An ESO/RadioNet Workshop
ESO Garching, 10–14 March 2014

3D2014

Gas and stars in galaxies: A multi-wavelength 3D perspective

Highlight talk session 6
Wednesday 16:25

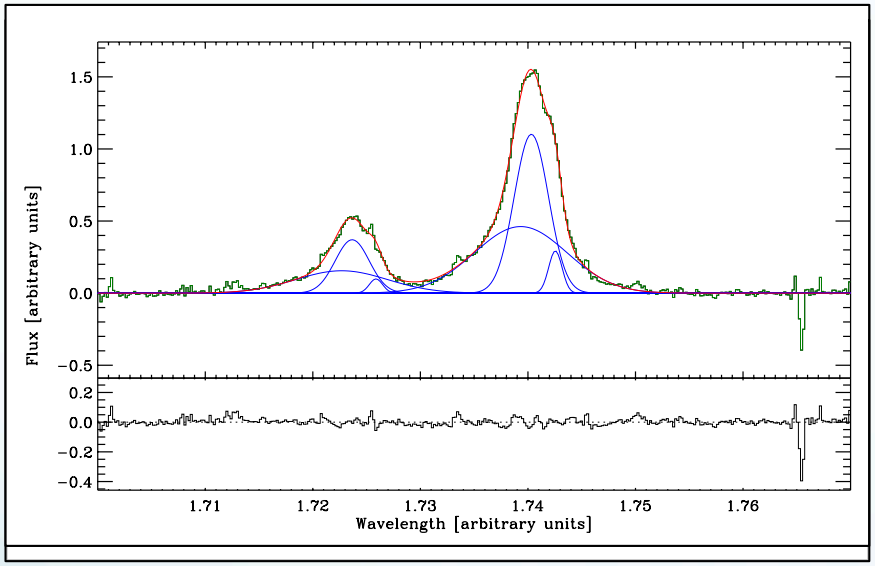
- **Carniani**
- **Sadler**
- **Husemann**
- **Burtscher**
- **Scharwaechter**

AGN outflow at redshift z=2.5

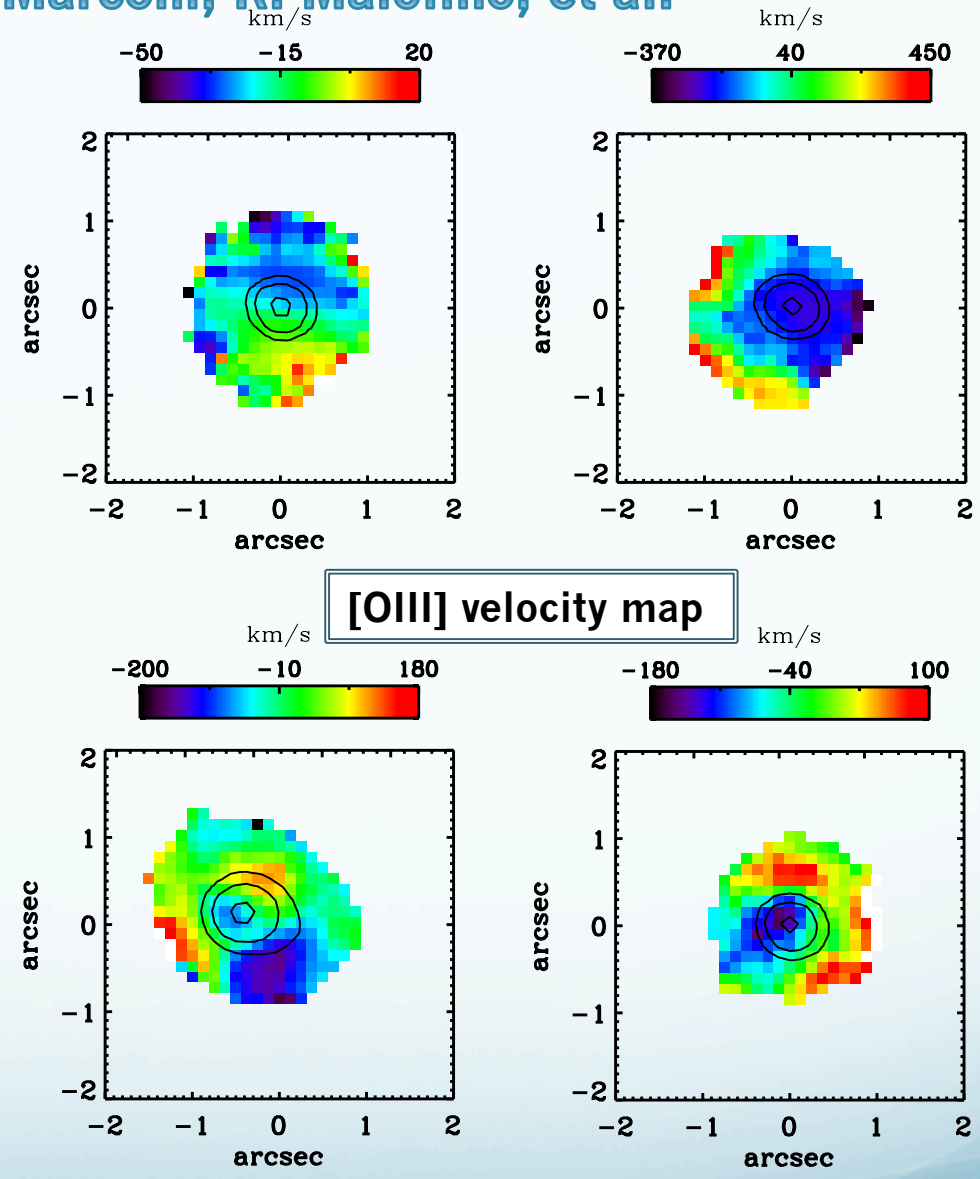
Stefano Carniani, A. Marconi, R. Maiolino, et al.

VLT/SINFONI observations of a sample of 6 quasar:

- z~ 2.3 – 2.5
- $L_{bol} \sim 10^{47} – 10^{48}$ erg/s
- Target [OIII] 5007 line



Fast (> 100 km/s) blue-shifted emission with very large velocity dispersion (FWHM > 1000 km/s)



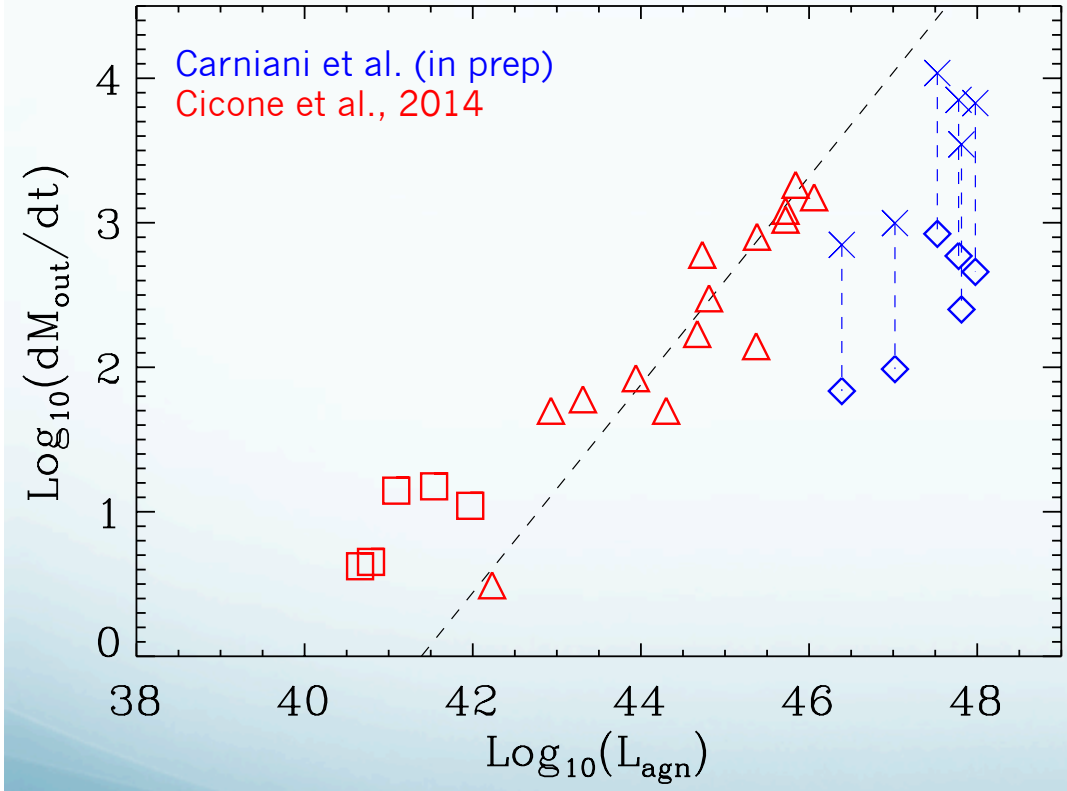
[OIII] velocity map

The strong blue asymmetry of the line suggests the presence of outflow ionized gas that, given the velocities, can only be ascribed to the AGN

$[OIII]_{\lambda 5100}$ as a tracer of ionized outflows

$$M_{[OIII]outflow} = 3.3 \times 10^7 M_\odot \left(\frac{C}{10^{[O/H]}}\right)\left(\frac{L_{[OIII]}}{10^{44} erg/s}\right)\left(\frac{< n_e >}{10^3 cm^{-3}}\right)^{-1} \qquad T_e = 10^4 K$$

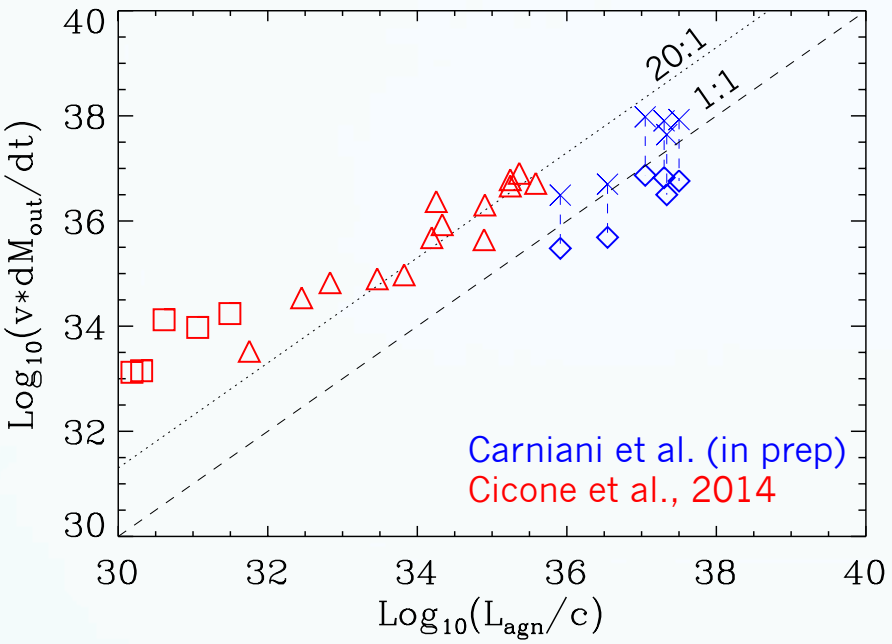
$$\dot{M} \approx \frac{M_{[OIII]outflow} v_{out}}{R_{out}}$$

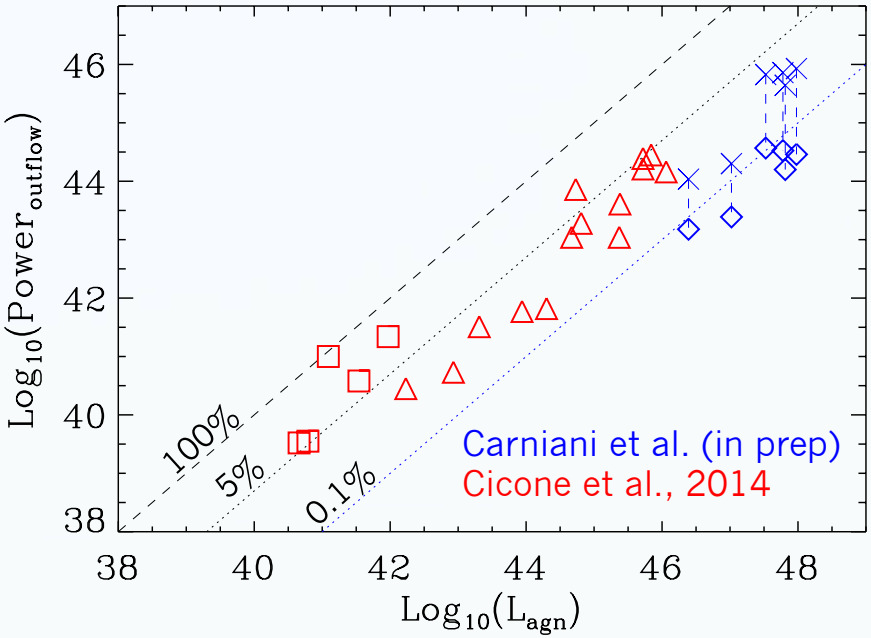


Outflow rate increases with AGN luminosity

- **Ionized outflow assuming $n_e = 10^3$ cm^{-3}**
- **Ionized outflow assuming $n_e = 10^2$ cm^{-3}**
- **Molecular outflow (local AGN)**
- **Molecular outflow (local starburst)**

$[OIII]_{\lambda 5100}$ as a tracer of ionized outflows

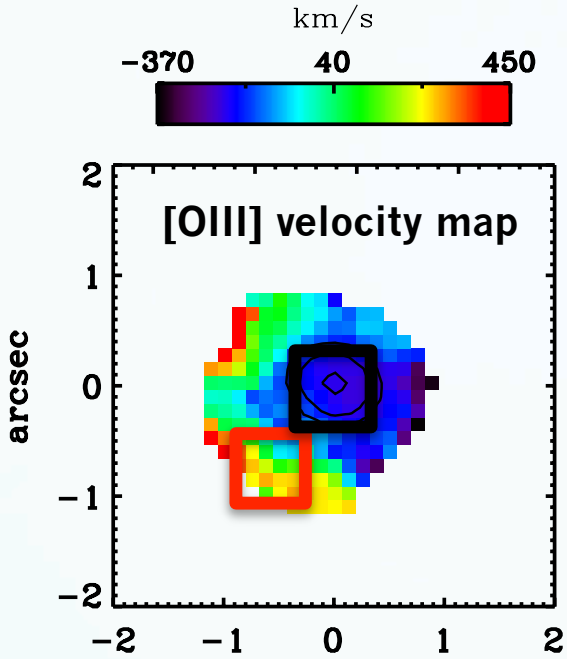


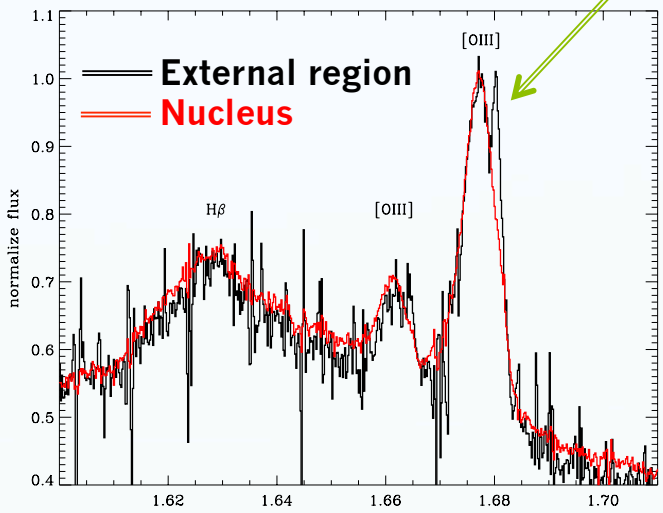


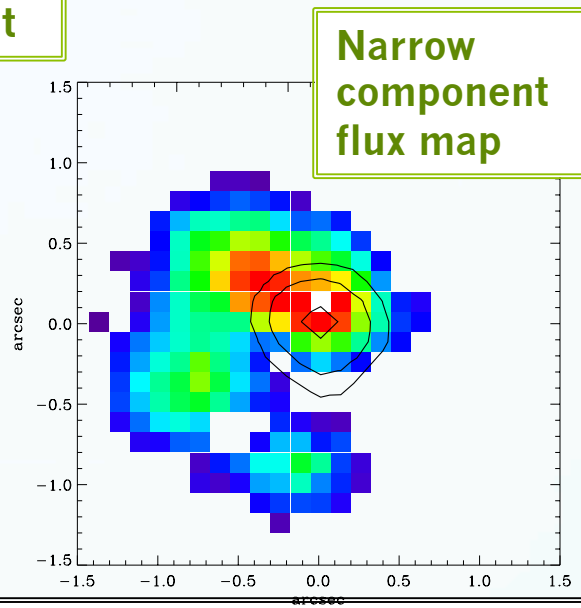
The momentum rate transferred by the AGN emission to the gas is given by the average number of photon scattering

The [OIII] ionized gas is accelerated far from the AGN nuclear region

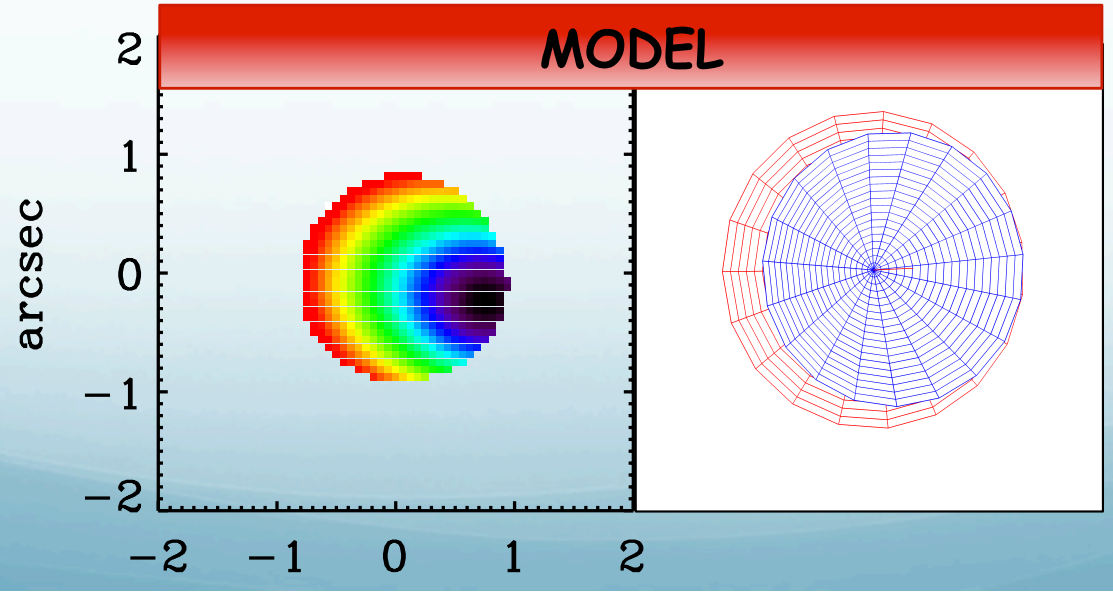
Star formation in the host galaxy is strongly suppressed from the outflow







In the region where the [OIII] outflow velocity is larger, the "narrow" line emission is suppressed



Large surveys for 21cm HI absorption

Elaine Sadler (University of Sydney/CAASTRO) and the ASKAP FLASH team

Motivation: Use 21cm HI absorption to probe neutral atomic hydrogen in distant galaxies - unlike HI emission, *sensitivity is independent of z*

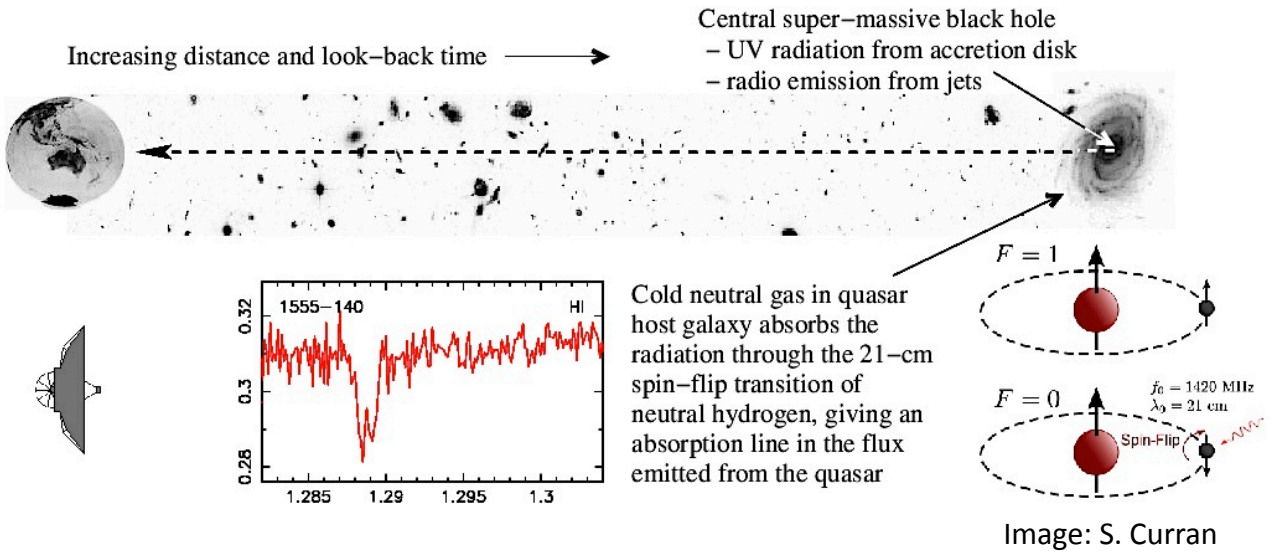


Image: S. Curran

Intervening absorbers: Cosmic evolution of HI in galaxies
Associated absorbers: AGN fuelling and feedback

ASKAP-FLASH

THE UNIVERSITY OF SYDNEY

ASKAP FLASH – the First Large Absorption Survey in HI

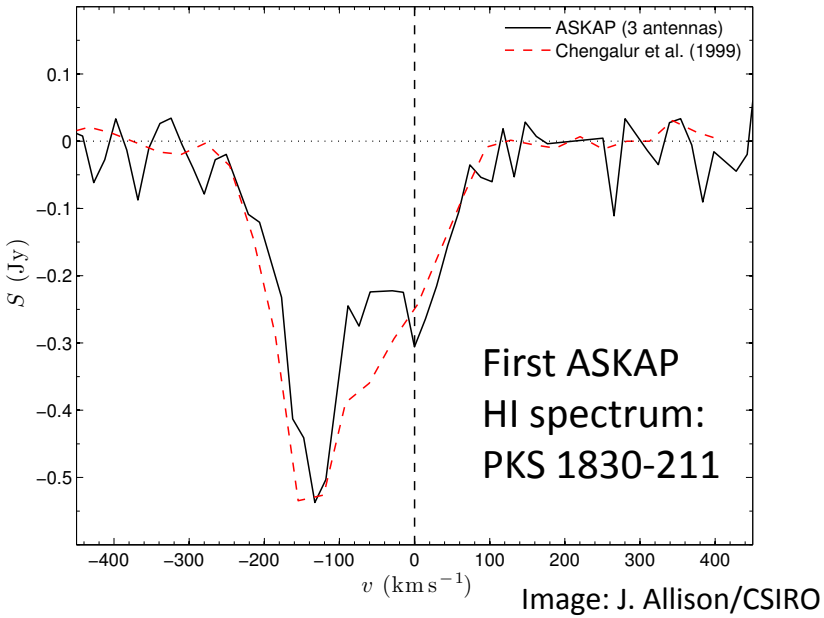


Image: J. Allison/CSIRO

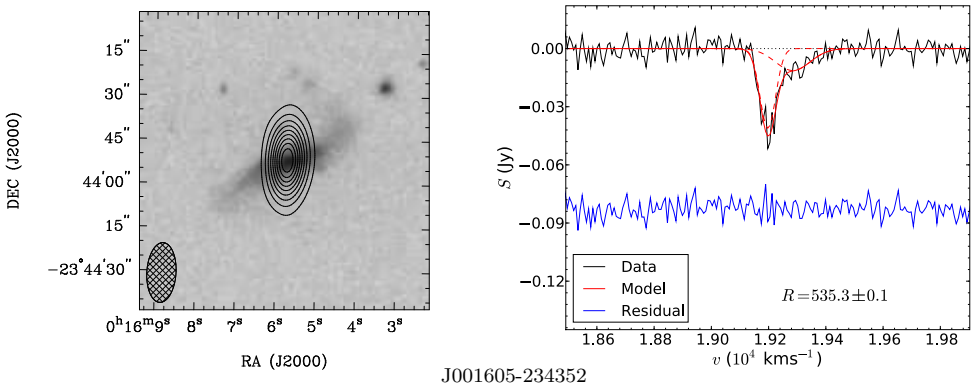
New parameter space opened up by ASKAP:

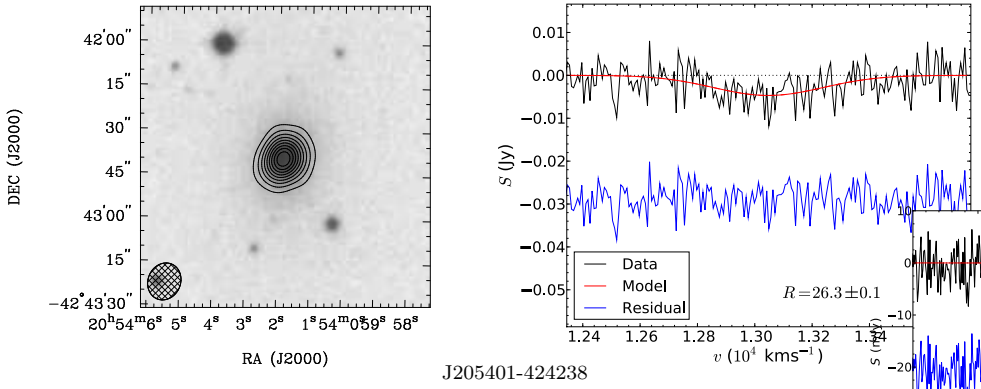
- 30 deg^2 field of view (PAF) – survey whole southern sky (>150,000 sightlines)
- Wide bandwidth – e.g. simultaneous coverage of redshift 0.5 < z < 1
- Radio-quiet site – RFI levels exceptionally low below 1 GHz

FLASH early science 2015-16, full survey from 2016-17

HI absorption in nearby compact radio galaxies

(with James Allison, Steve Curran, Bjorn Emonts, Katinka Gereb, Elizabeth Mahony, Sarah Reeves, Martin Zwaan)

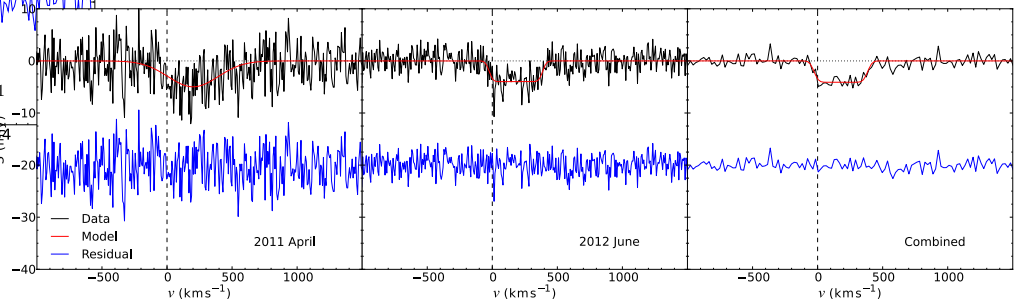




Australia Telescope Compact Array – targeted observations of ~40 compact radio galaxies at $0.04 < z < 0.1$.

Used an automated Bayesian line-finding tool (Allison et al. 2012) to find and fit HI absorption lines.

HI detection rate ~10%, mixture of early- and late-type galaxies.

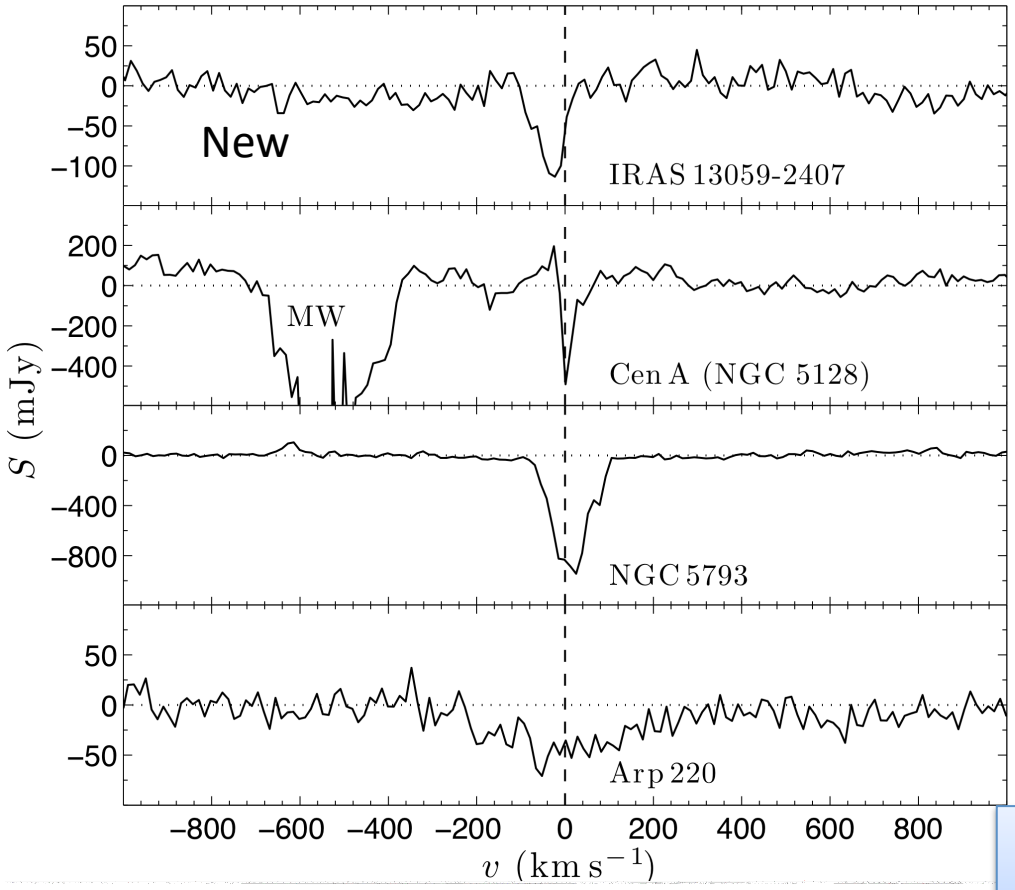


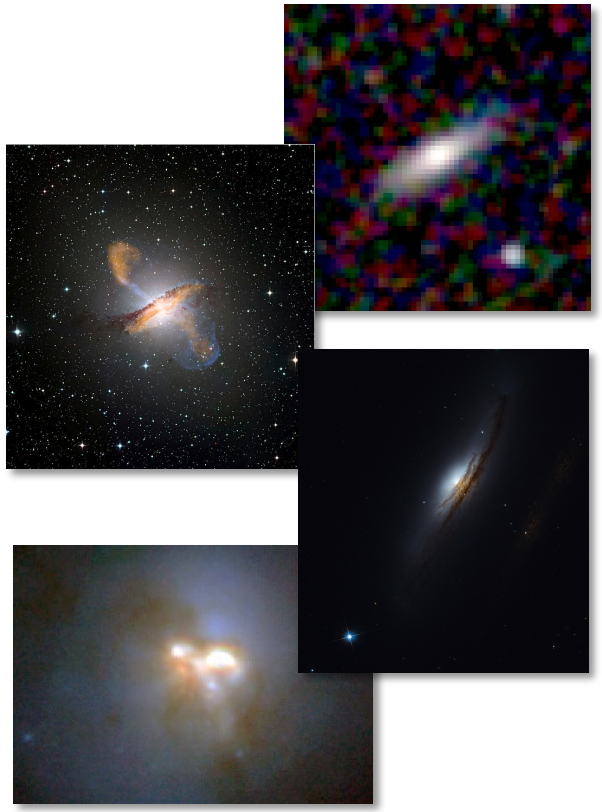
(Allison et al. 2012, 2013)

Associated HI absorption in HIPASS

4 detections in 210 nearby radio-loud galaxies (z < 0.04)

(with James Allison and Alex Meekin)





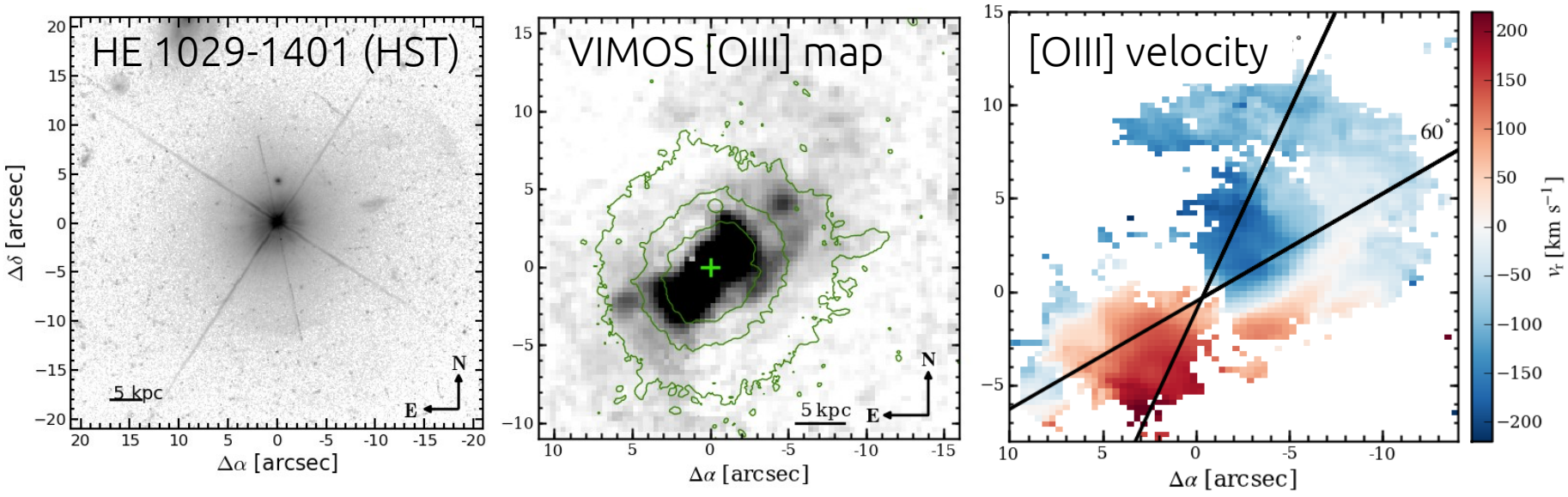
(Allison et al. 2014, MNRAS in press)

Strong associated HI absorption linked to presence of OH/H_20 megamasers?

Probing the QSO-host galaxy connection with 3D spectroscopy

Bernd Husemann (ESO fellow)

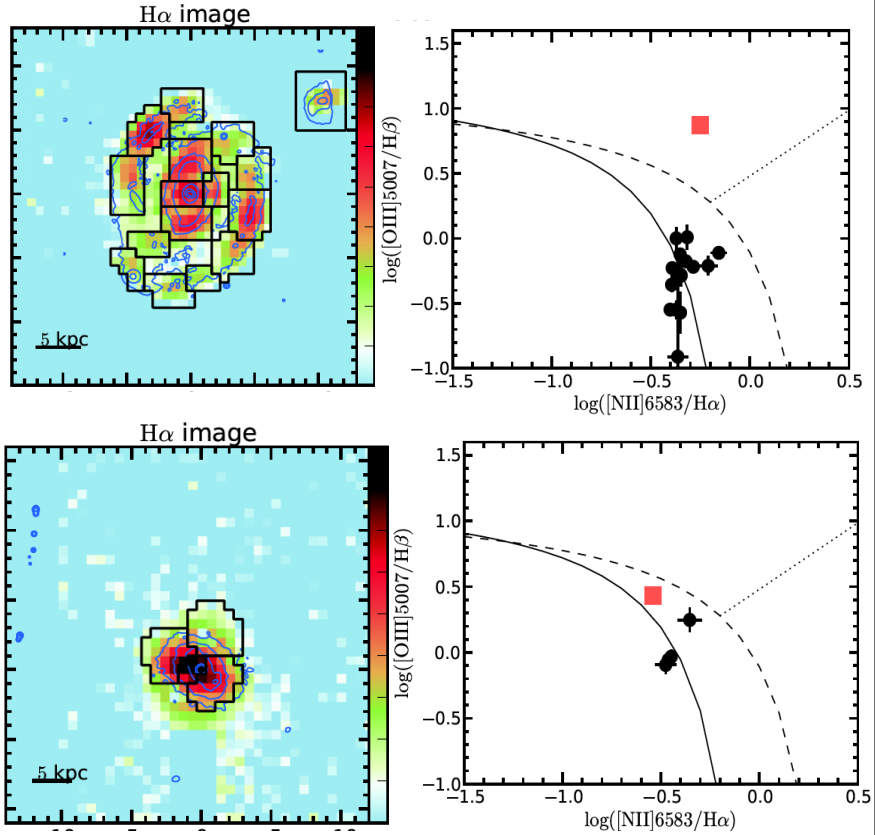
L. Wisotzki (AIP), K. Jahnke (MPIA), S. F. Sanchez (UNAM),
T. Davis (ESO), H. Dannerbauer (Uni Vienna), J. Hodge (NRAO),
V. Wild (St. Andrews), D. Gadotti (ESO), S. Bekeraite (AIP)



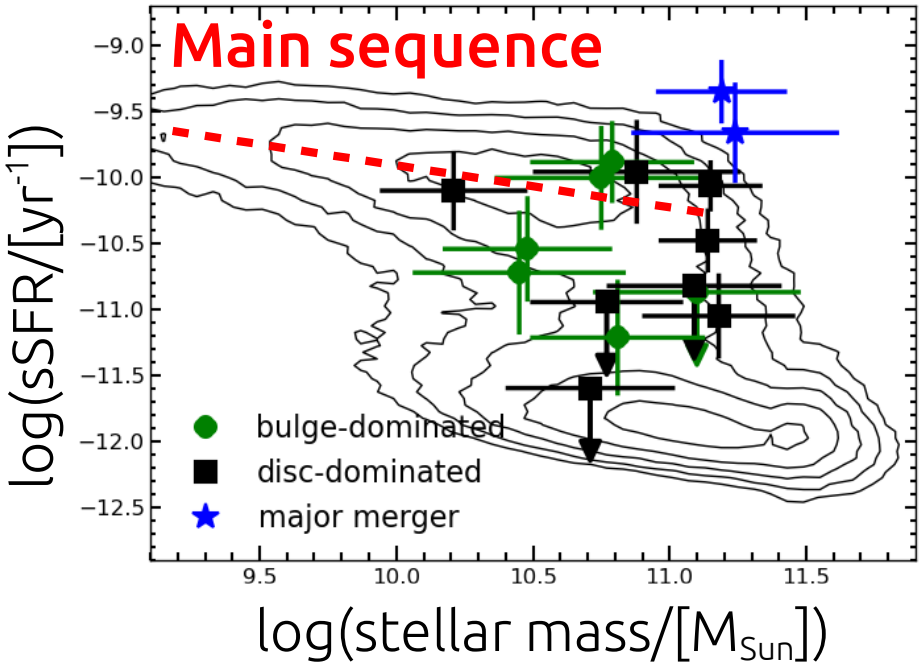
QSO emission can be subtracted in 3D spectroscopic data!

Quenching of star formation by AGN feedback?

Extinction-corrected Hα emission as SFR tracer



- 18 QSOs at 0.027<z<0.2
- deep HR VIMOS IFU spectroscopy

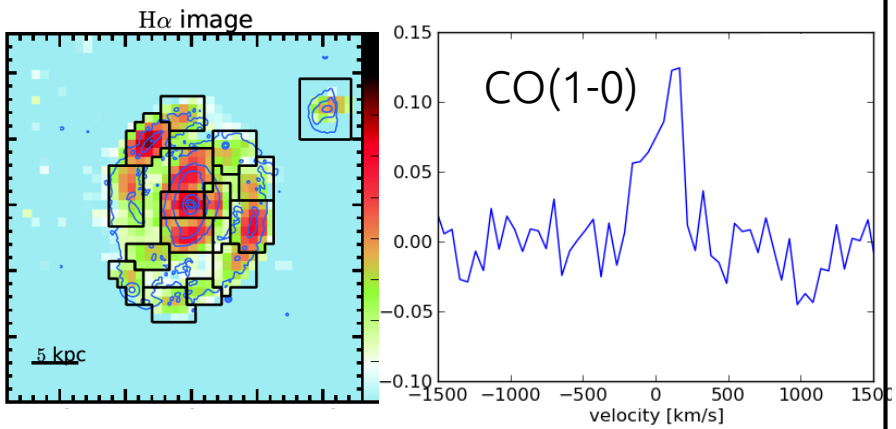


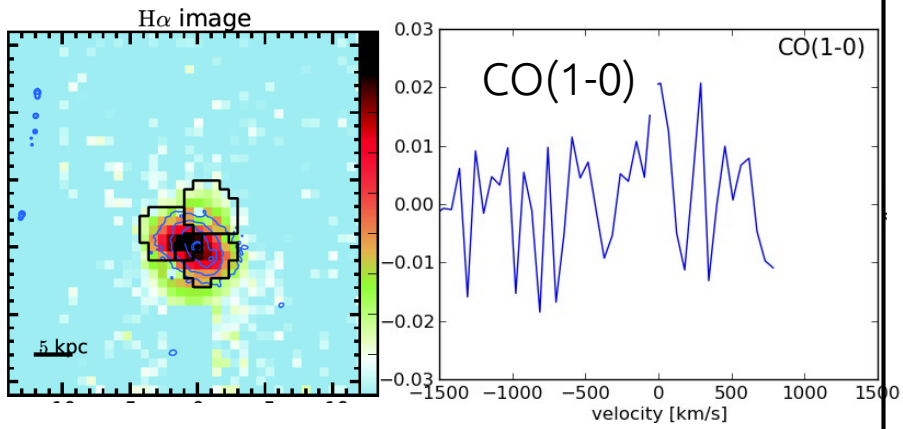
- **SFR in QSO hosts is diverse**
- **Major mergers above MS**
- **Several QSOs below MS**

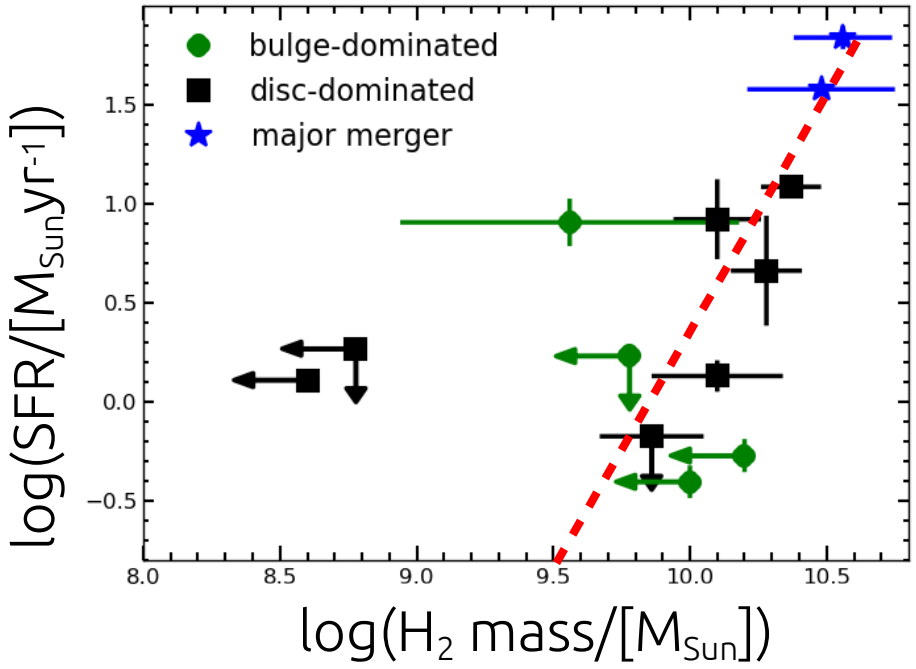
➔ **Signature of AGN feedback?**

The star formation efficiency of QSO hosts

Combining VIMOS IFU & IRAM 30m sub-mm data







- **Linear relation between SFR and H2 gas mass**
- **Only a few objects are significantly off the relation**

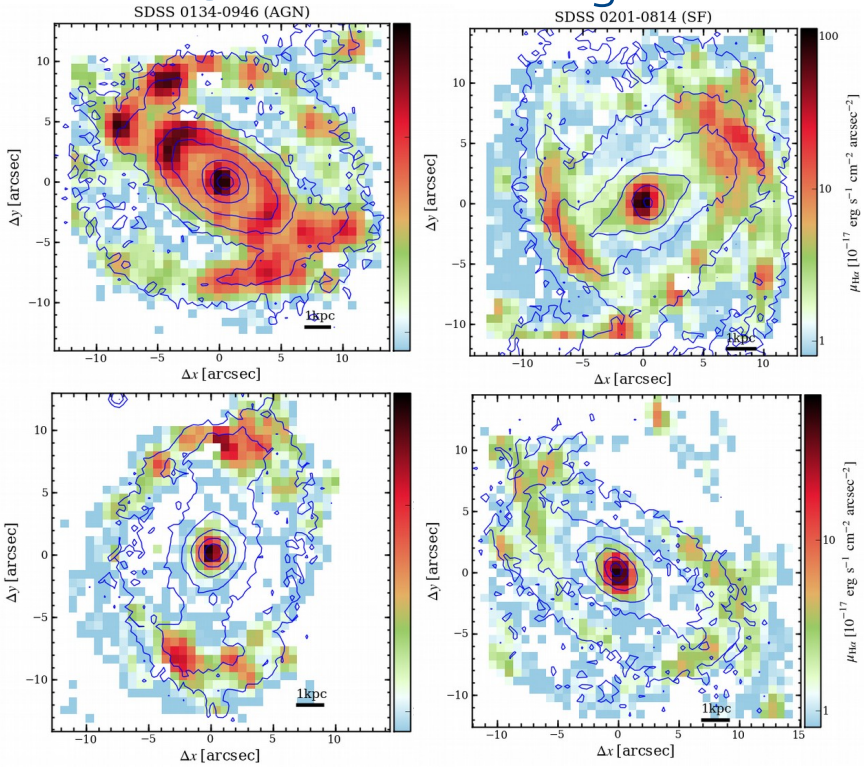
➔ **Normal conditions for SF?**

Spatially resolved comparison study of star formation in AGN and SF galaxies

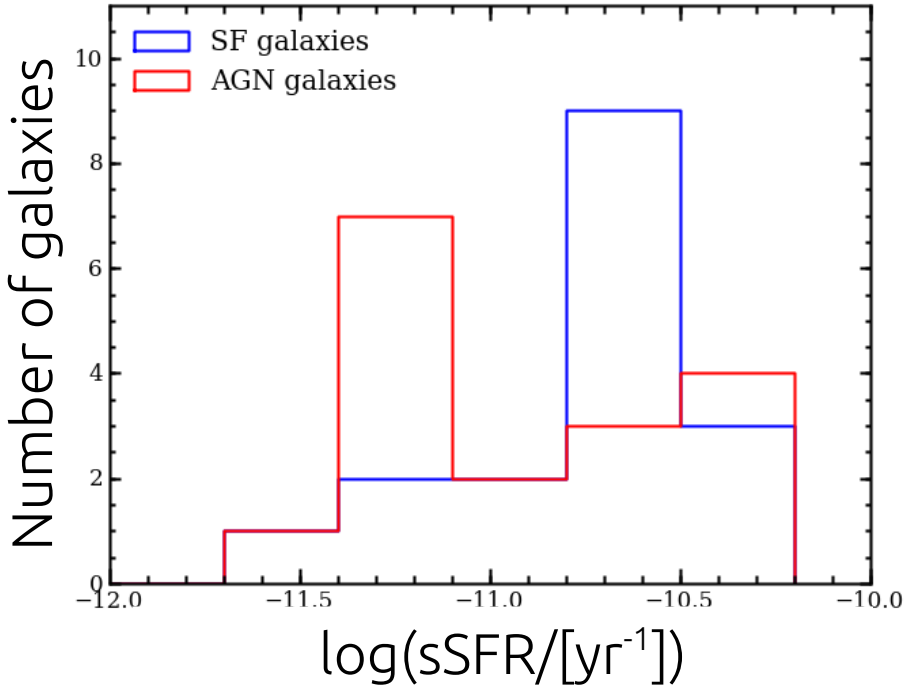
Reconstructed Hα images

AGN galaxies

SF galaxies



- 20 AGN and 20 star forming galaxies
- Narrow stellar mass range
- Late-type and face-on galaxies
- Redshift $0.03<z<0.05$ and $\delta<10°$



- **AGN distribution peaks at lower SFR than SF galaxies**
- **Need to be sure that the AGN is causing this change**

➔ Comparison samples are the key to study the effect of AGN

~~The disappearance of the AGN torus~~

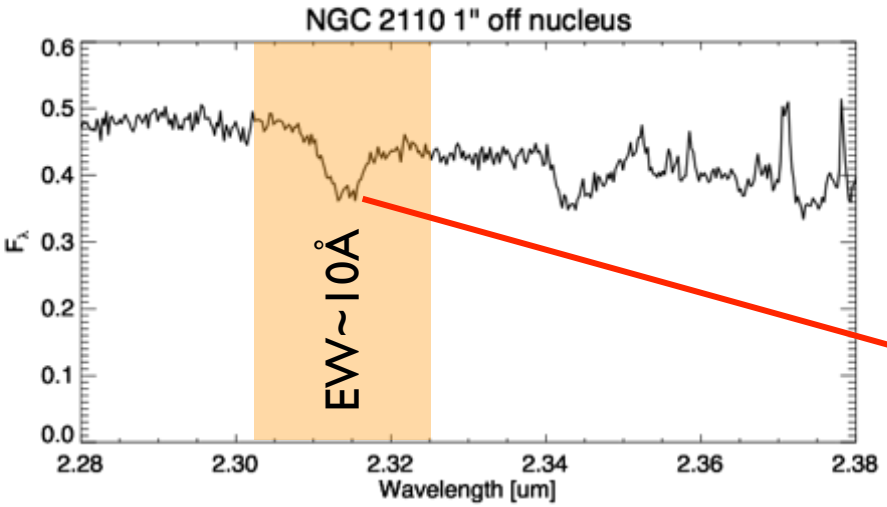
The nuclear non-stellar continuum in the near-IR

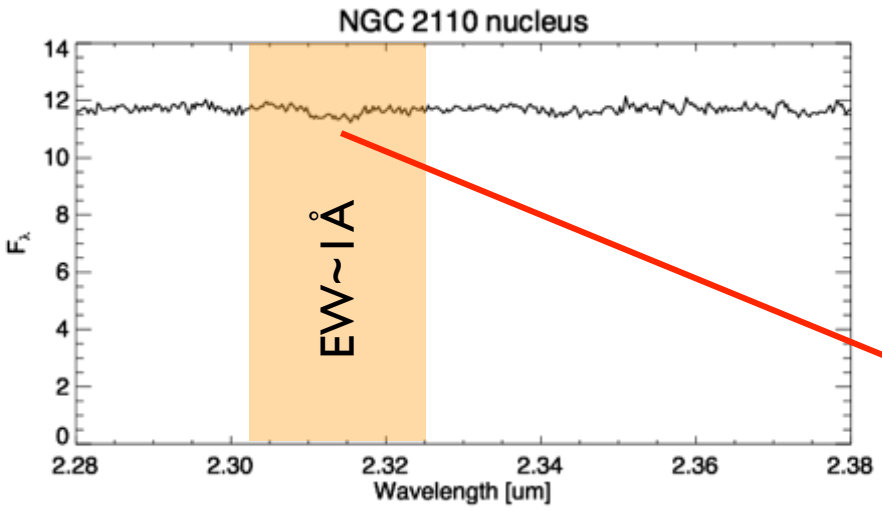
Leonard Burtscher, Ric Davies, Ming-Yi Lin,
Gilles Orban de Xivry, David Rosario

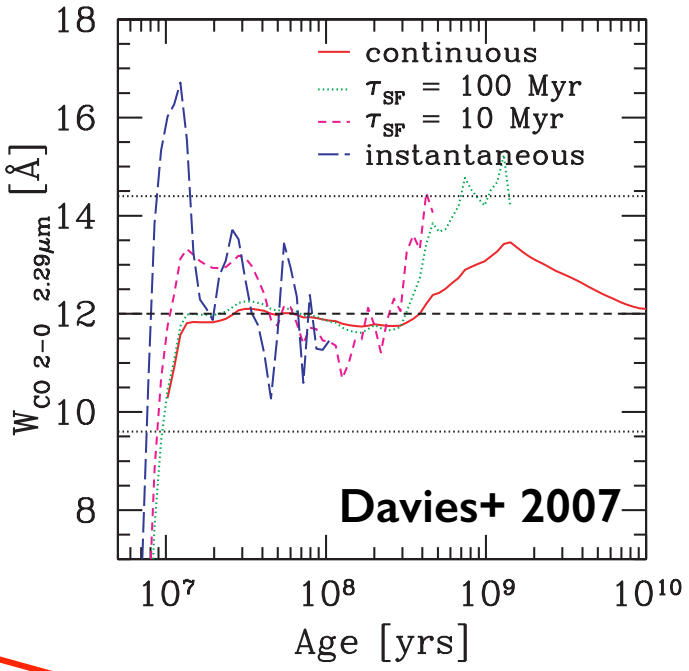
Bottomline:
There is a strong correlation between the nuclear near-IR continuum and the X-Rays as well as nuclear mid-IR continuum, with no difference between type 1/2 AGNs

Burtscher et al. (soon to be submitted)

Probing the non-stellar continuum with SINFONI

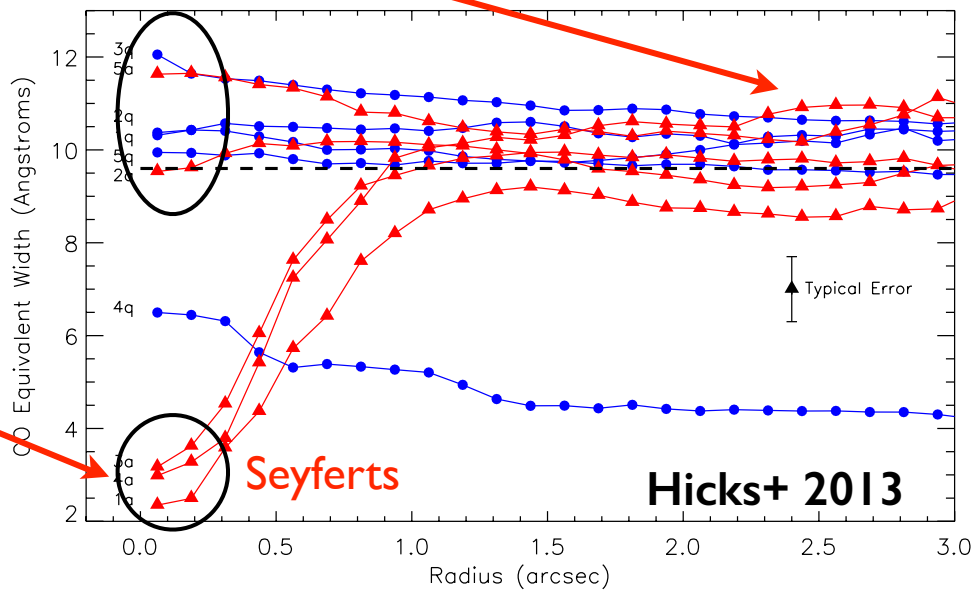


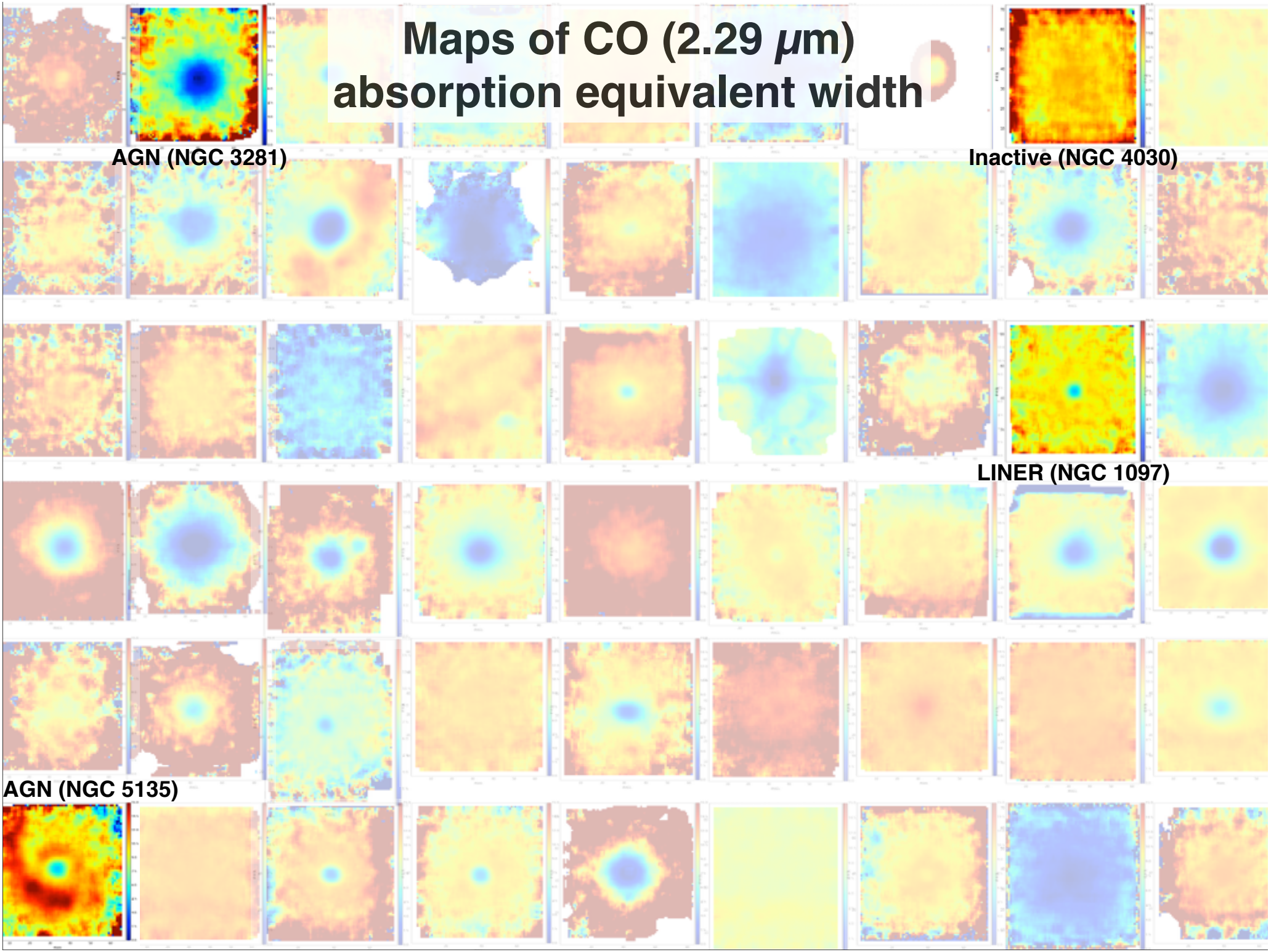




LLAGNs

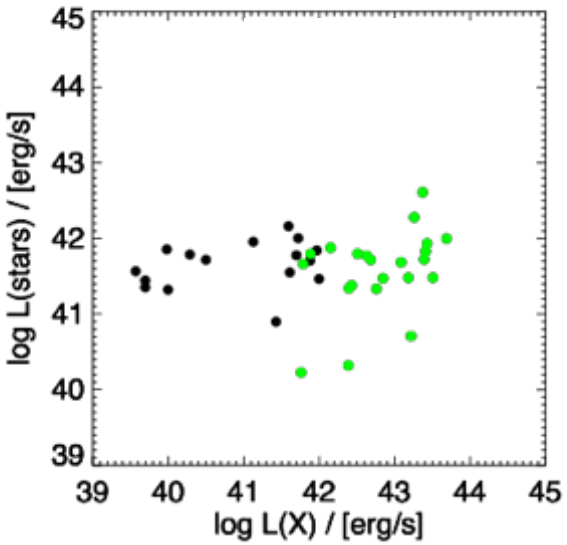
inactive

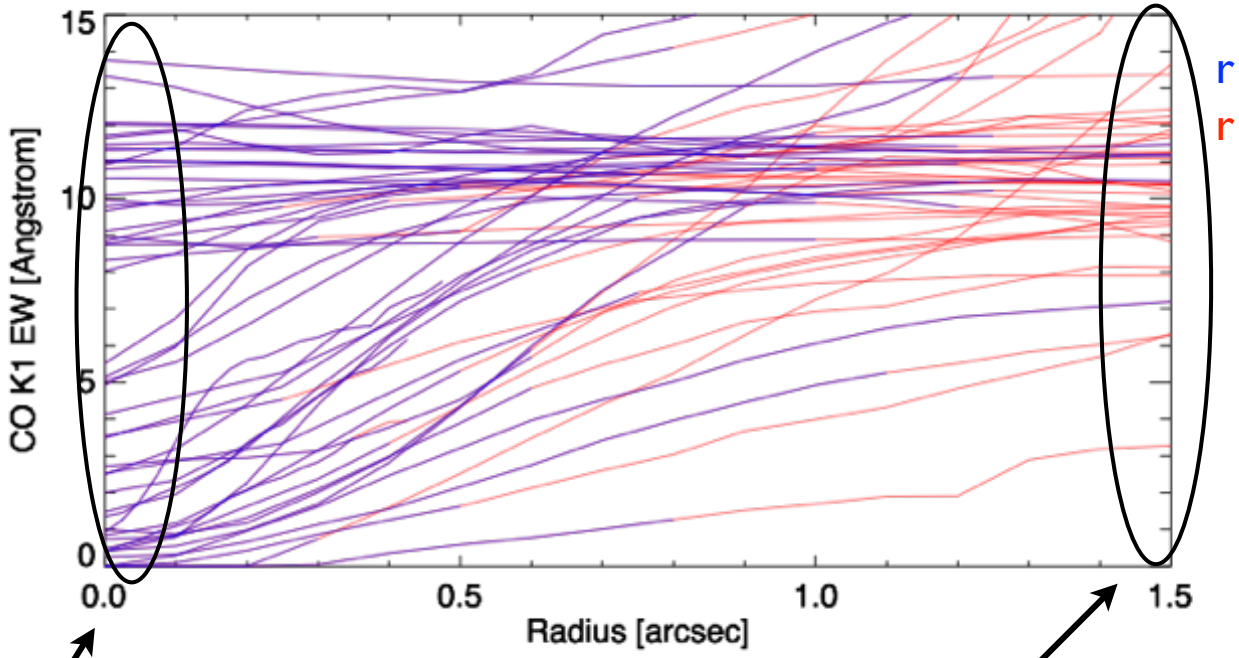



Maps of CO (2.29 μm)
absorption equivalent width
AGN (NGC 3281)
Inactive (NGC 4030)
LINER (NGC 1097)
AGN (NGC 5135)

Equivalent Width (r)

And the reason is:





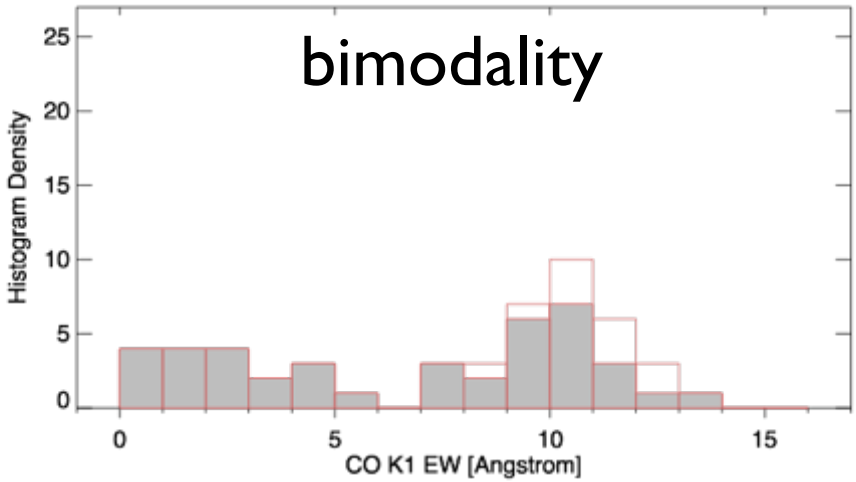
r < 200 pc

r > 200 pc

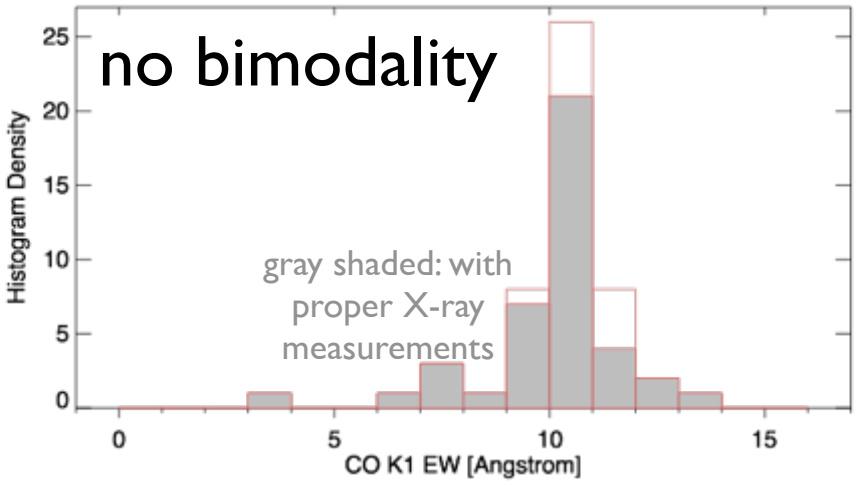
nuclear distribution

intrinsic distribution

bimodality

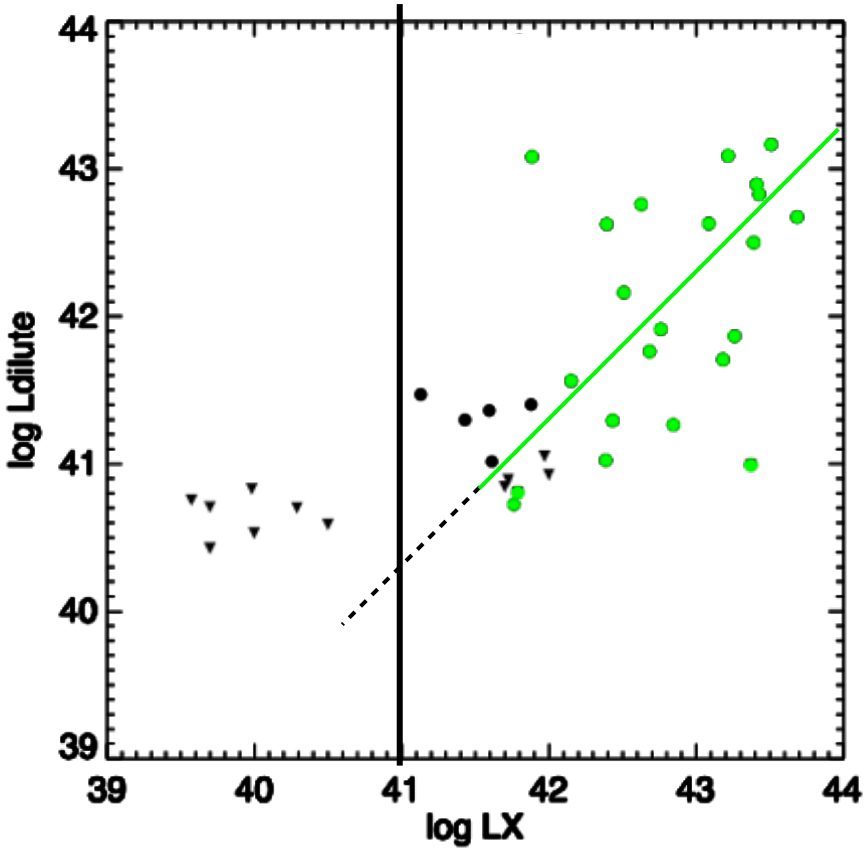


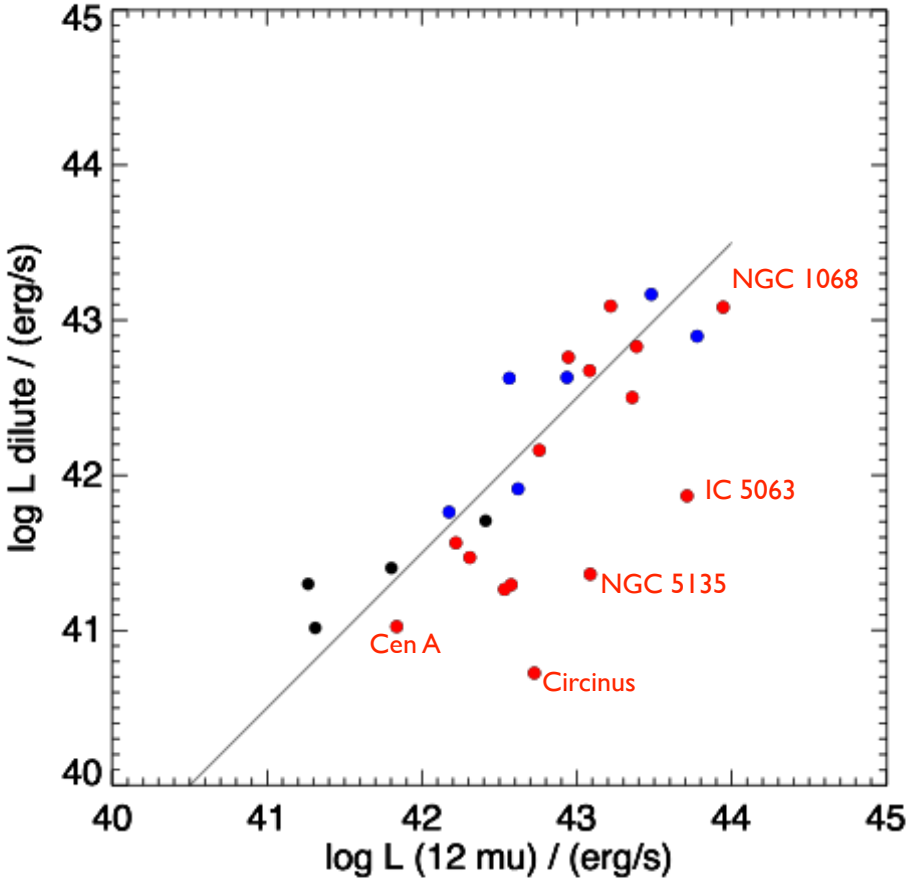
no bimodality



The non-stellar continuum

$L_{bol} \sim 10^{42}$ erg/s





Need ~ 10x better resolution to discriminate between stellar and non-stellar light in very weak AGNs...

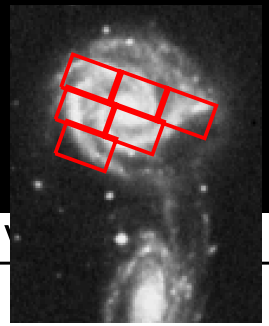
Burtscher et al. (soon to be submitted)

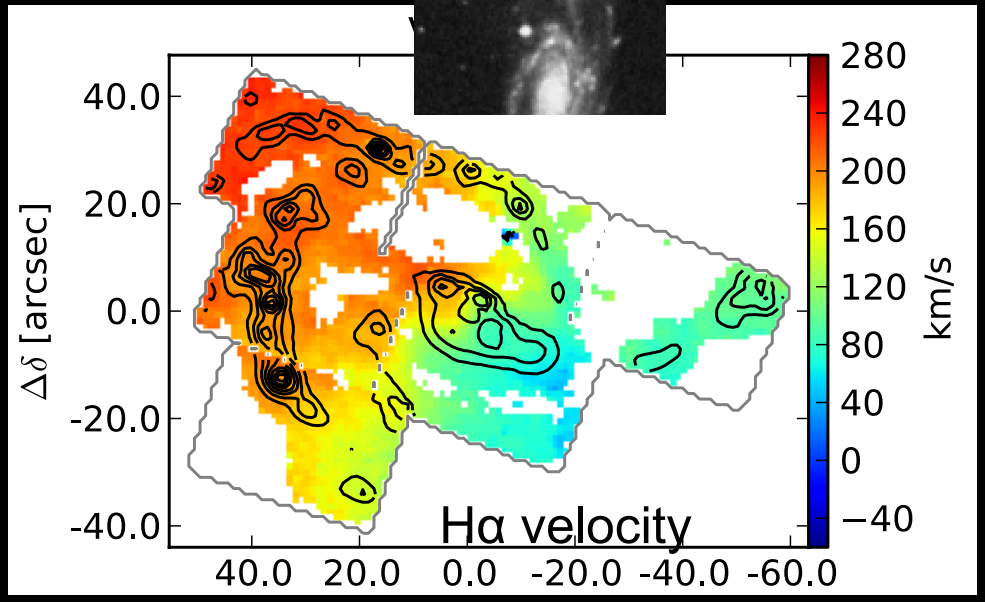
- Tight correlation between near-IR non-stellar light and nuclear mid-IR
- no type 1/2 dichotomy, as in Lmir - LX relation
- but: perhaps some interesting outliers

3D view on ionised gas in Seyfert galaxies

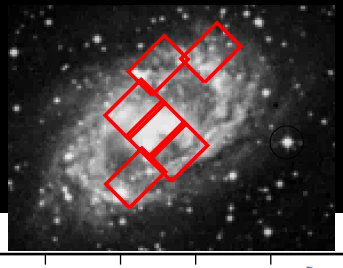
Julia Scharwächter (Observatoire de Paris, LERMA)

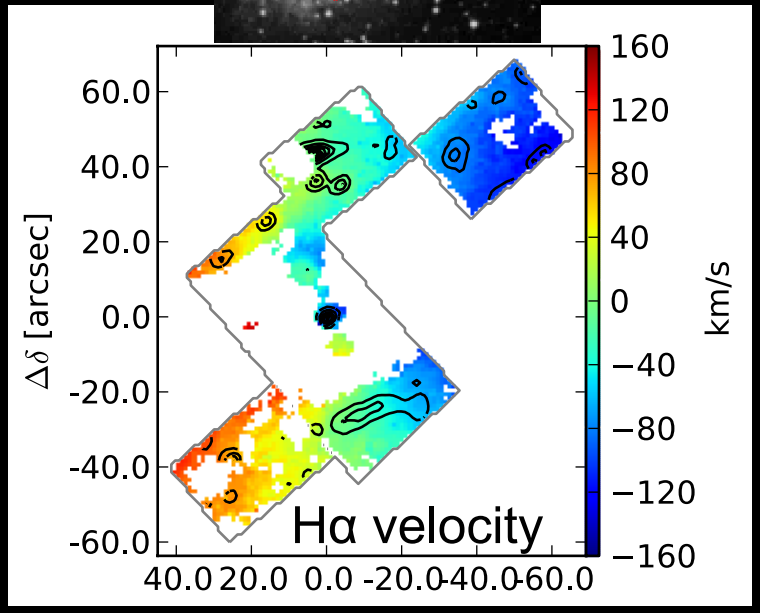
NGC 5427
(Seyfert 2)





NGC 6300
(Seyfert 2)





This large-field IFU study is part of....

S7 Siding Spring Southern Seyfert Spectroscopic Snapshot Survey

Team **Michael Dopita[1], Prajval Shastri[2]**, Lisa Kewley[1], Julia Scharwächter[3], Preeti Kharb[2], Jessy Jose[2], Rebecca Davies[1], Julie Banfield[4], Ralph Sutherland[1], Elise Hampton[1], Harish Bhatt[2], Ramya Sethuram[2], Shweta Srivastava[5]

[1] Australian National University; [2] Indian Institute of Astrophysics; [3] Observatoire de Paris; [4] CSIRO, Australia; [5]Gorakhpur University, India

Project Optical integral field survey of >100 Seyfert galaxies

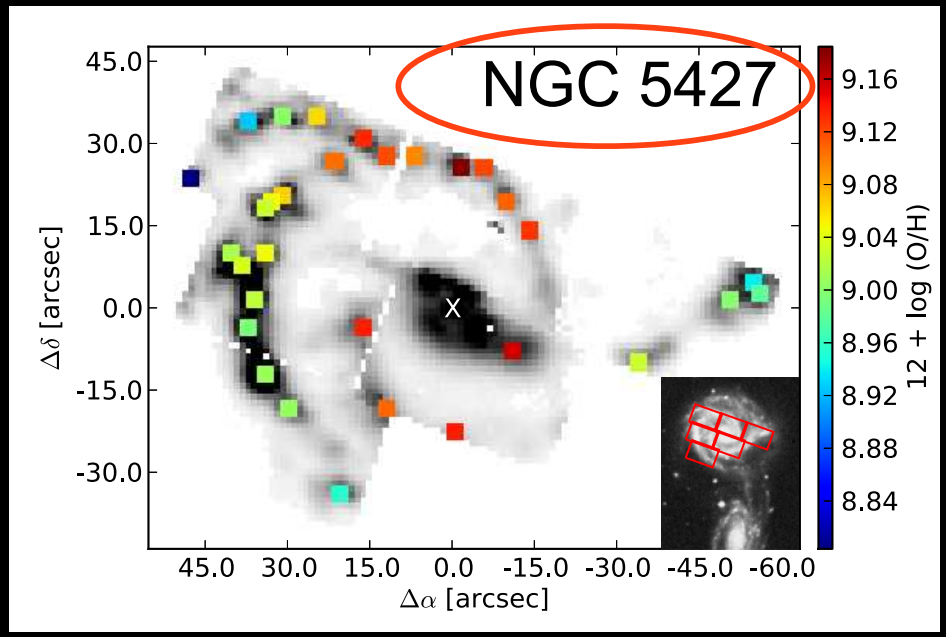
Data Wide Field Spectrograph - WiFeS (Dopita et al. 2010)

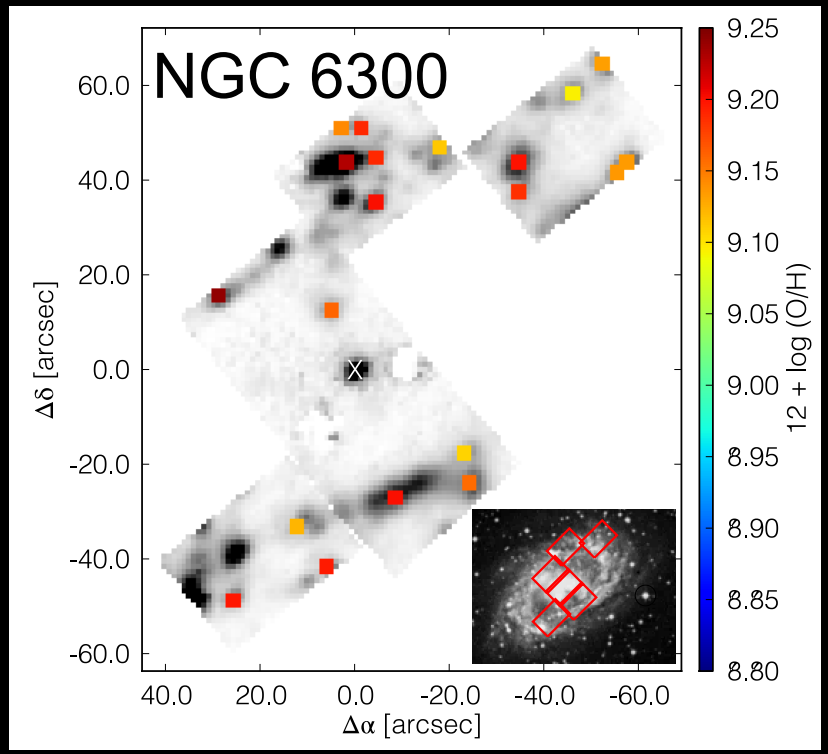
Science (Extended) NLR, NLR kinematics, AGN EUV continuum, chemical abundance, gas inflows/outflows, role of jet, ...

NGC 5427 and NGC 6300: Six WiFeS fields

Large data set for line diagnostics at ~3600-7000 Å

- E.g. HII region metallicities (using *pyqz,* Dopita et al. 2013)

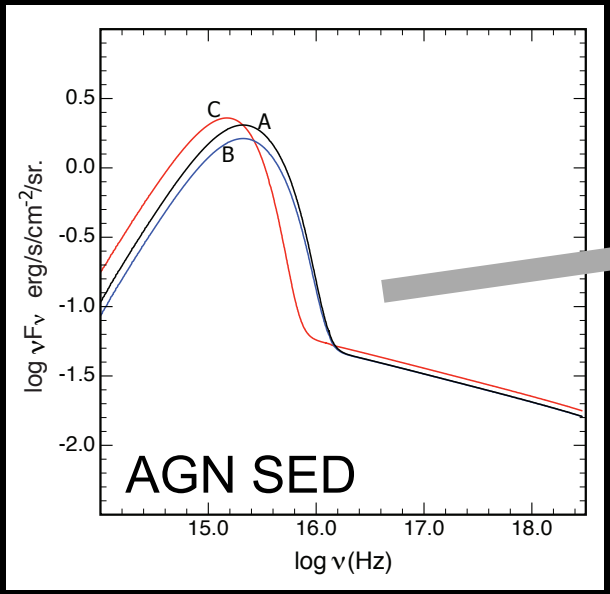


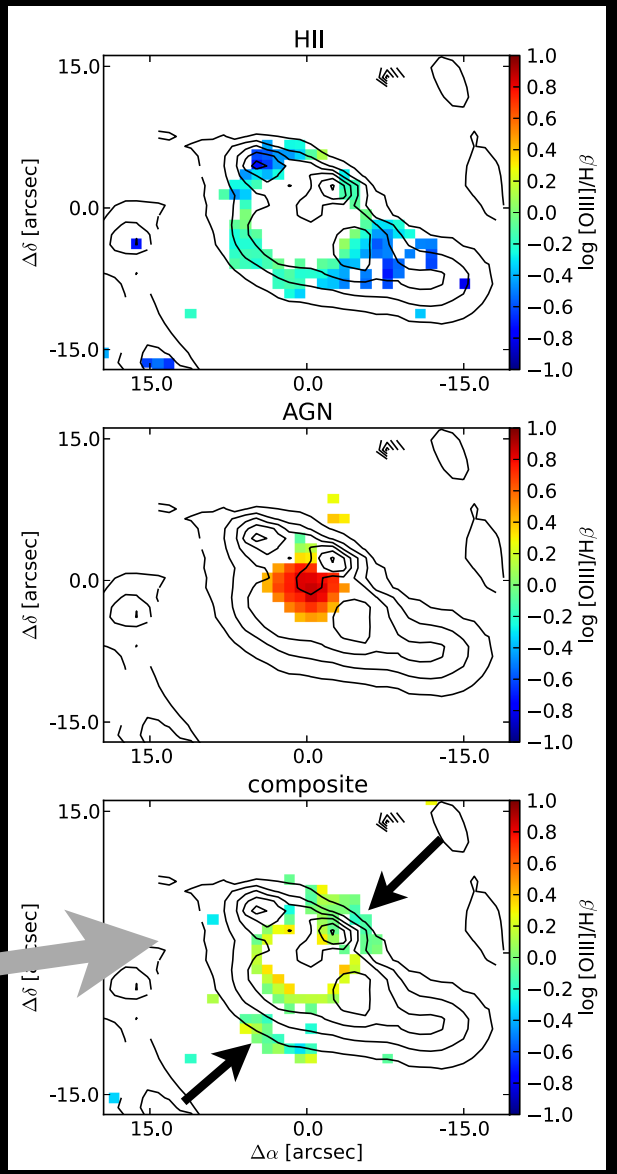


First results: NGC 5427

Dopita, Scharwächter, Shastri, Kewley, Davies, Sutherland, Kharb, Jose, Hampton, Jin, Banfield, Basurah & Fischer, submitted

Using HII regions to constrain nuclear chemical abundances and the AGN photoionising continuum





Extended NLR:
Mixing between NLR spectrum and HII regions
(cf. Scharwächter et al. 2011, Davies et al. 2014)