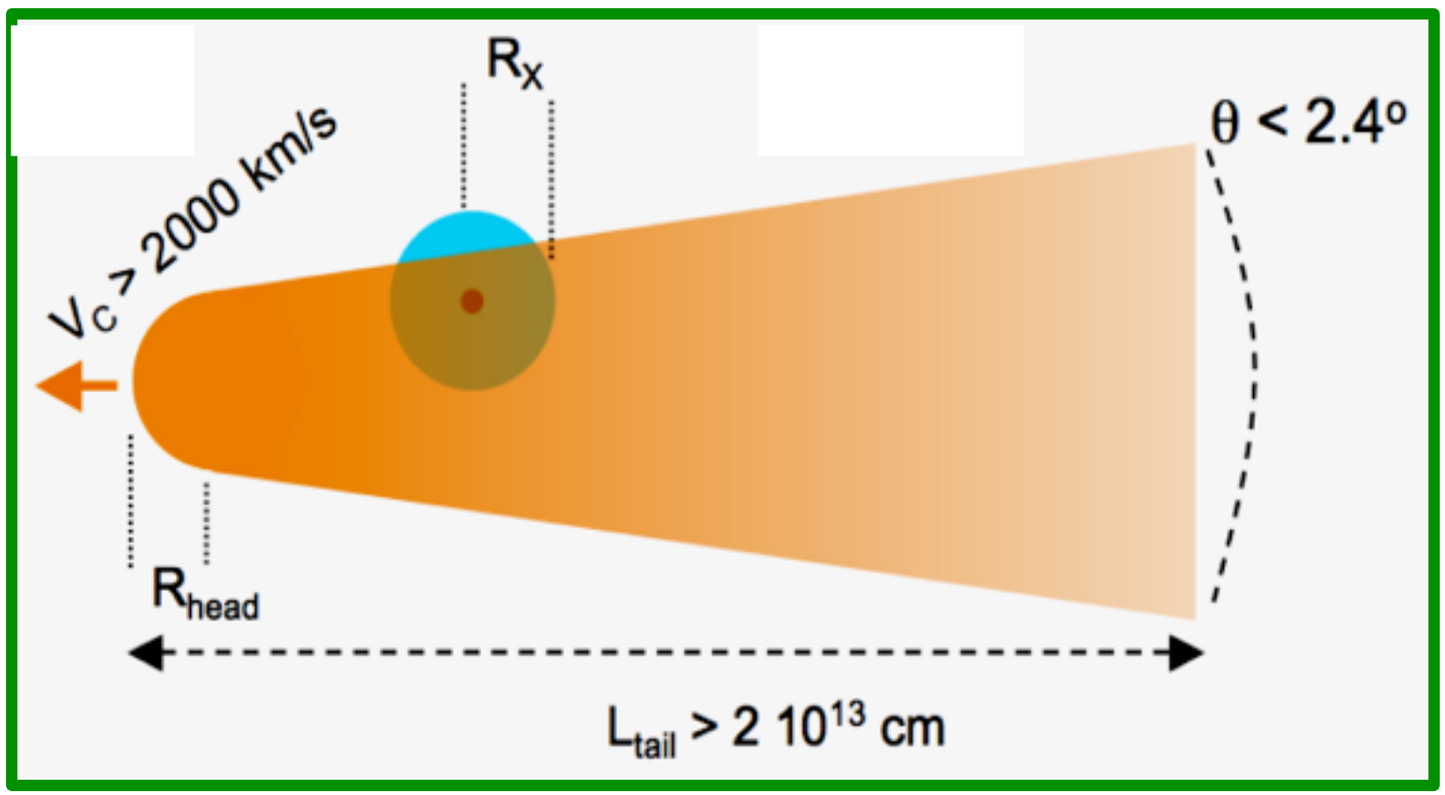
A big project, based on long X-ray observations (or of repeated short ones) of bright obscured AGN.

People: Pietrini, Risaliti, Salvati, Torricelli, Bianchi, Maiolino, Matt, Miniutti, Elvis, Fabbiano, Marinucci, Nardini, Wang

Data:
~ 10 acc. proposals with with Chandra, XMM, Suzaku (~ 1.5 Ms)
~15 publications
Funds: 70 keuro (ASI) (+ ~800 k$, NASA)

Results:
- X-ray absorber == BLR clouds
- "cometary" shape of BLR clouds
- Size of the X-ray source: a few R_G
- A new standard technique for X-ray spectral analysis of AGN



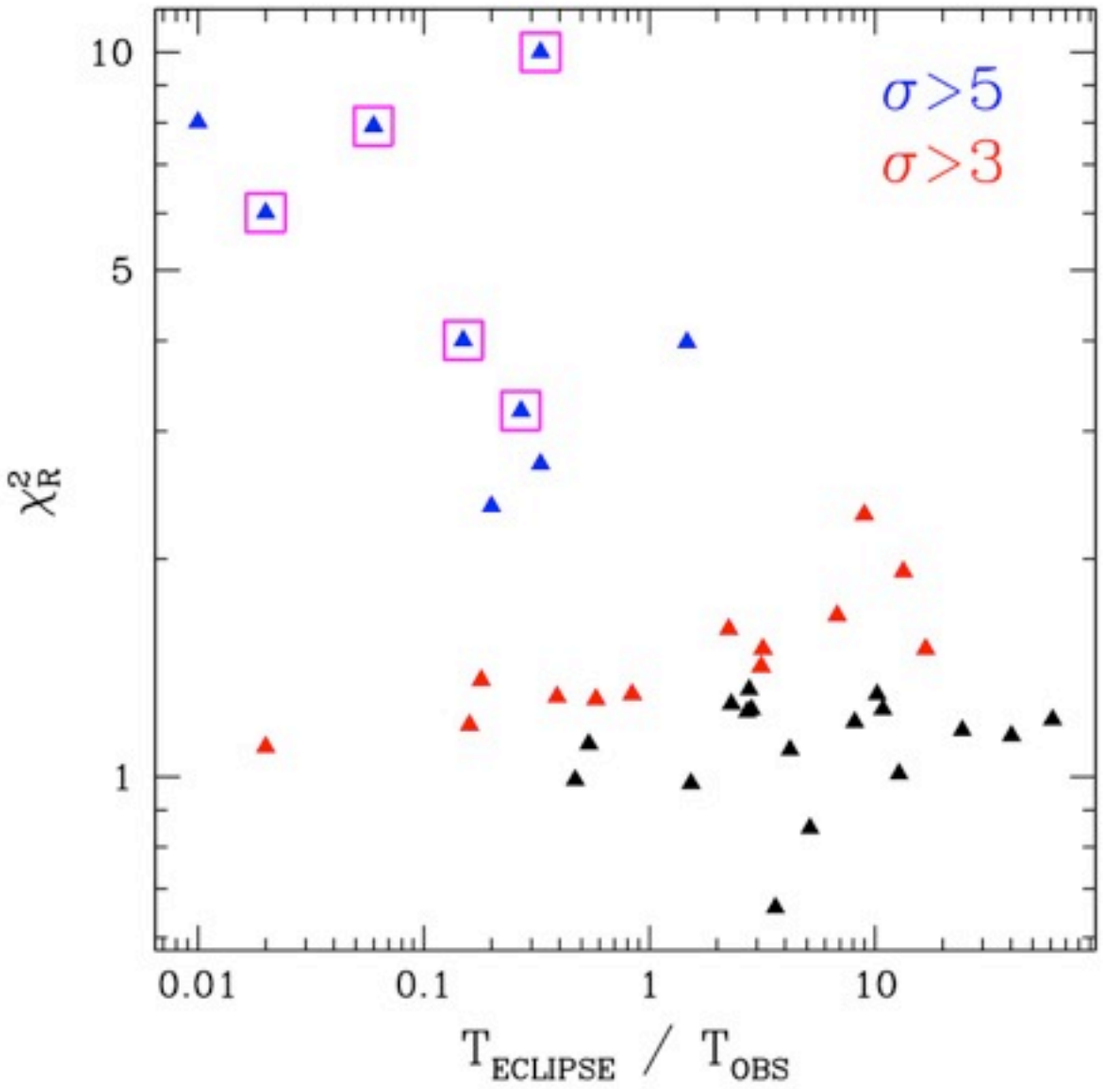


Absorption Variability in AGNs: future

1) Systematic analysis of X-ray variability of ~40 nearby bright AGN: towards a complete characterization of the the inner structure of AGN.

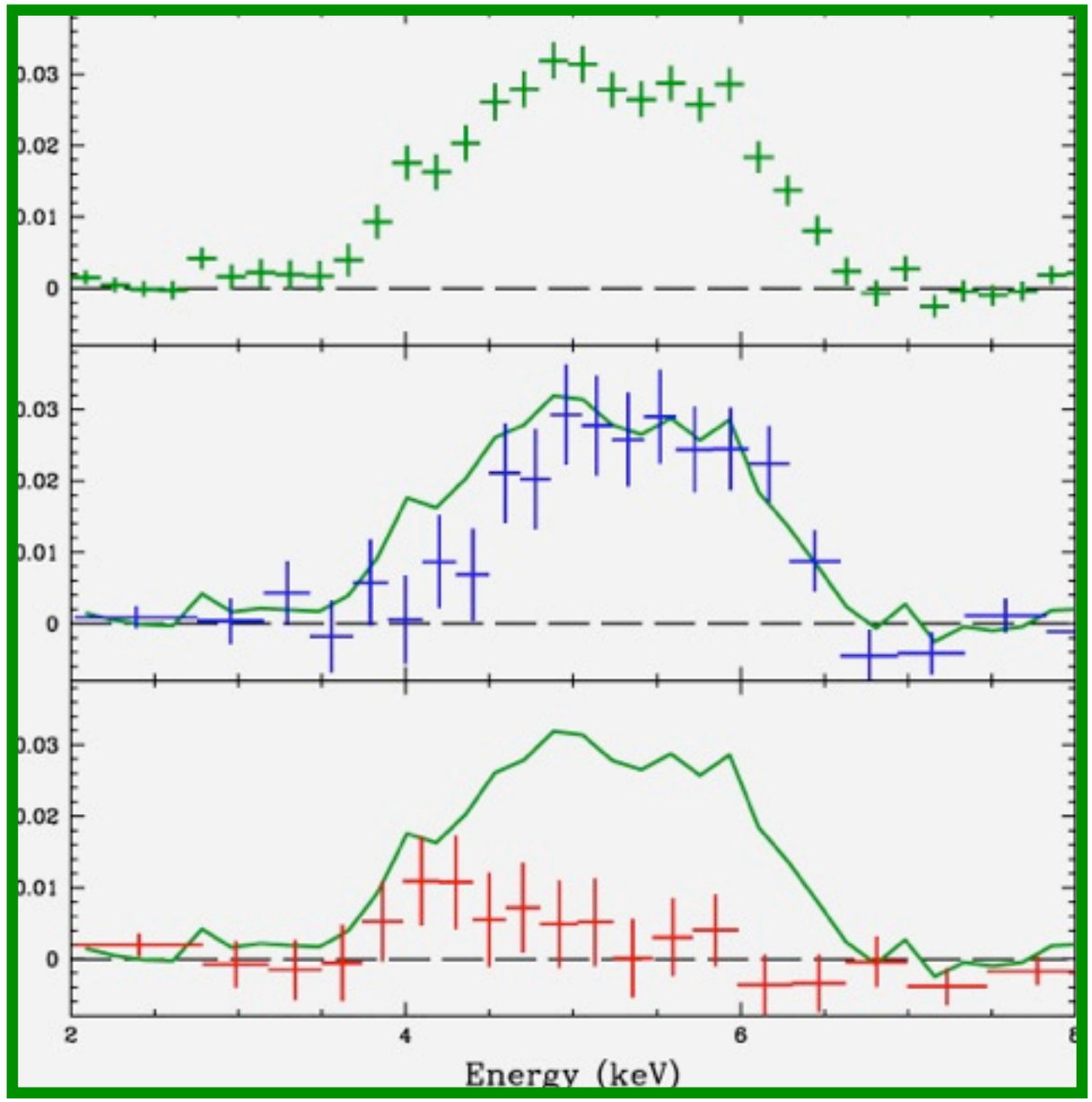
Preliminary results:

Eclipses COMMON in AGNs; time scales suggest BLR clouds.



Pietrini, Torricelli et al., in prep.

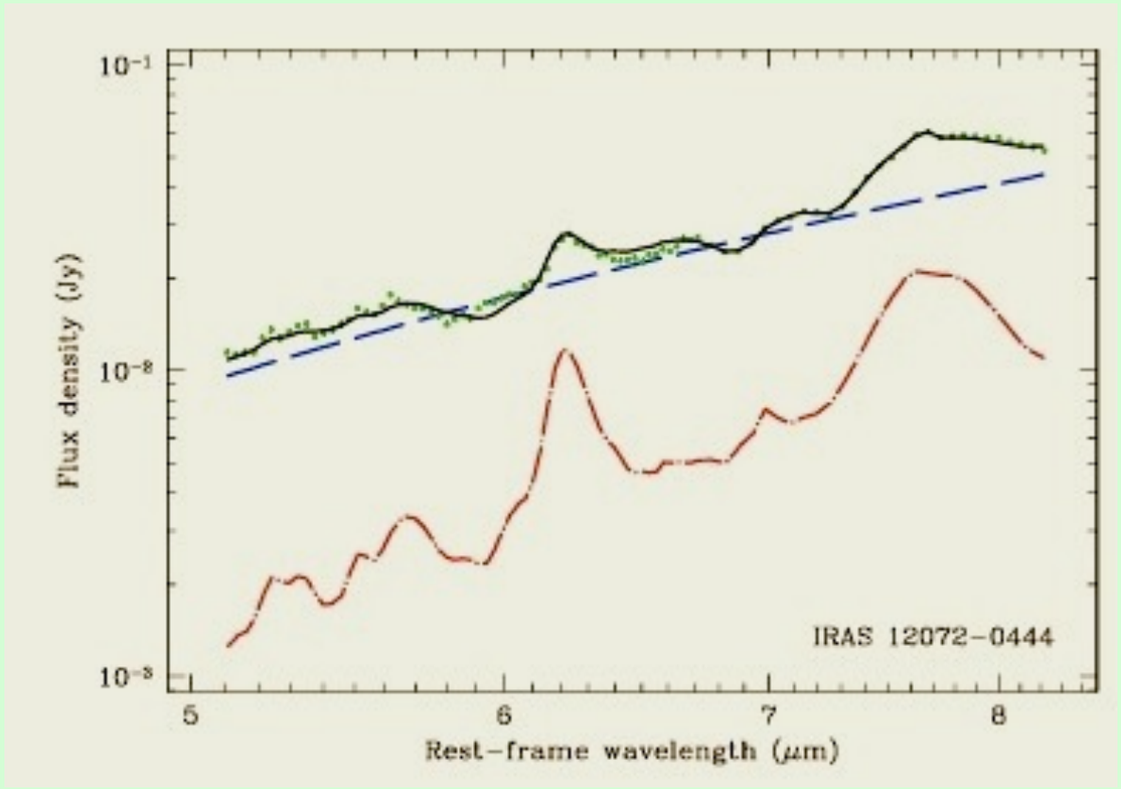
2) Probing GR effects through X-ray eclipses. Approved Large XMM + NuSTAR program (500 ks)



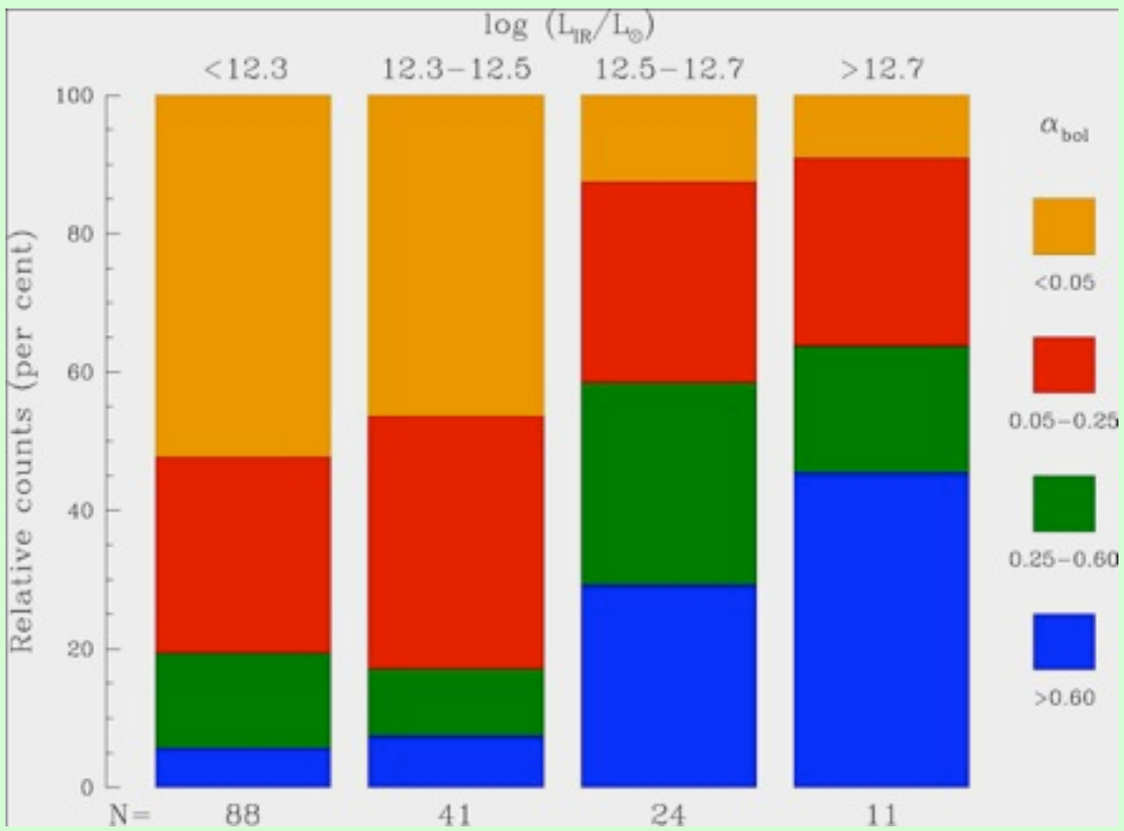
Risaliti et al. 2011

AGN/SB Quantitative Devoconvolution in ULIRGs and nearby AGN

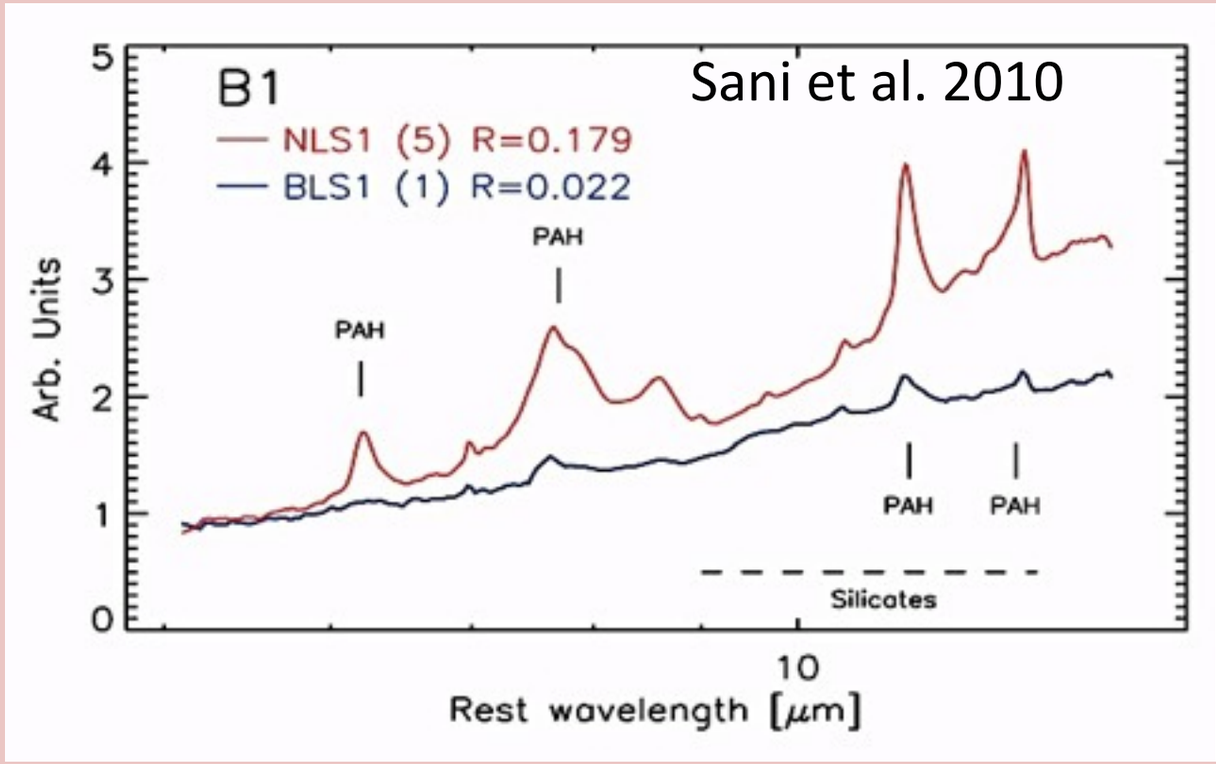
Marconi, Risaliti, Salvati, Sani, Nardini

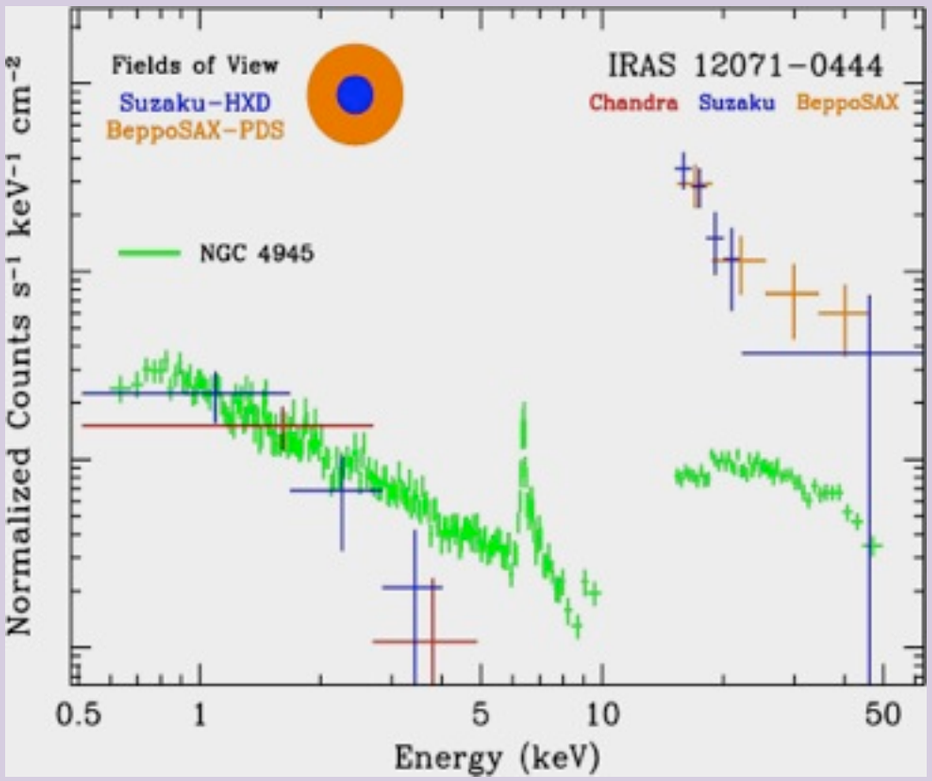


Spitzer – ULIRGs (Nardini et al, 09,10,11)



NLS1: excess of SF with respect to BLS1





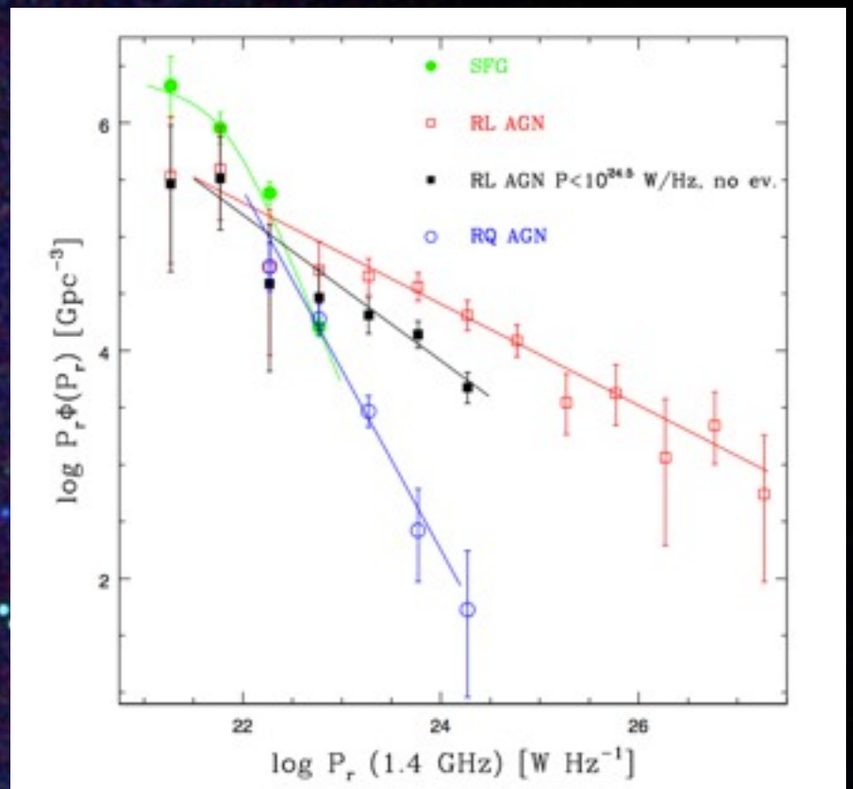
X-rays: Detection of hidden QSO2 in ULIRGs

(Sani et al in prep.)

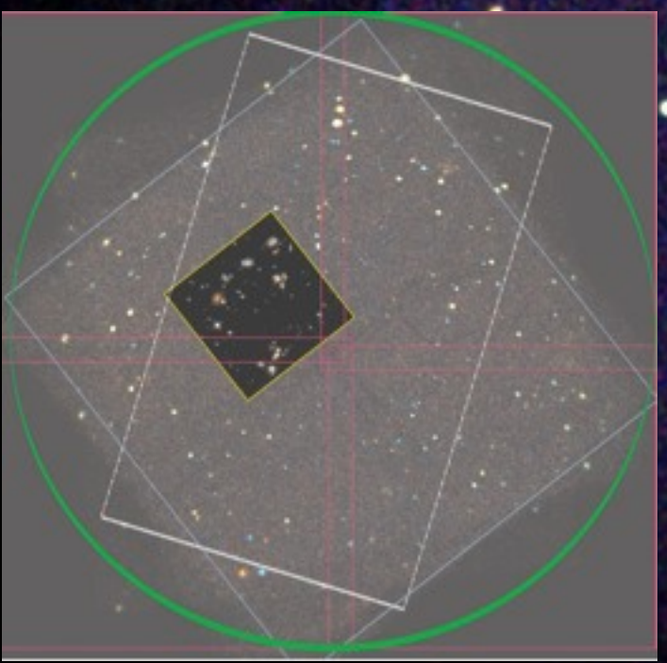
Properties of Radio Sources in CDFS and COSMOS

People: P. Tozzi et al.

Sub mmJy radio sources in CDFS divided in AGN radio loud/quiet and SF galaxies (Kellerman et al. 2008; Tozzi et al. 2009; Miller et al. 2008; Mainieri et al. 2010; Padovani et al. 2009/2011)



X-ray properties of FRI in COSMOS (Tundo, Tozzi & Chiaberge 2012)



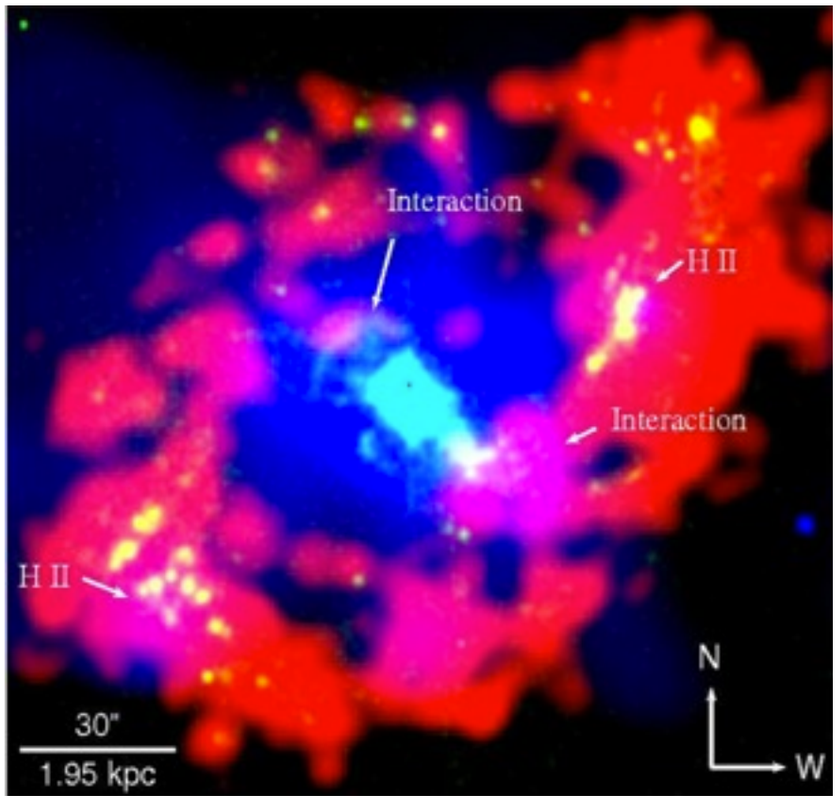
Optical data:
GOODS /ACS (i)
UDF/ACS
GEMS/ACS
VLT/FORS R-I
EIS/WFI

IR data:
GOODS/ISAAC Ks
EIS/SOFI Ks (wider)
GOODS/IRAC
GOODS/MIPS

Radio data:
VLA+EVLA
240 h @ 20cm
rms 6.4 μJy

Resolving the AGN – host galaxy interaction in X-rays

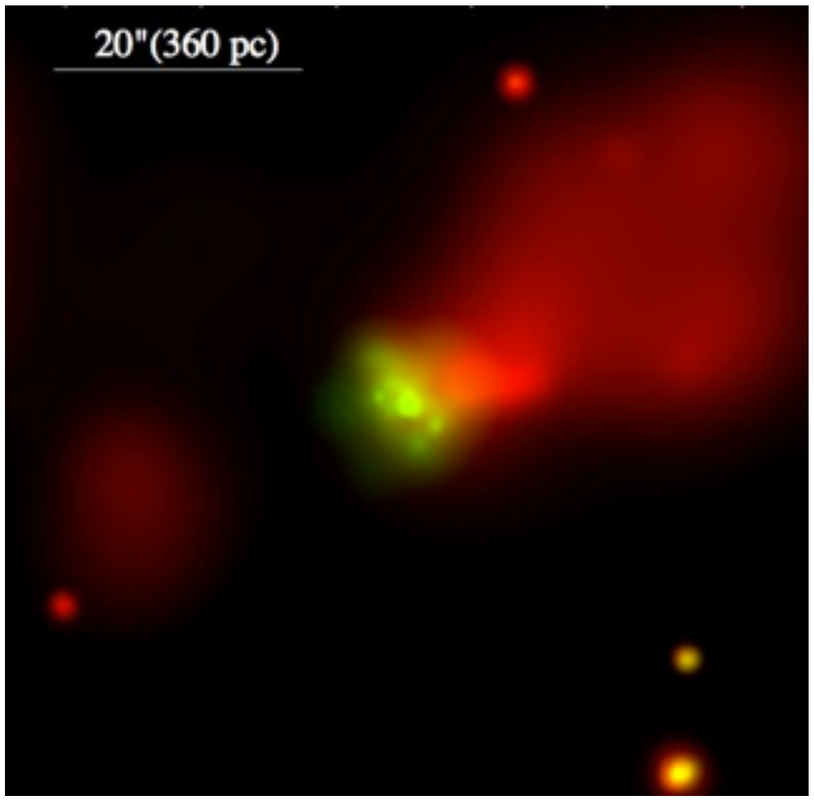
(Risaliti + CfA collaborators)



AGN feedback in action:

The hot gas ionized by the AGN (blue, X-rays) forms a cavity in the HI gas (red) in the active galaxy NGC 4151

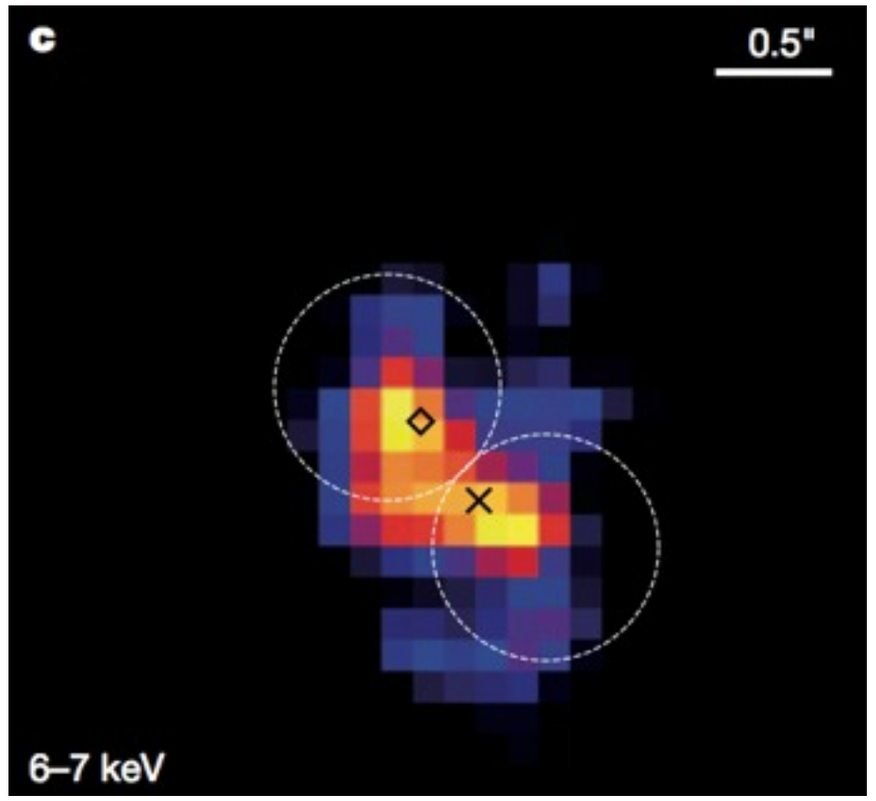
(Wang et al., ApJ, 2010)



Resolving the torus:

The circumnuclear torus (green) is spatially resolved for the first time in the obscured AGN in NGC 4945

(Marinucci et al., MNRAS, 2012)



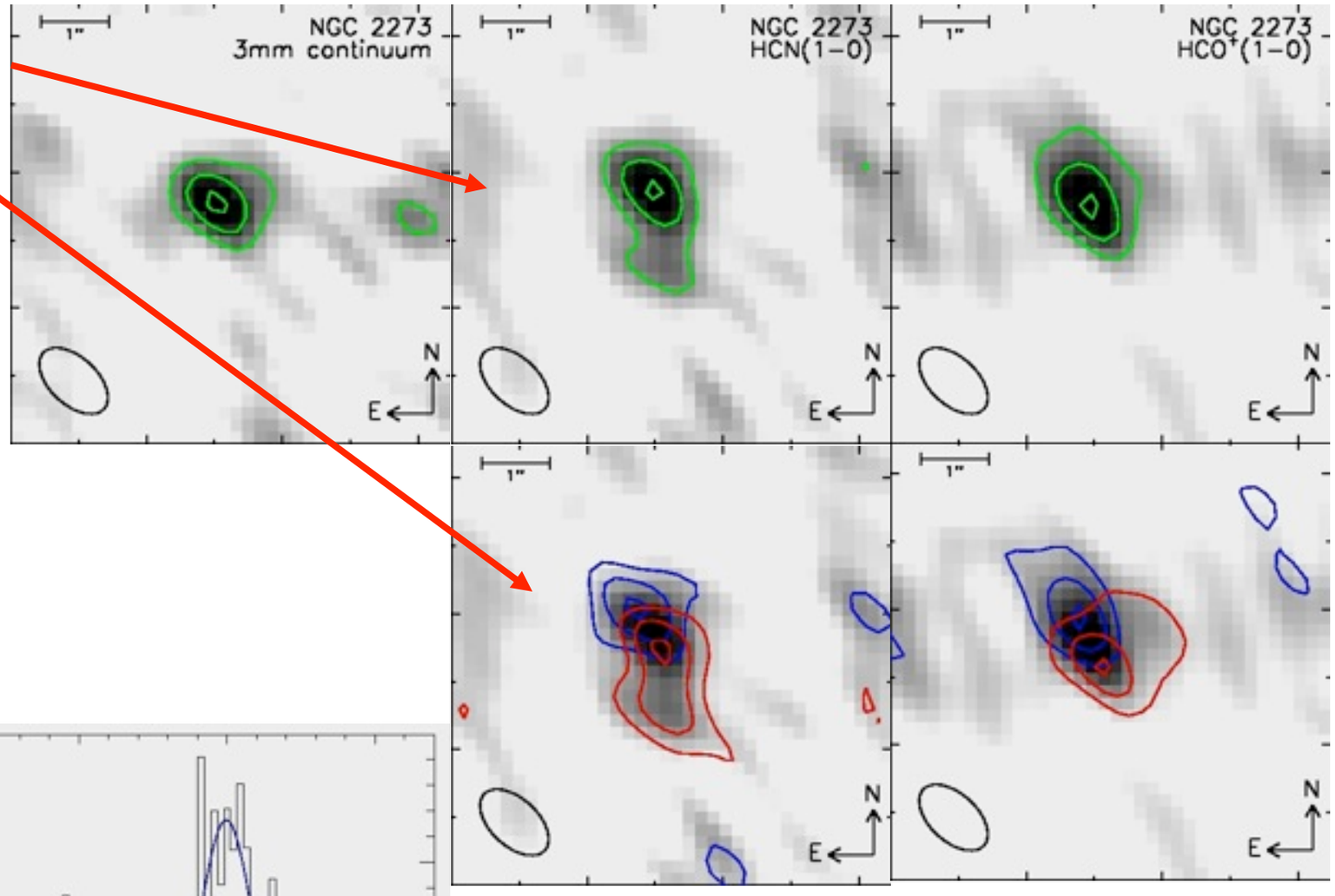
Resolving a BH merger:

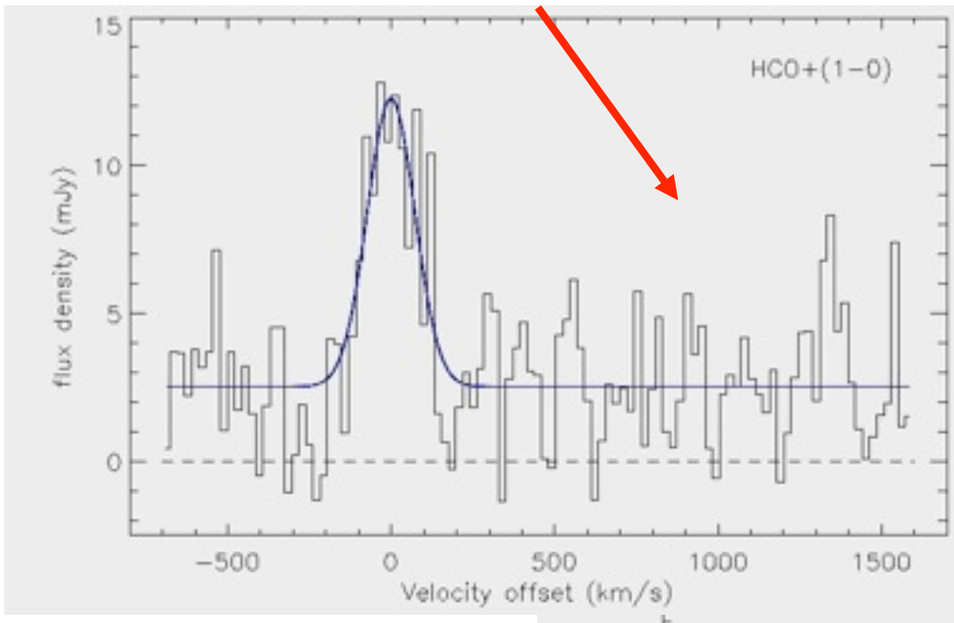
The nearest known pair of active BHs in the regular spiral galaxy NGC 3393

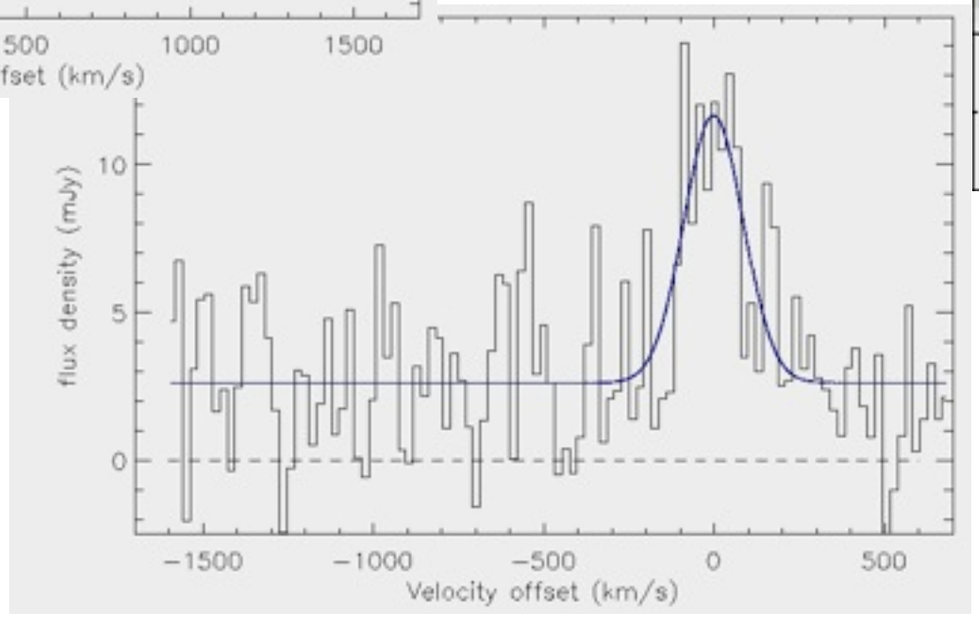
(Fabbiano et al., Nature,2011)

Molecular gas kinematic in Seyfert nuclei

HCN observations probe dense >3x10^{4}cm^{-3} gas
<1” resolution from PdBI–NGC 3227, 2273, 4051, 6951
Directly observable constraints:
1. major & minor axis size, & PA
2. separation & PA of red/blue channels
3. integrated line width





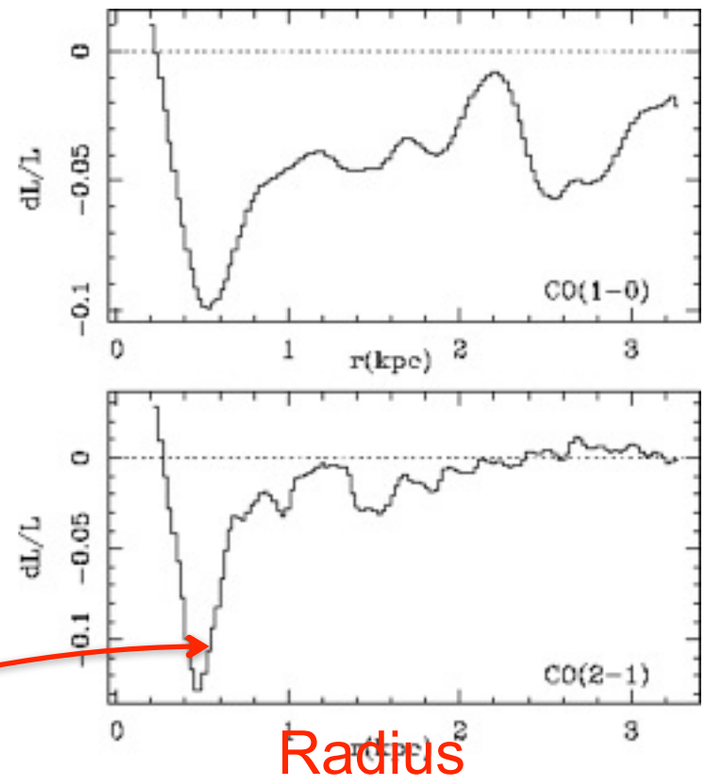


Sani et al. 2011

AGN fueling and AGN feedback: Insights from molecular gas (NUGA)

People: L. Hunt et al.

A 5-yr survey of 12 galaxies in two CO transitions with IRAM-Plateau de Bure Inferometer requiring ~300 hrs of telescope time (PI s Combes, Garcia-Burillo, Hunt among cols): Nuclei of Galaxies (NUGA) with 15 publications to date; the statistical analysis in progress. One example shown here. NUGA-South underway with ALMA Cycle 0 (Combes et al.).

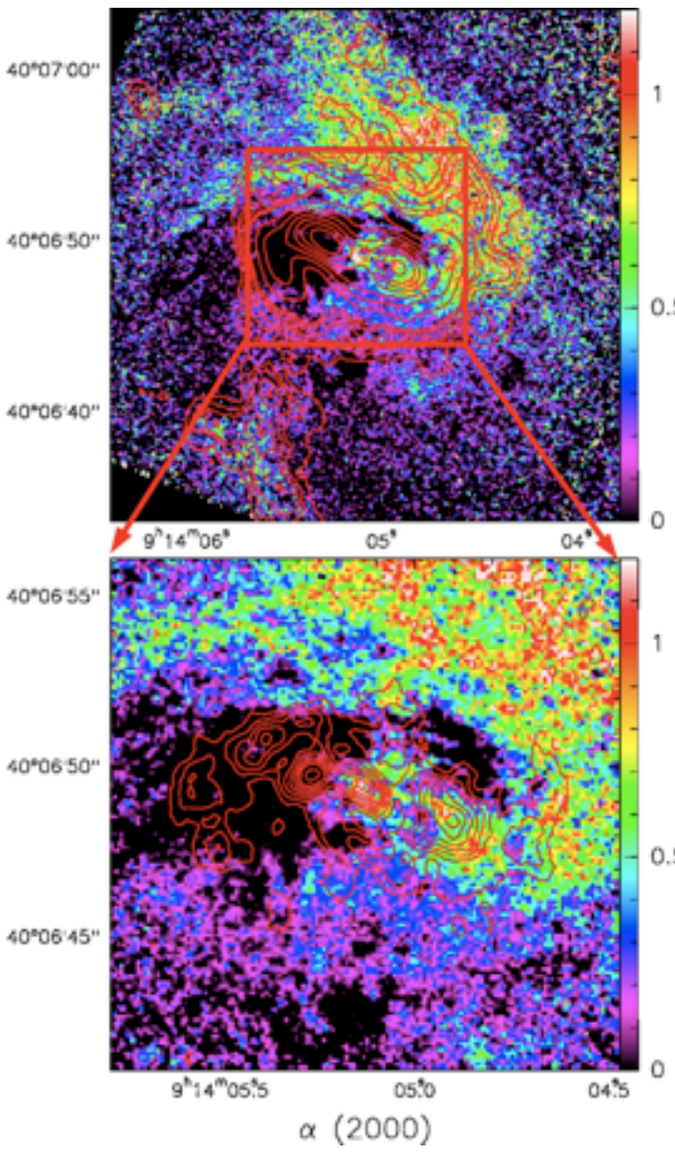


Torque

Radius

NGC 2782, interacting Seyfert 1: red CO contours over HST extinction map. Molecular gas follows dust.

Inflow currently occurring in NGC 2782.



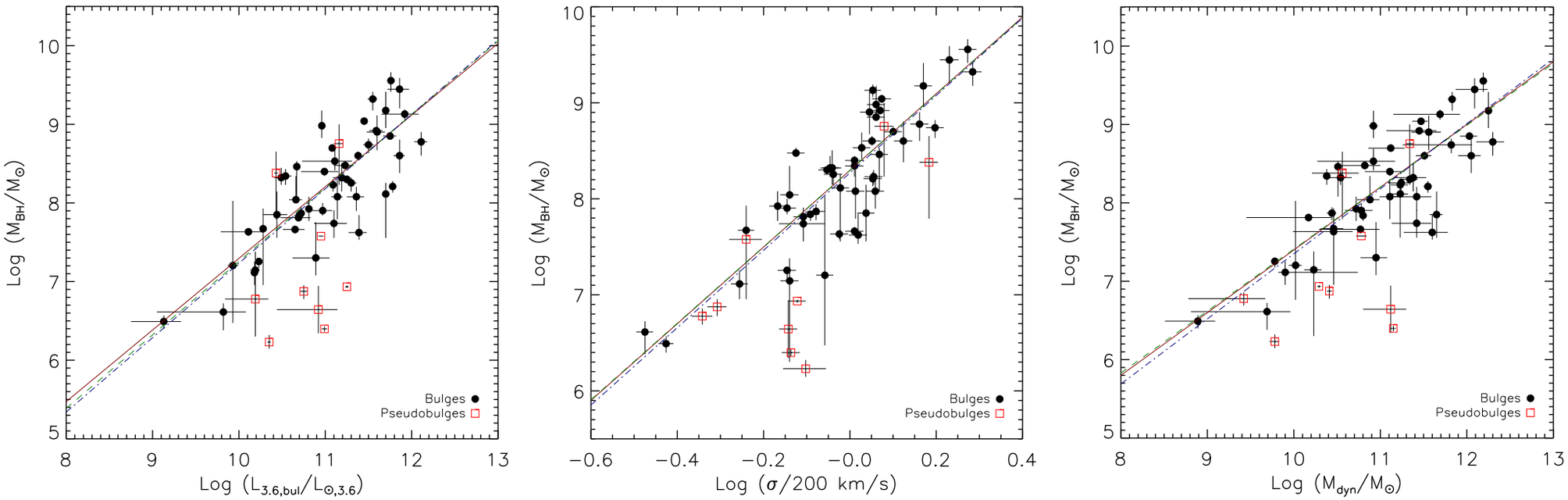
With stellar potential from a near-infrared image, and gas response from CO image, derive the azimuthally averaged gravitational torque exerted by stars on the gas. Look for negative torques= inflow (fueling) and positive torques=outflow (starving, possible feedback).

Black Hole Masses and Relations with Host galaxies

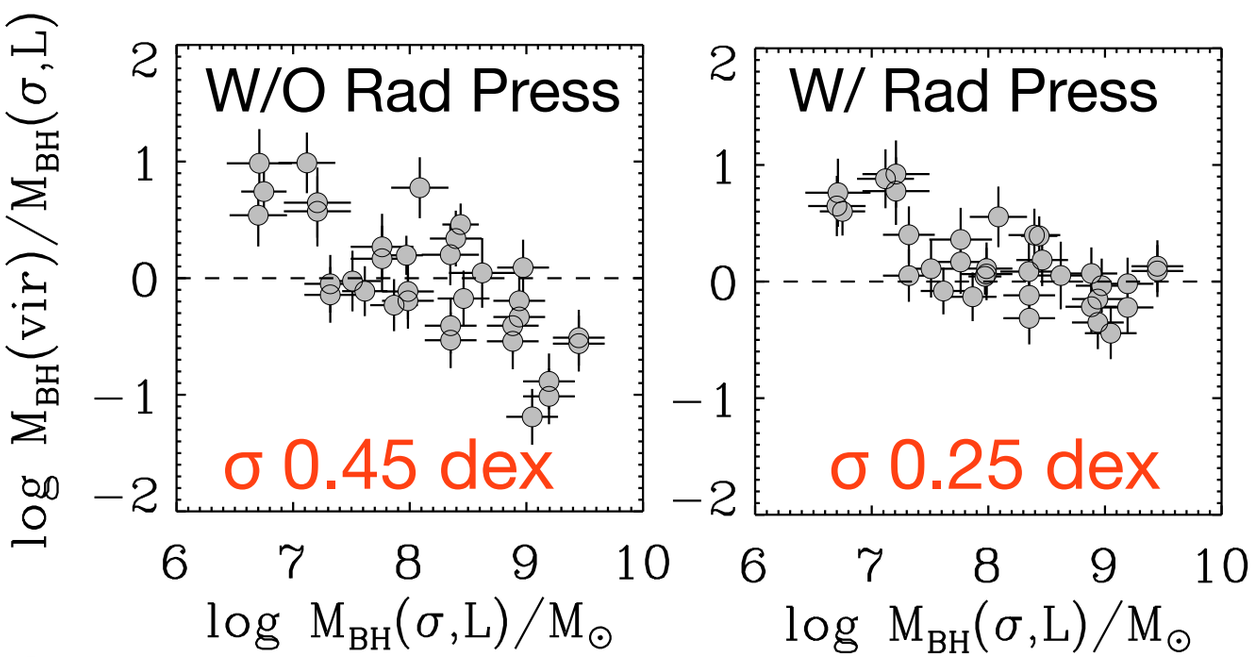
People: Marconi, Hunt Pietrini, Risaliti, Salvati, Sani, Sirigu, Torricelli, Axon, Robinson, Peterson, Vestergaard, Netzer

Sani, Marconi, Hunt & Risaliti 2011

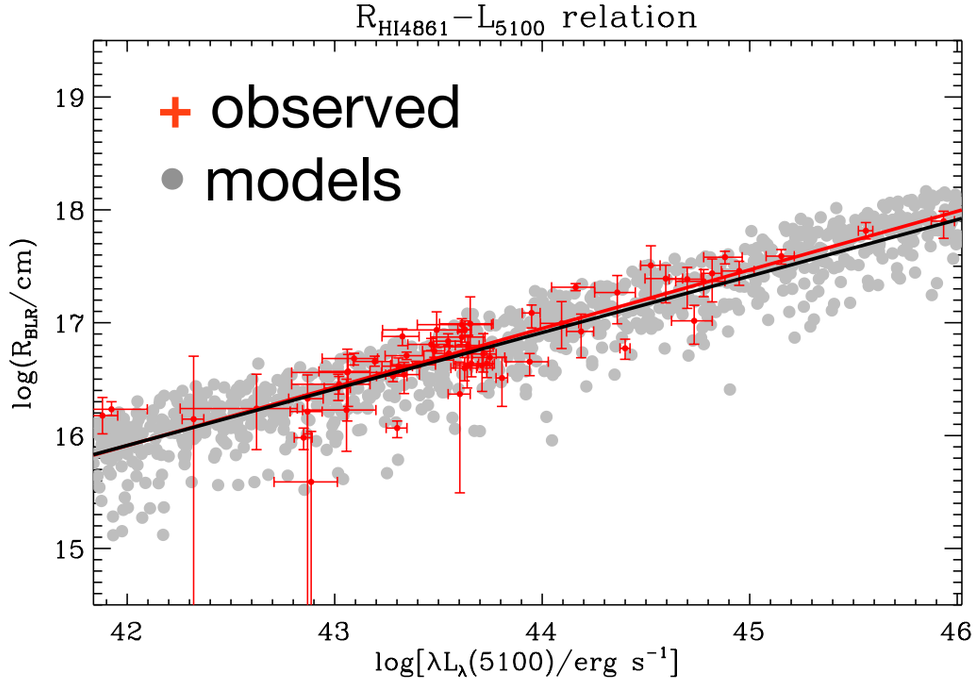
M_{BH} vs Bulge L, σ, M from Spitzer photometry at 3.6μm



The effect of radiation pressure on virial BH masses (Marconi et al. 2008, 2009, 2012)



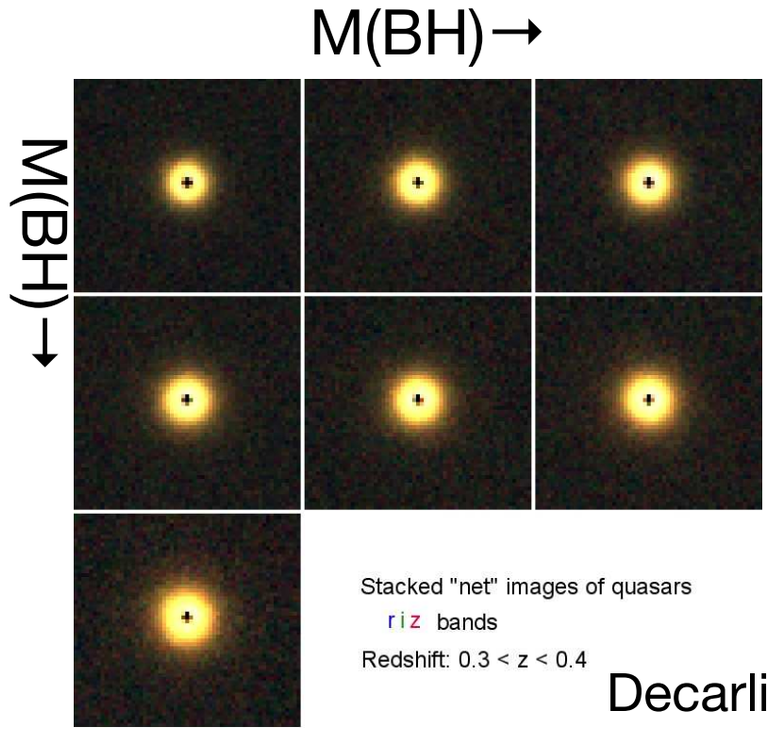
The origin of the Radius-Luminosity relation (Sirigu et al. 2012)



SMBH-host relations in QSOs and their z evolution from imaging stacking of the SDSS

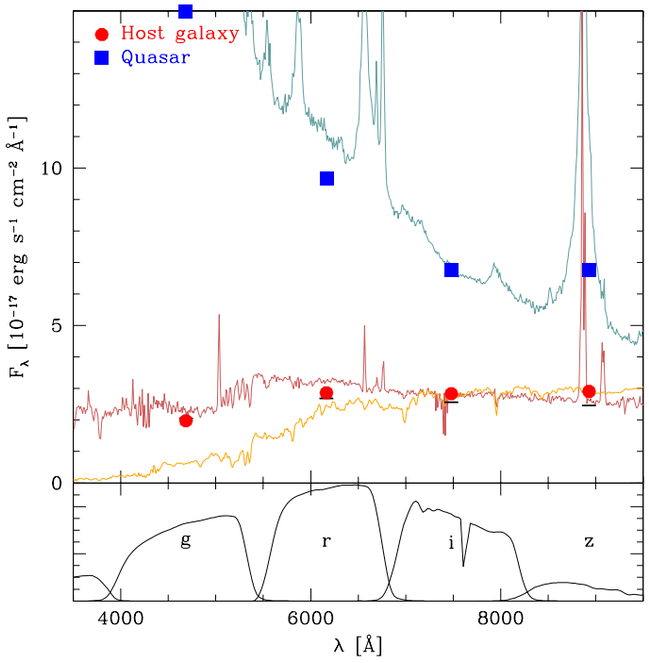
Stefano Zibetti (INAF-OAA, DARK) & Roberto Decarli (MPIA-Heidelberg)

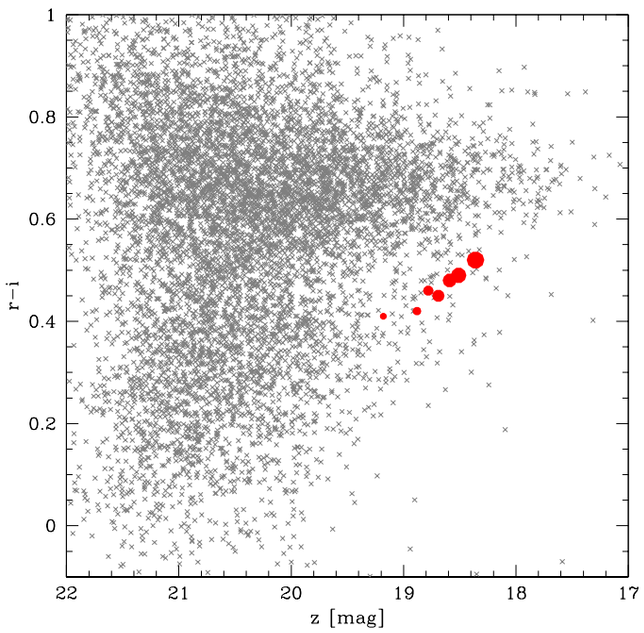
- Disentangling the light of QSOs from their host galaxy is extremely challenging, normally requiring high spatial resolution (HST, AO) and SNR: only relatively small samples available so far.
- The statistical work-around: stacking a large number of SDSS images allows to perform extremely accurate PSF subtraction and limit systematics.
- SED for hosts in 0.3<z<1, 7.5<Log M(BH)<10
  - Stellar masses
  - Evolution of the scaling relations



Decarli+11

Zibetti & Decarli, Decarli & Zibetti in prep.



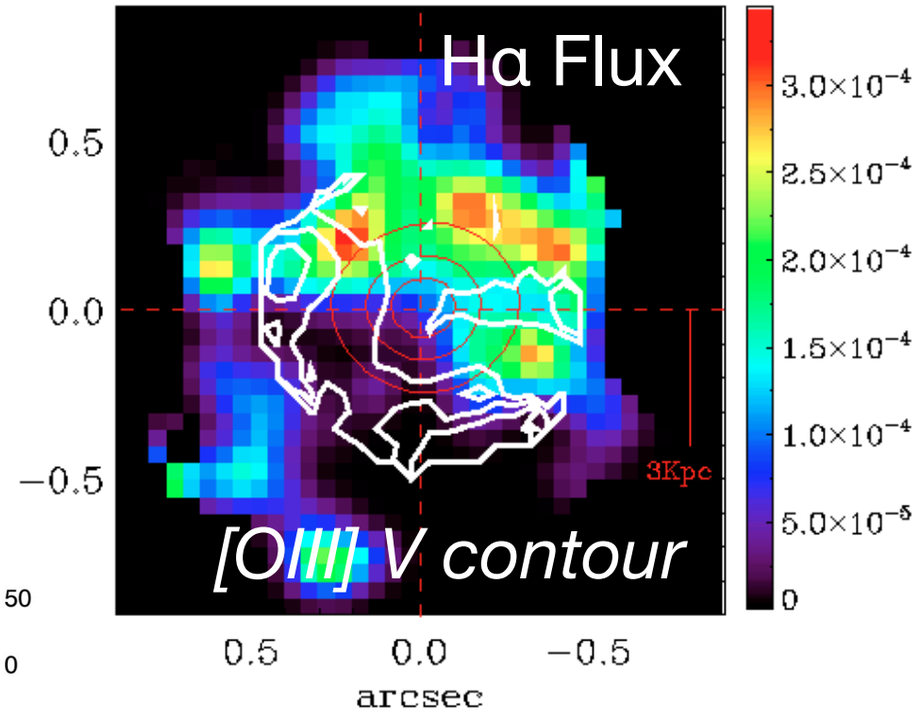


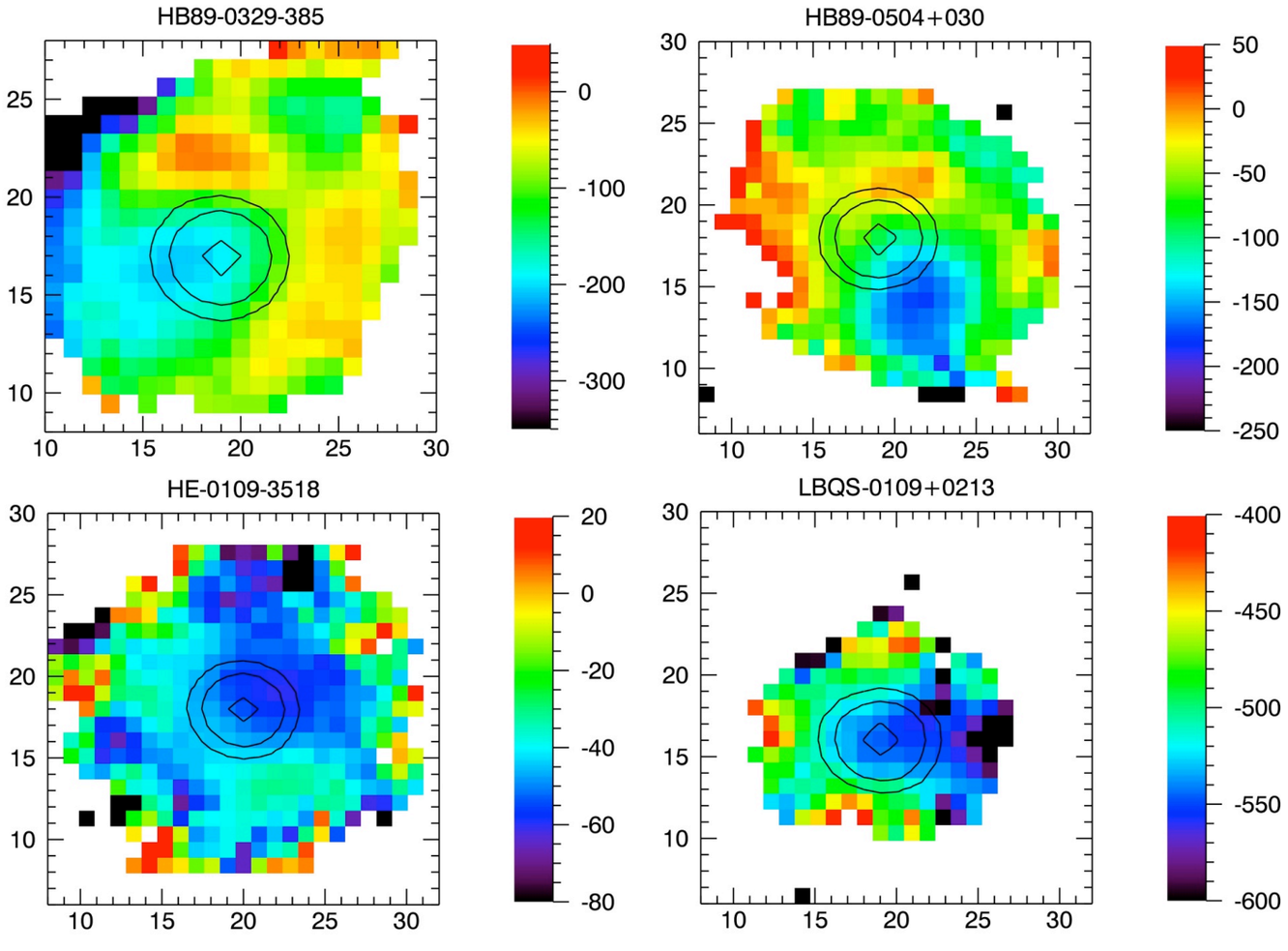
CMD for hosts at z~0.35 compared to galaxies

AGN Feedback

People: Marconi, Cresci, Salvati, Sirigu, Risaliti, Cano, Maiolino, Netzer, Axon, Robinson

z~2.4 quasar with outflow in [OIII] of ~300 km/s, associated with a velocity dispersion of ~700 km/s (FWHM ~ 1500 km/s!).
Hα from star formation is suppressed from outflow (Cano Diaz+11)





Other examples of fast conical outflows in z~2.4 quasars (Marconi et al. 2012, Cano Diaz et al. 2012)