



SIGNATURES OF QUASAR FEEDBACK

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INTRODUCTION



INTRODUCTION



INTRODUCTION



released energy by BH

$$0.1 M_{\text{BH}} c^2$$

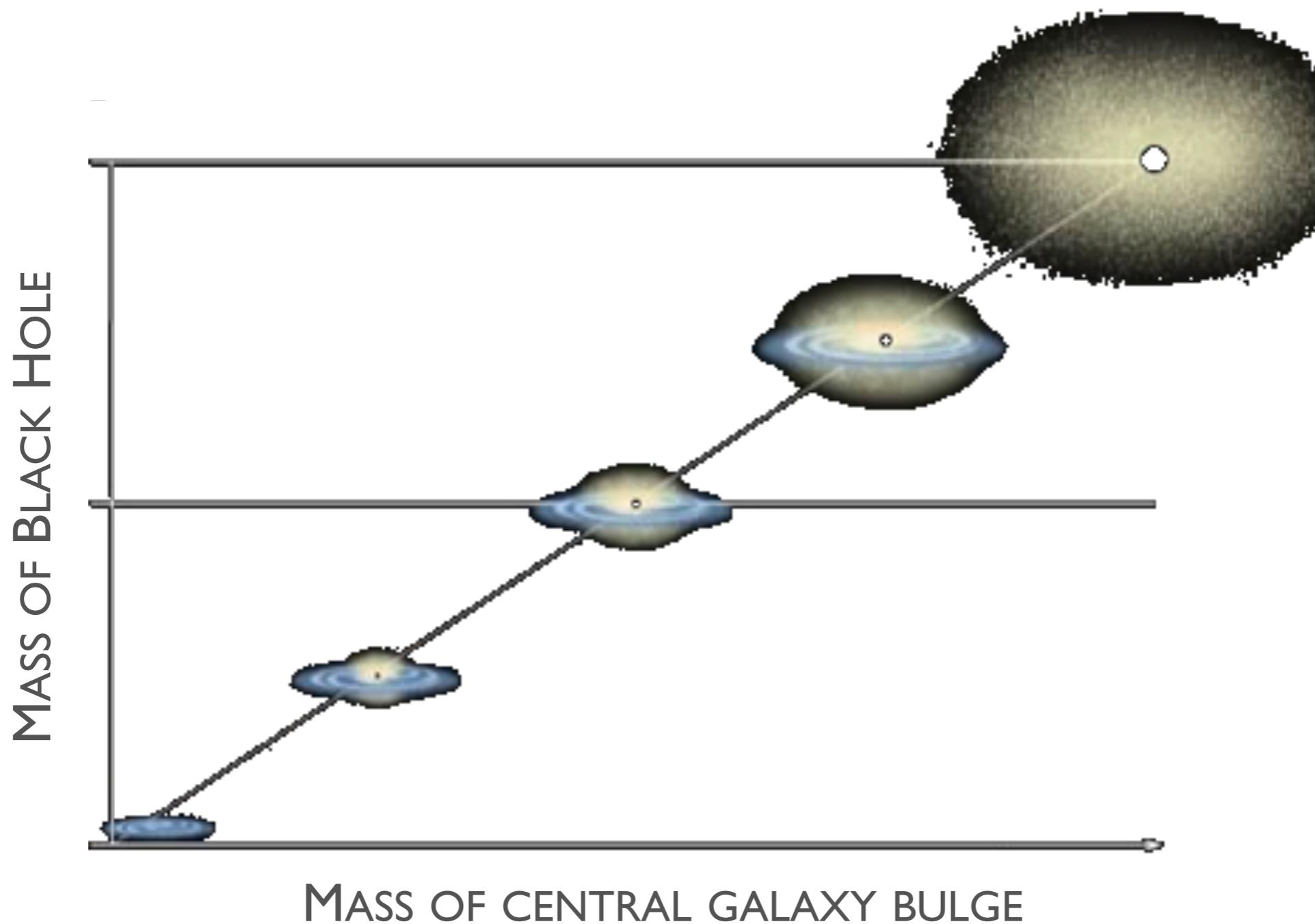


binding energy of galaxy

$$M_{\text{gal}} \sigma^2$$



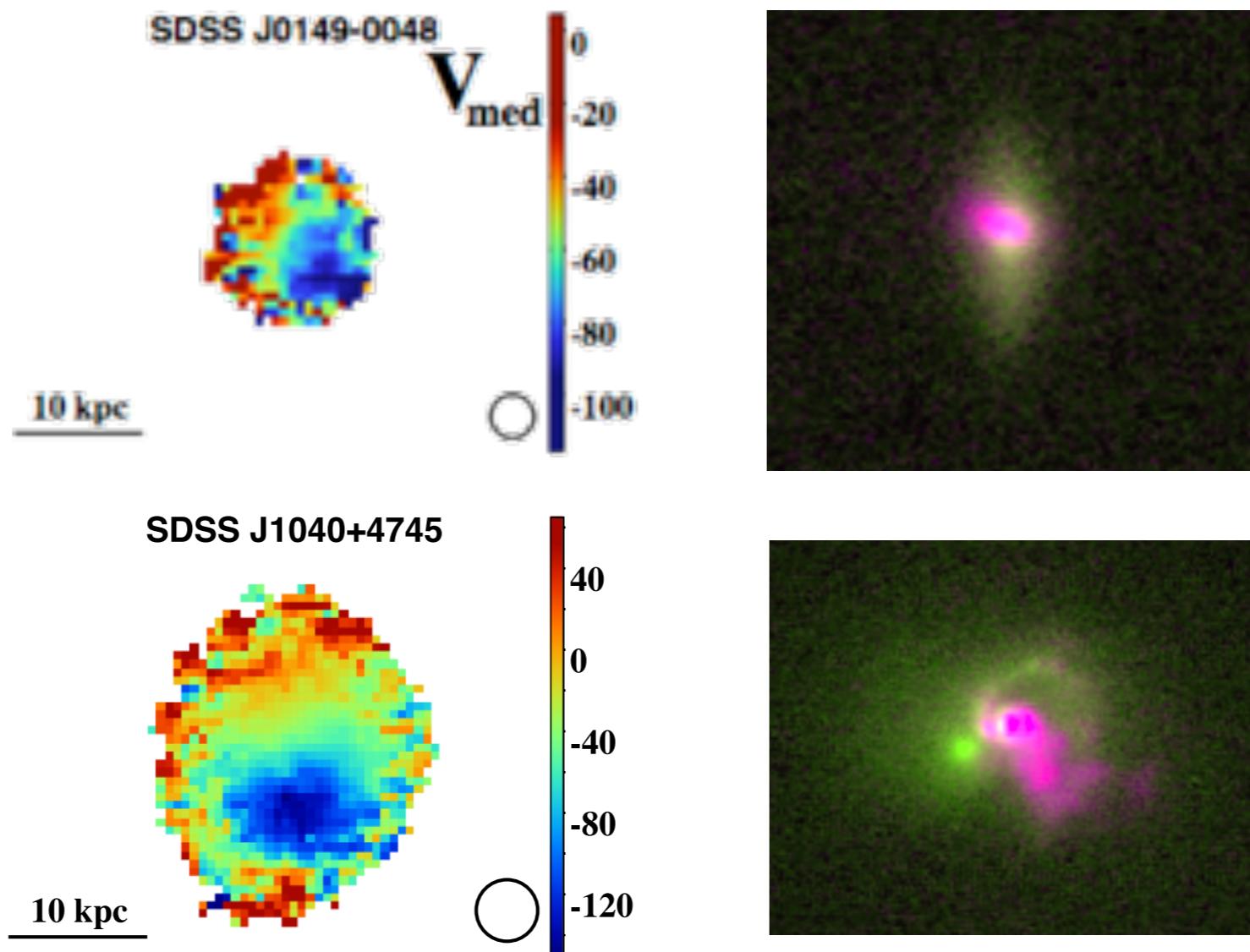
INTRODUCTION



OBSERVATIONAL EVIDENCE

galaxy-wide
outflows

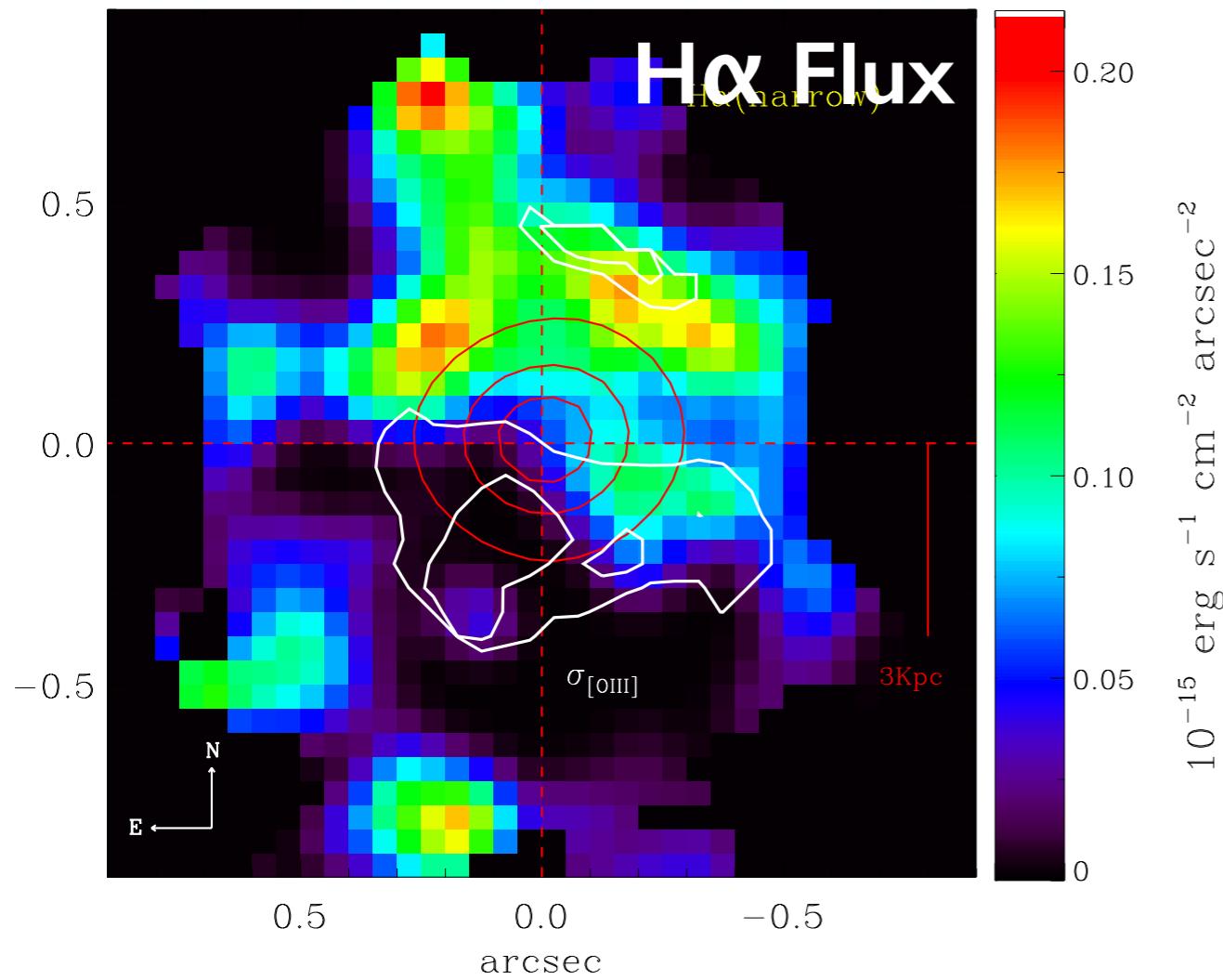
scattering cones



Liu+2013a,b, Wylezalek+2016a, Obied+2016

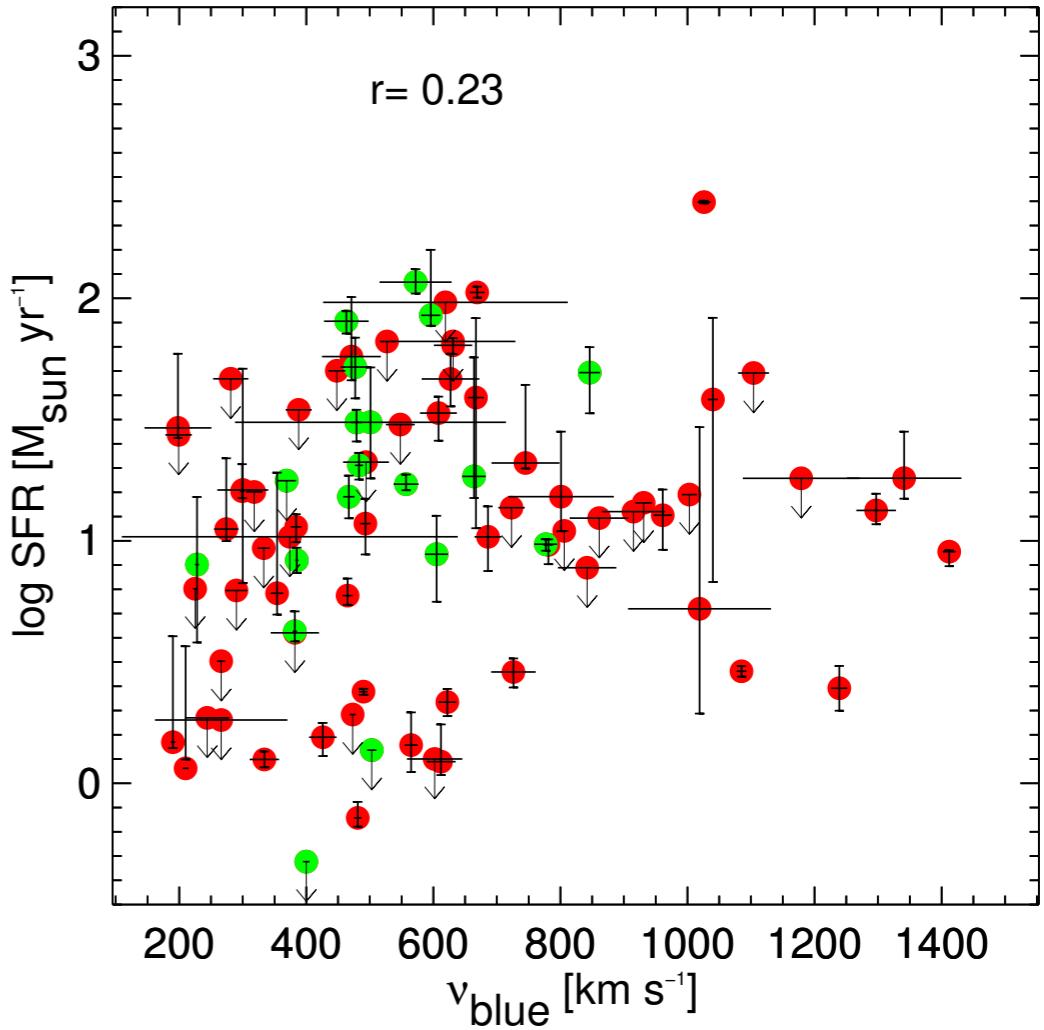
OBSERVATIONAL EVIDENCE

LOCAL EVIDENCE



Cano-Diaz+2012

GLOBAL EVIDENCE?

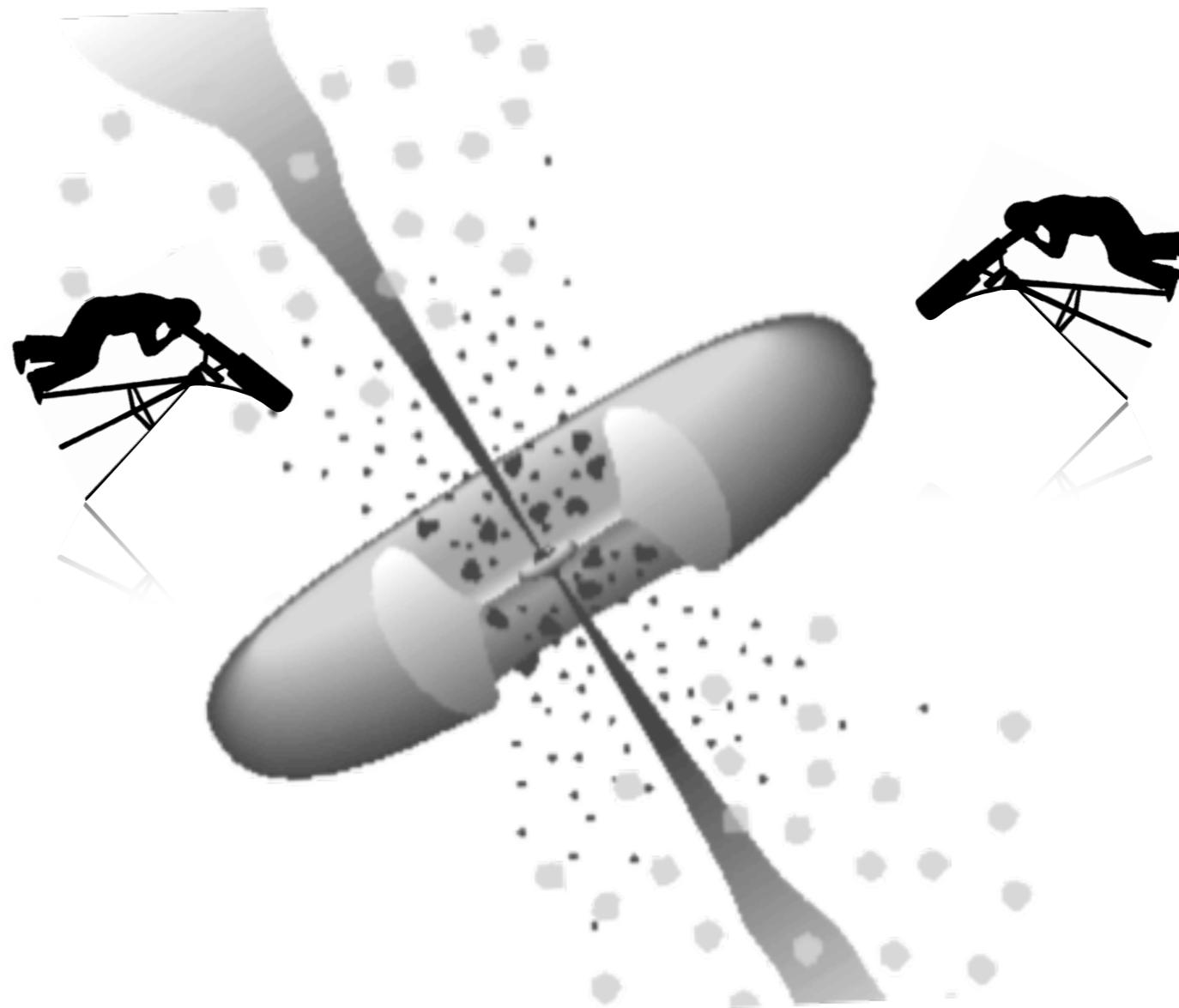


Balmaverde+2015

**WHAT ARE THE OBSERVATIONAL SIGNATURES
OF AGN FEEDBACK?**

HOW CAN WE QUANTIFY AGN FEEDBACK?

SAMPLE SELECTION



type-2 AGN

SAMPLE SELECTION

OUTFLOW STRENGTH

STAR FORMATION RATE

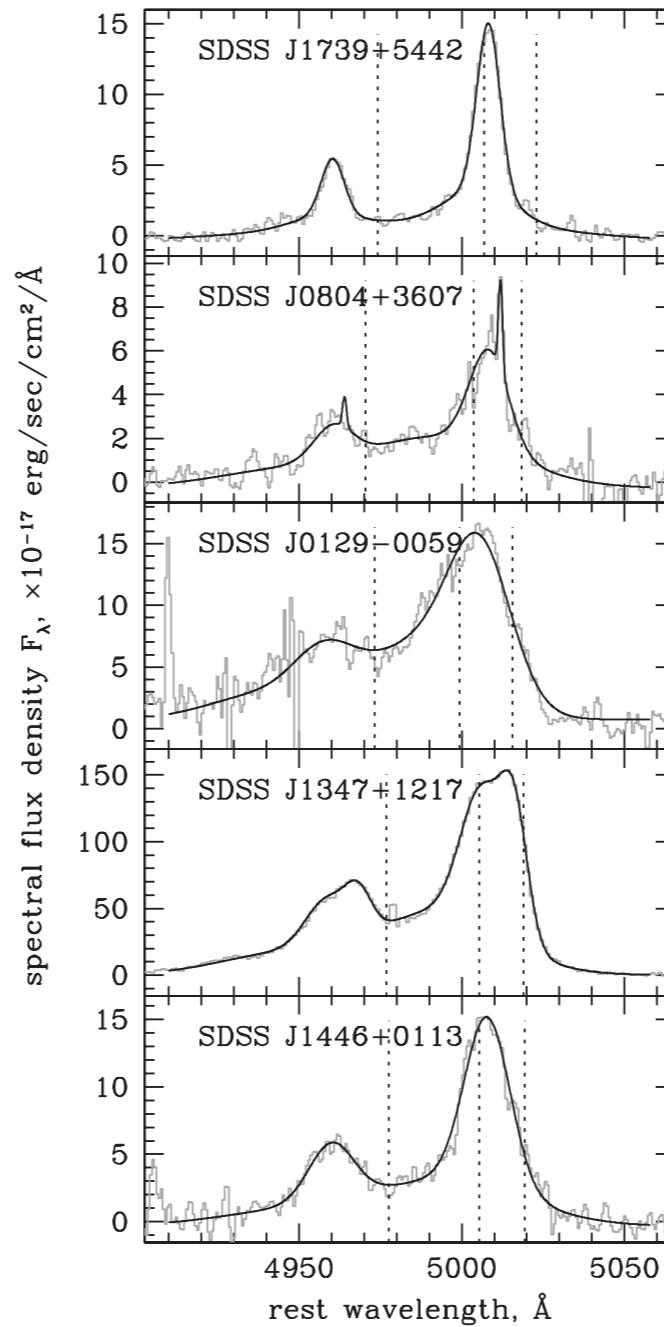
STELLAR MASS

SAMPLE SELECTION

OUTFLOW STRENGTH

[OIII] emission line at
5007Å

velocity width to quantify
outflow strength



SAMPLE SELECTION

OUTFLOW STRENGTH

STAR FORMATION RATE

[OIII] emission line at
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far-IR emission

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SAMPLE SELECTION

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STELLAR MASS

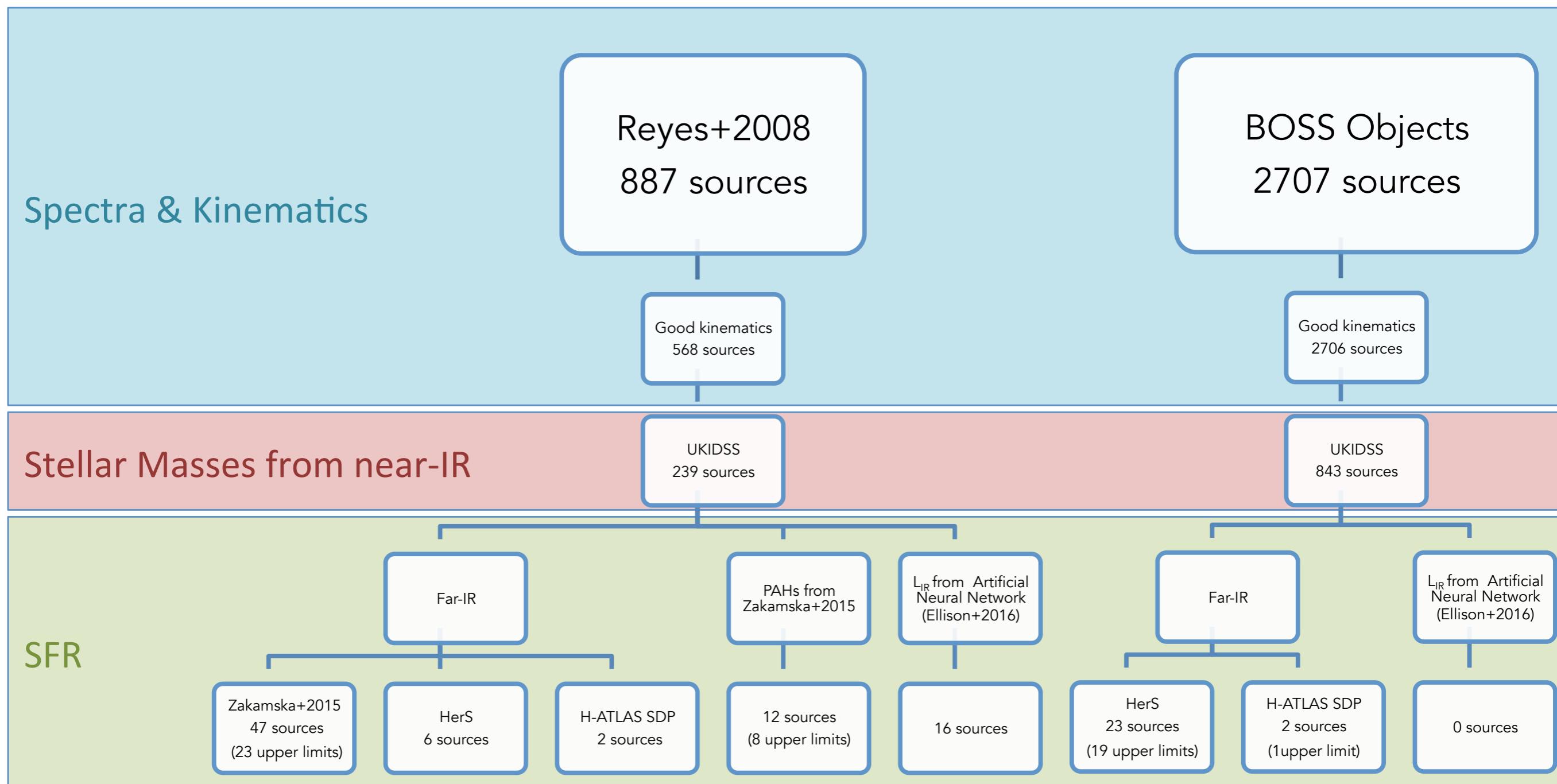
[OIII] emission line at
5007Å

far-IR emission

NEAR-IR IMAGING
DATA

velocity width to quantify
outflow strength

SAMPLE SELECTION



SAMPLE SELECTION

OUTFLOW STRENGTH

STAR FORMATION RATE

STELLAR MASS

[OIII] emission line at
5007Å

far-IR emission

NEAR-IR IMAGING
DATA

velocity width to quantify
outflow strength

specific star formation rate sSFR

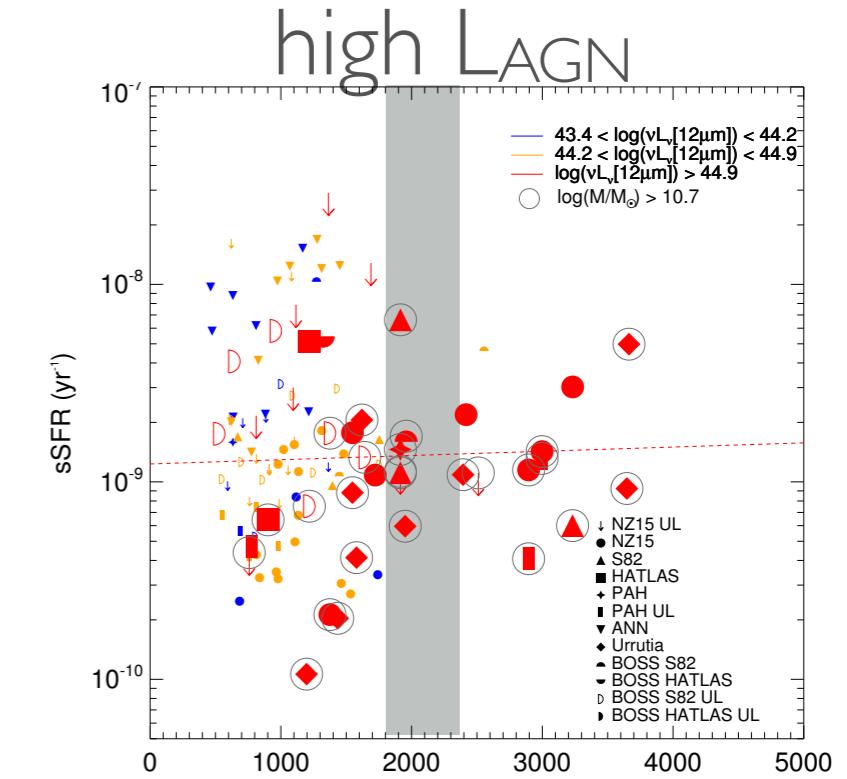
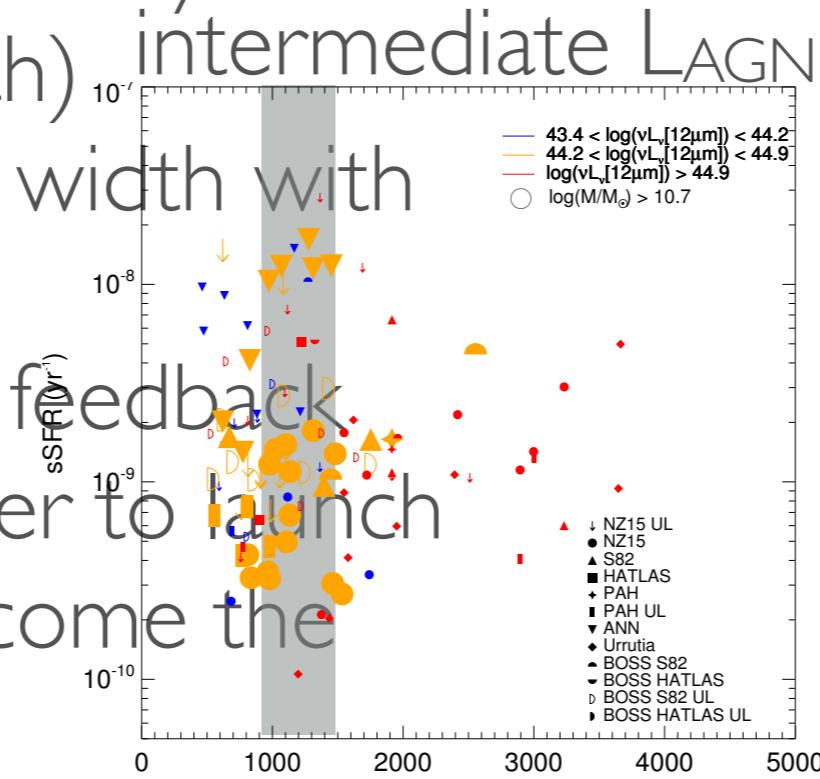
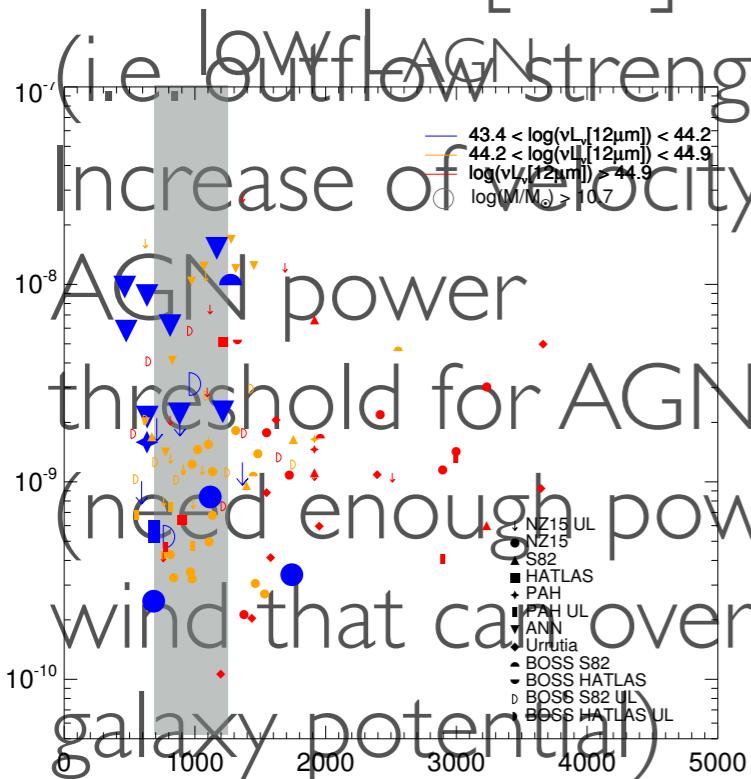
SSFR VS. VELOCITY WIDTH

No dependence of sSFR as a function of [OIII] velocity width
(i.e. outflow strength)

- No dependence of sSFR as a function of [OIII] velocity width

(i.e. low AGN outflow strength)

sSFR

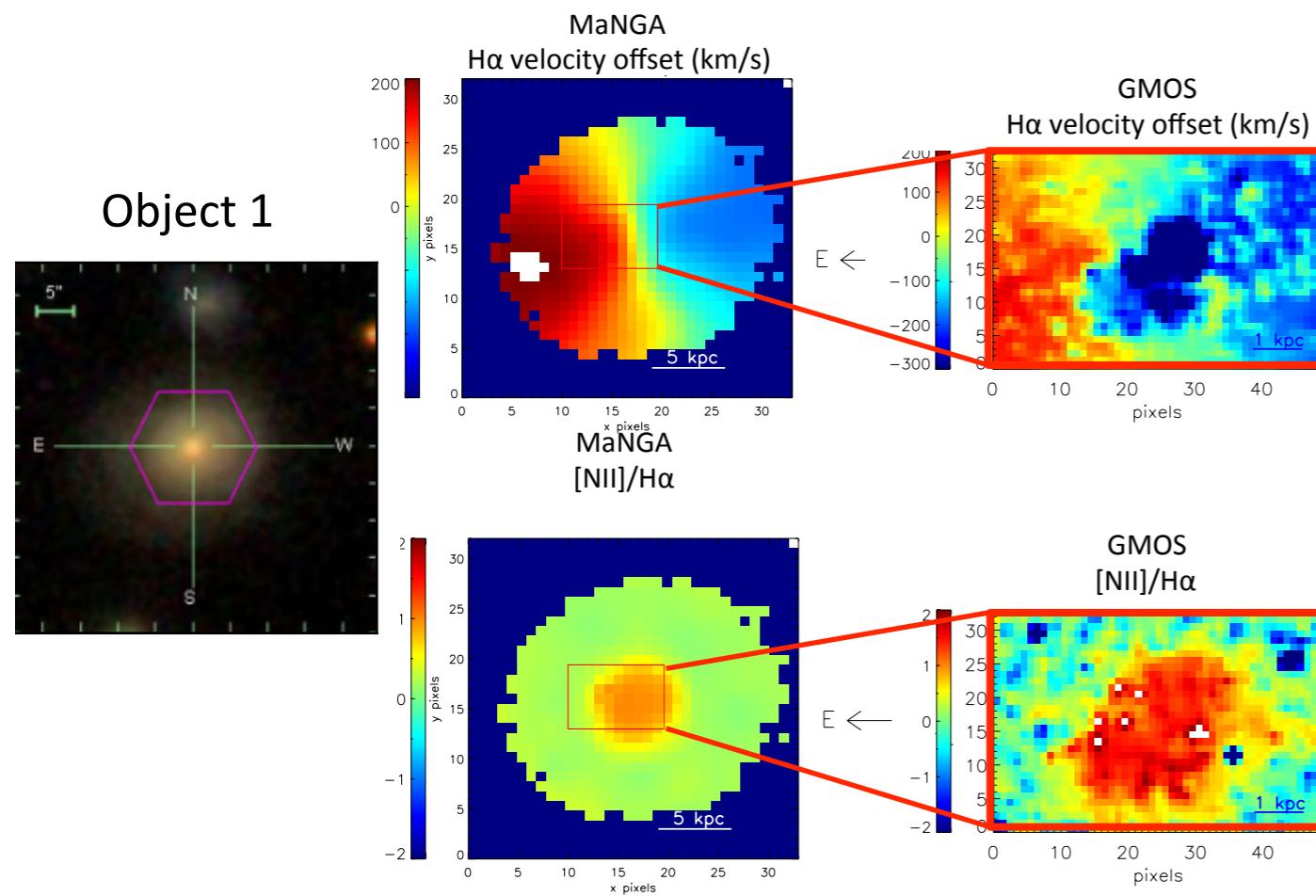


velocity width of [OIII] (W90)

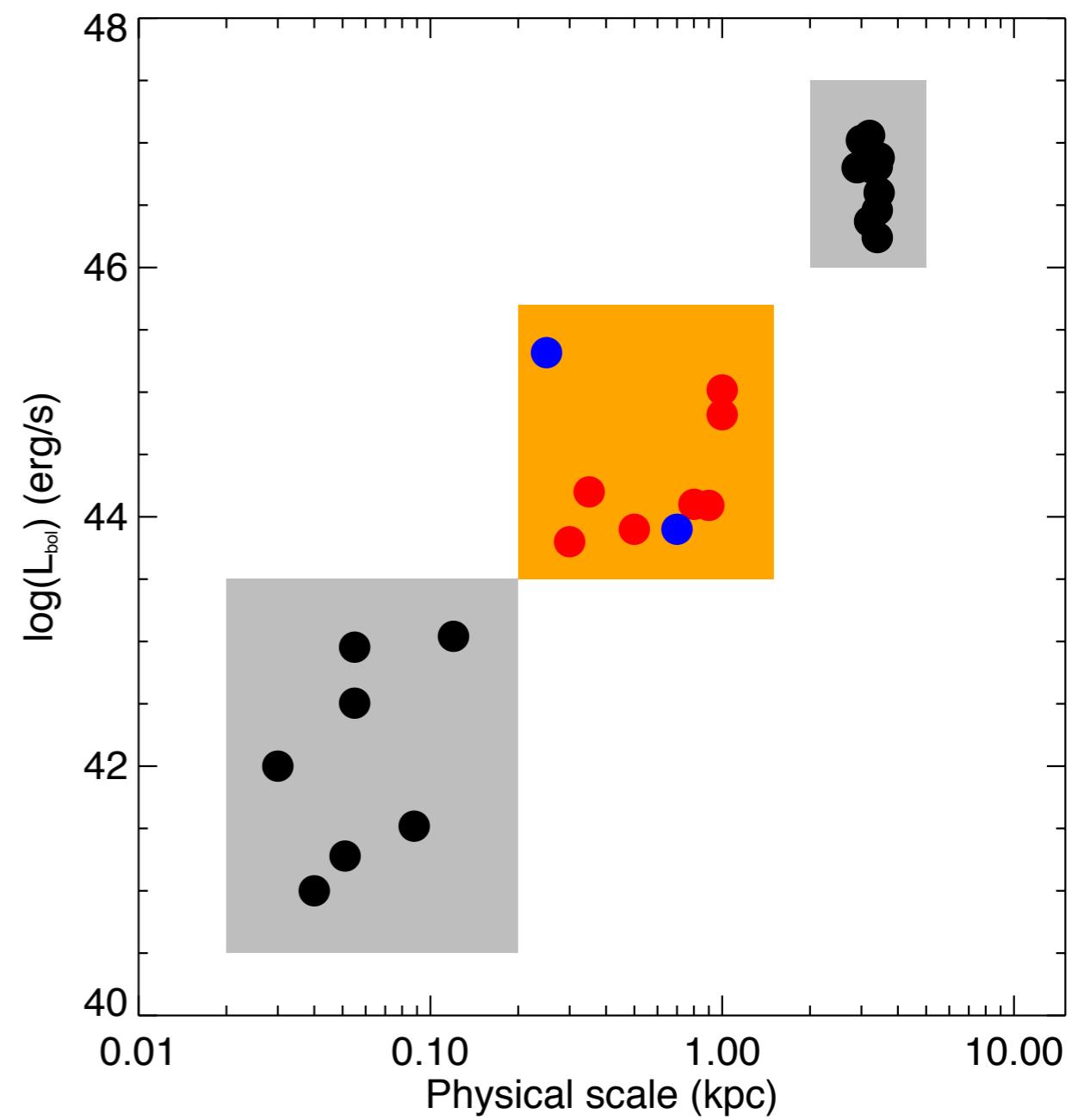
Wylezalek+2016b (in prep.)

FEEDBACK THRESHOLD WITH MANGA/GMOS

Object 1

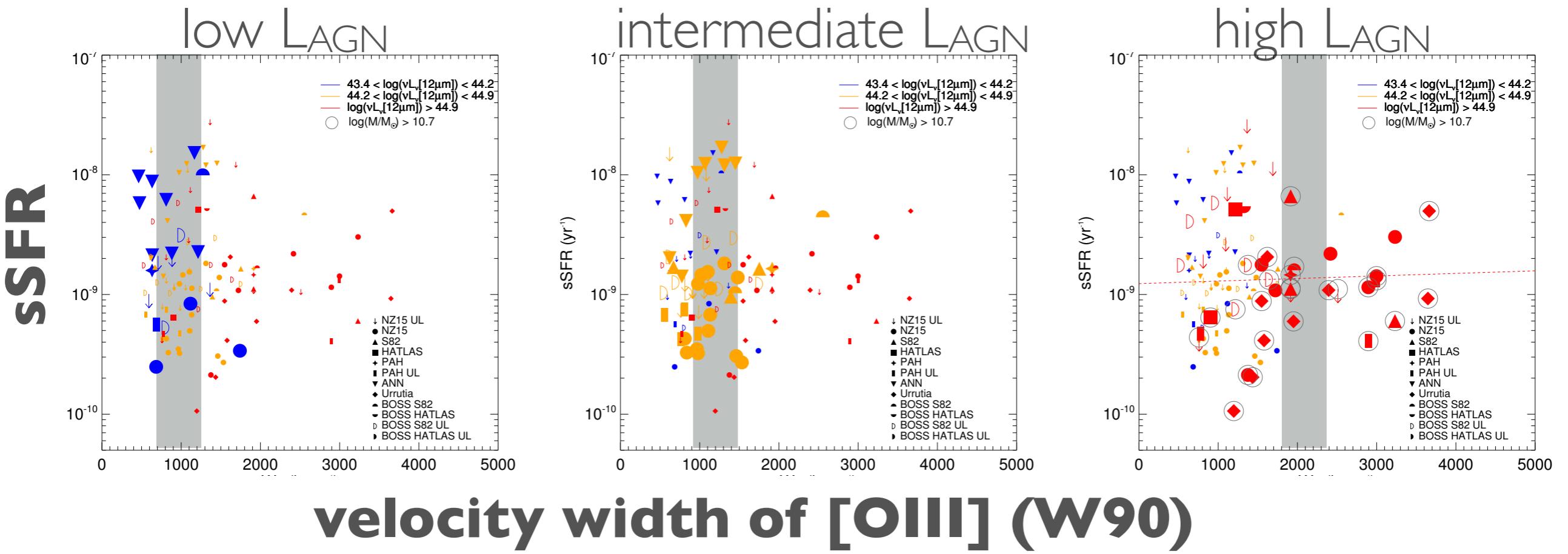


Wylezalek, Zakamska, Schnorr Müller,
Storchi-Bergmann+ in prep.



SSFR VS. VELOCITY WIDTH

No dependence of sSFR as a function of [OIII] velocity width
(i.e. outflow strength)



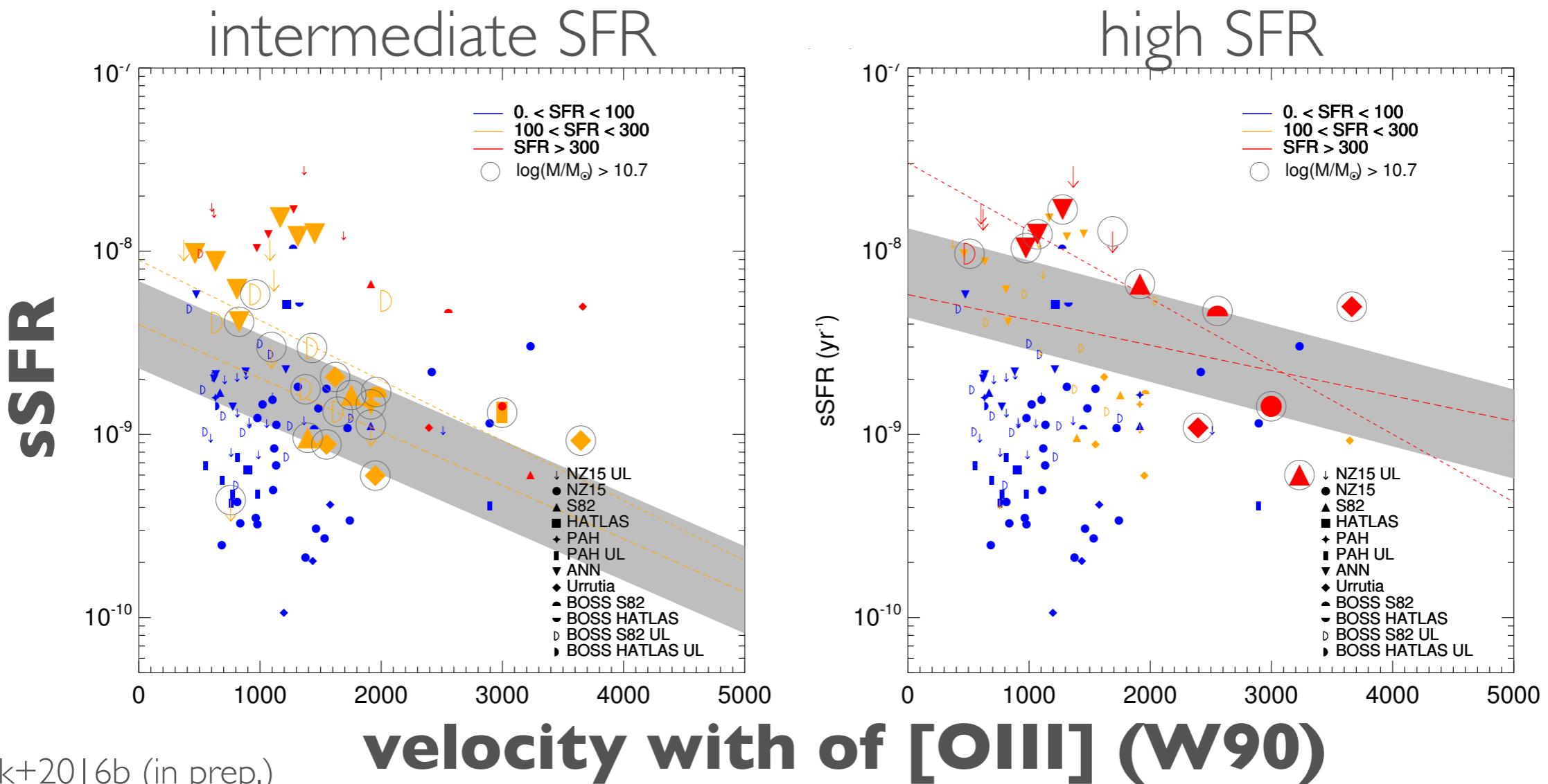
Wylezalek+2016b (in prep.)



BUT

SSFR VS. VELOCITY WIDTH

Strong negative correlation between sSFR and velocity width
at high SFRs



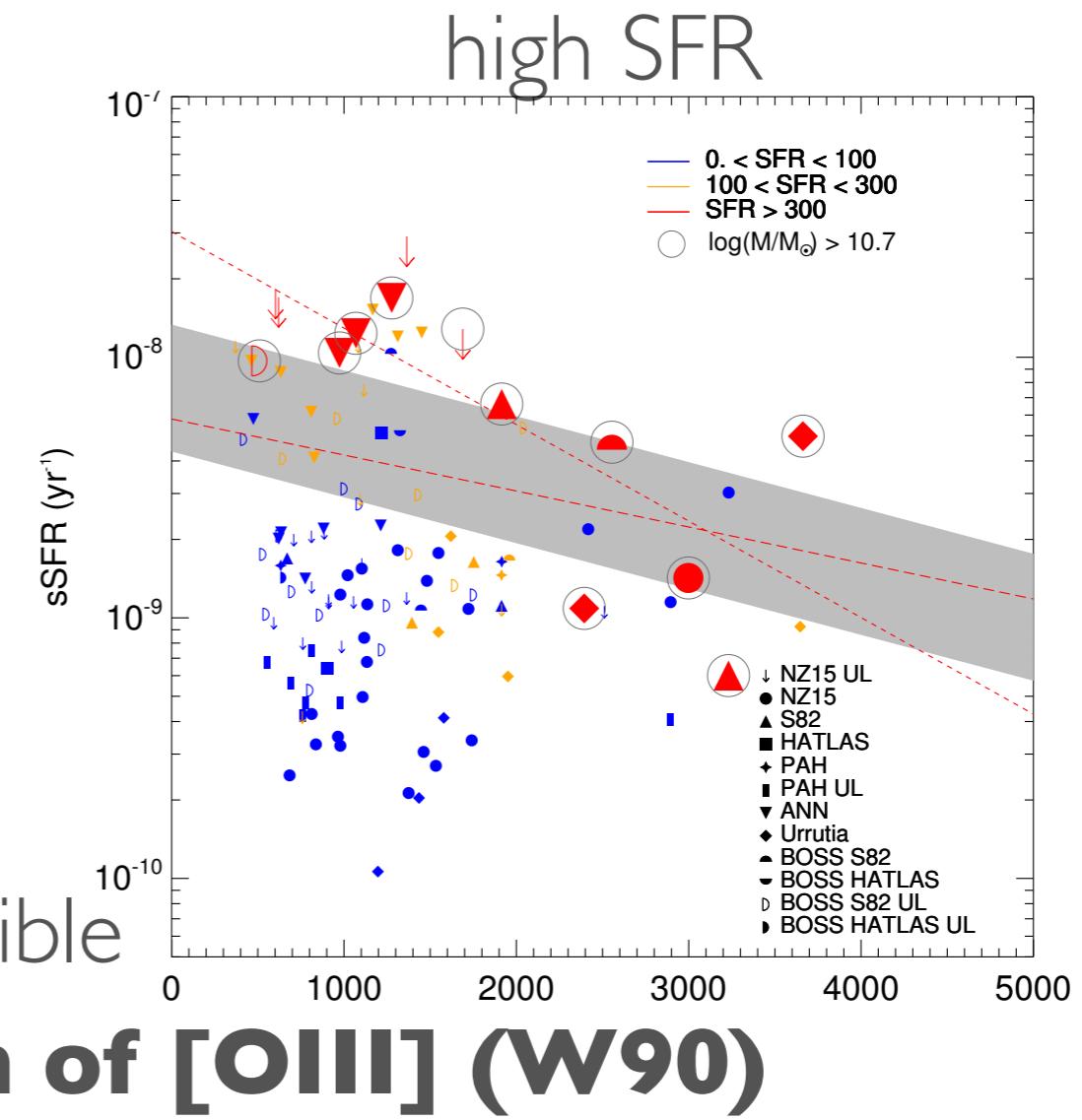
Wylezalek+2016b (in prep.)

DOMIENKA WYLEZALEK, JHU, GALAXIES 2016, COZUMEL

SSFR VS. VELOCITY WIDTH

Strong negative correlation between sSFR and velocity width at high SFRs

- negative correlation between sSFR and velocity width at high SFRs
 - coupling between wind+gas is potentially strongest
 - relative velocities of AGN feedback
 - decrease of sSFR due to increase in stellar mass
 - effect of galaxy potential negligible
-
- This scatter plot shows the relationship between specific star formation rate (sSFR) and velocity width. The x-axis is labeled 'velocity width of [OIII] (W90)' and ranges from 0 to 5000. The y-axis is labeled 'sSFR (yr⁻¹)' and ranges from 10⁻¹⁰ to 10⁻⁷. Data points are color-coded by SFR: blue for 0 < SFR < 100, orange for 100 < SFR < 300, red for SFR > 300, and grey circles for log(M/M_⊙) > 10.7. A dashed diagonal line represents the trend for low SFRs, while a solid line with shaded confidence intervals represents the trend for high SFRs. Most data points are concentrated along the high-SFR trend line, showing a clear negative correlation.



velocity width of [OIII] (W90)

SUMMARY

- one of the first direct observational proofs of AGN having a “negative” impact on galaxy evolution
- effect of wind-gas coupling important, at high SFRs can be neglected
- large, uniform samples needed

THANK YOU!

- one of the first direct observational proofs of AGN having a “negative” impact on galaxy evolution
- effect of wind-gas coupling important, at high SFRs

Dominika Wylezalek
can be neglected

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 large, uniform samples needed
<http://sites.krieger.jhu.edu/wylezalek>

SAMPLE SELECTION

OUTFLOW STRENGTH

[OIII] emission line at
5007Å

velocity width to quantify
outflow strength

STAR

see a

