# SIGNATURES OF QUASAR FEEDBACK


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N. ZAKAMSKA

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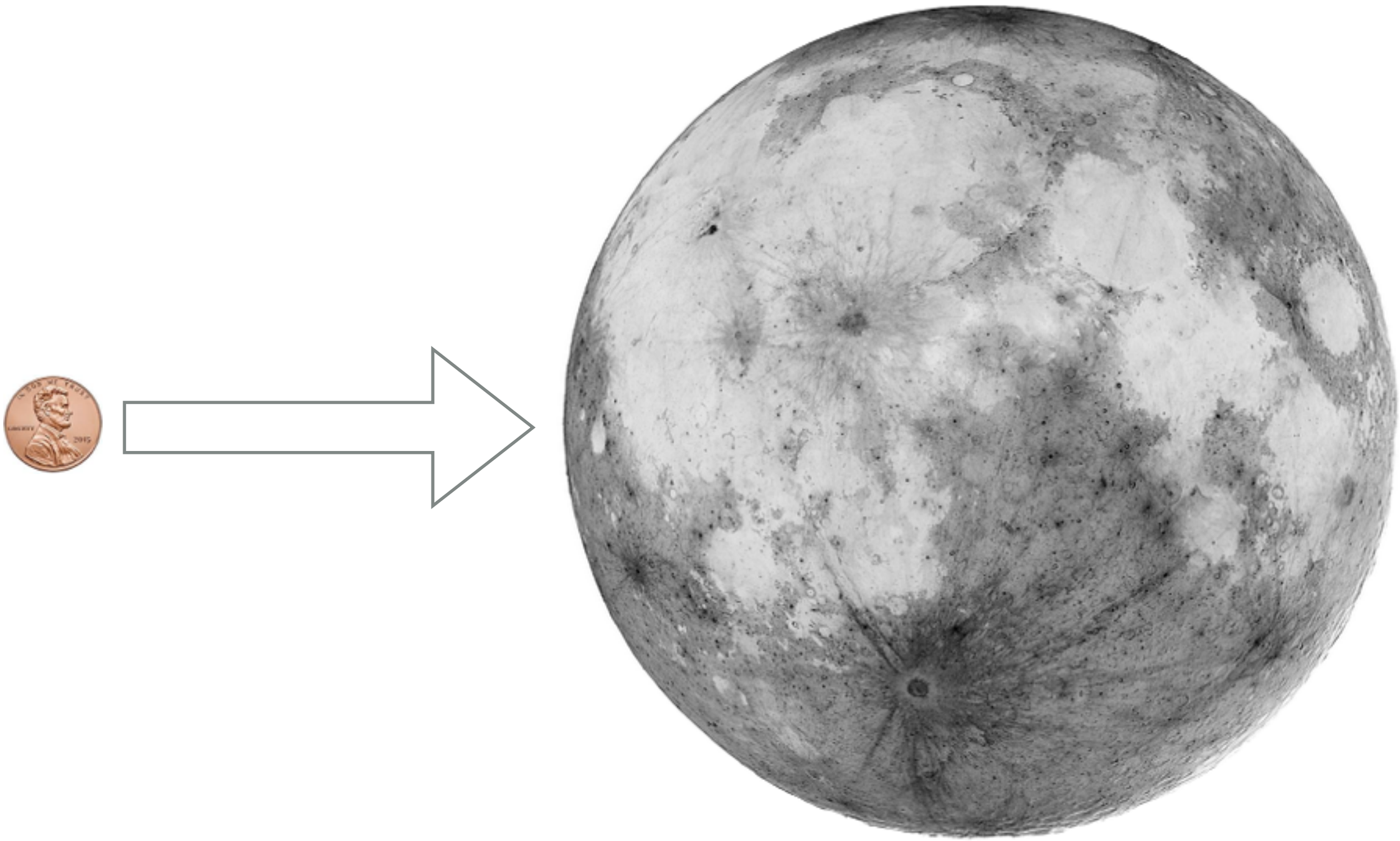
# INTRODUCTION



# INTRODUCTION



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released energy by BH

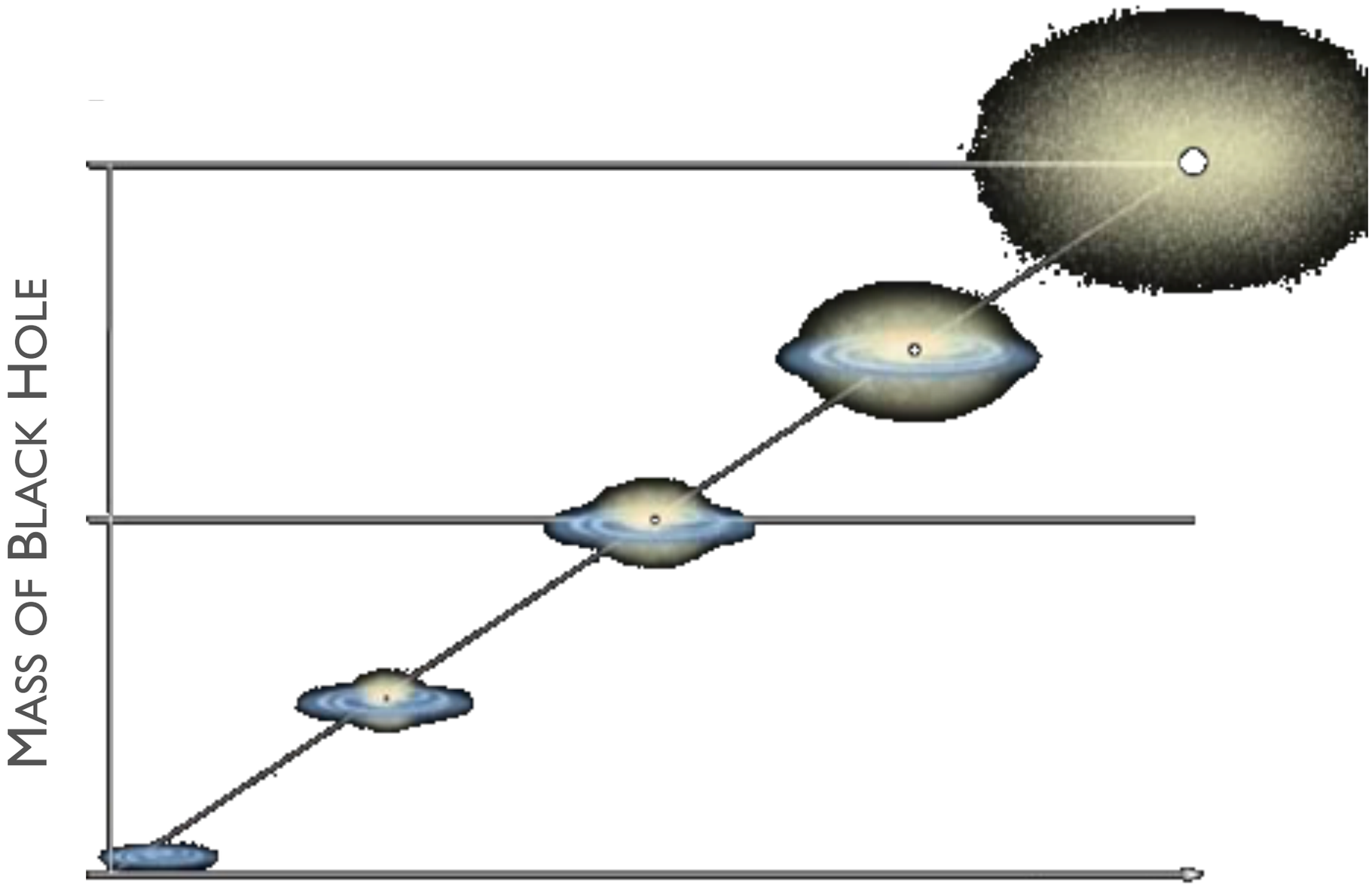
$0.1 M_{BH} c^2$

$\gg$

binding energy of galaxy

$M_{gal} \sigma^2$

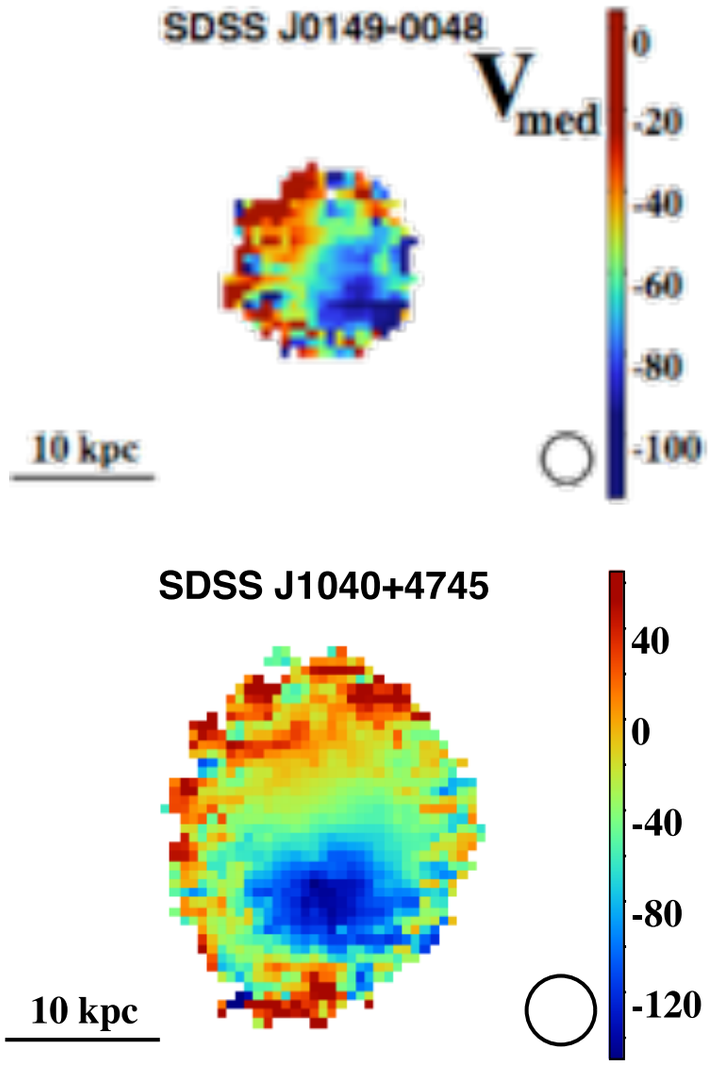
# INTRODUCTION

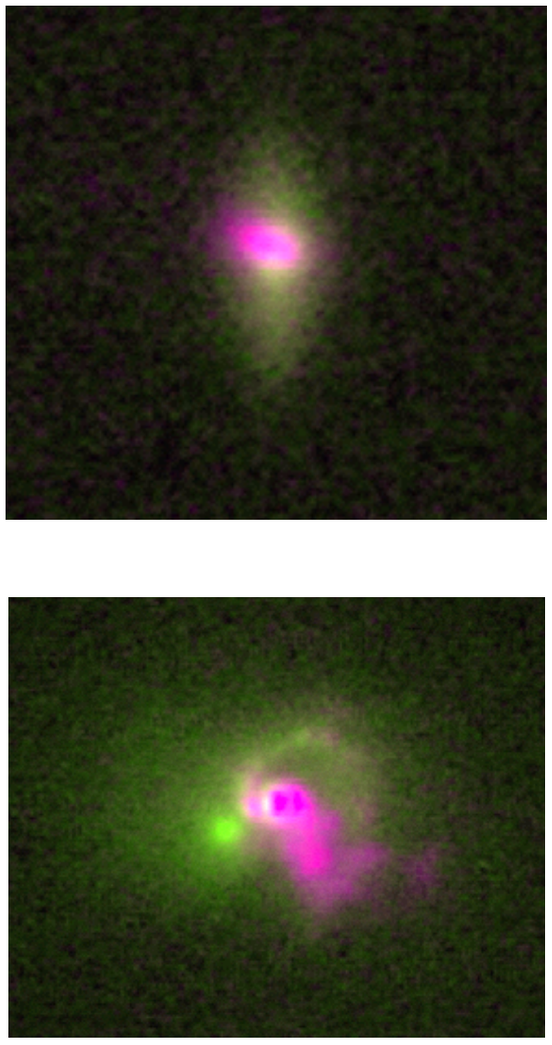


# OBSERVATIONAL EVIDENCE

galaxy-wide outflows

scattering cones

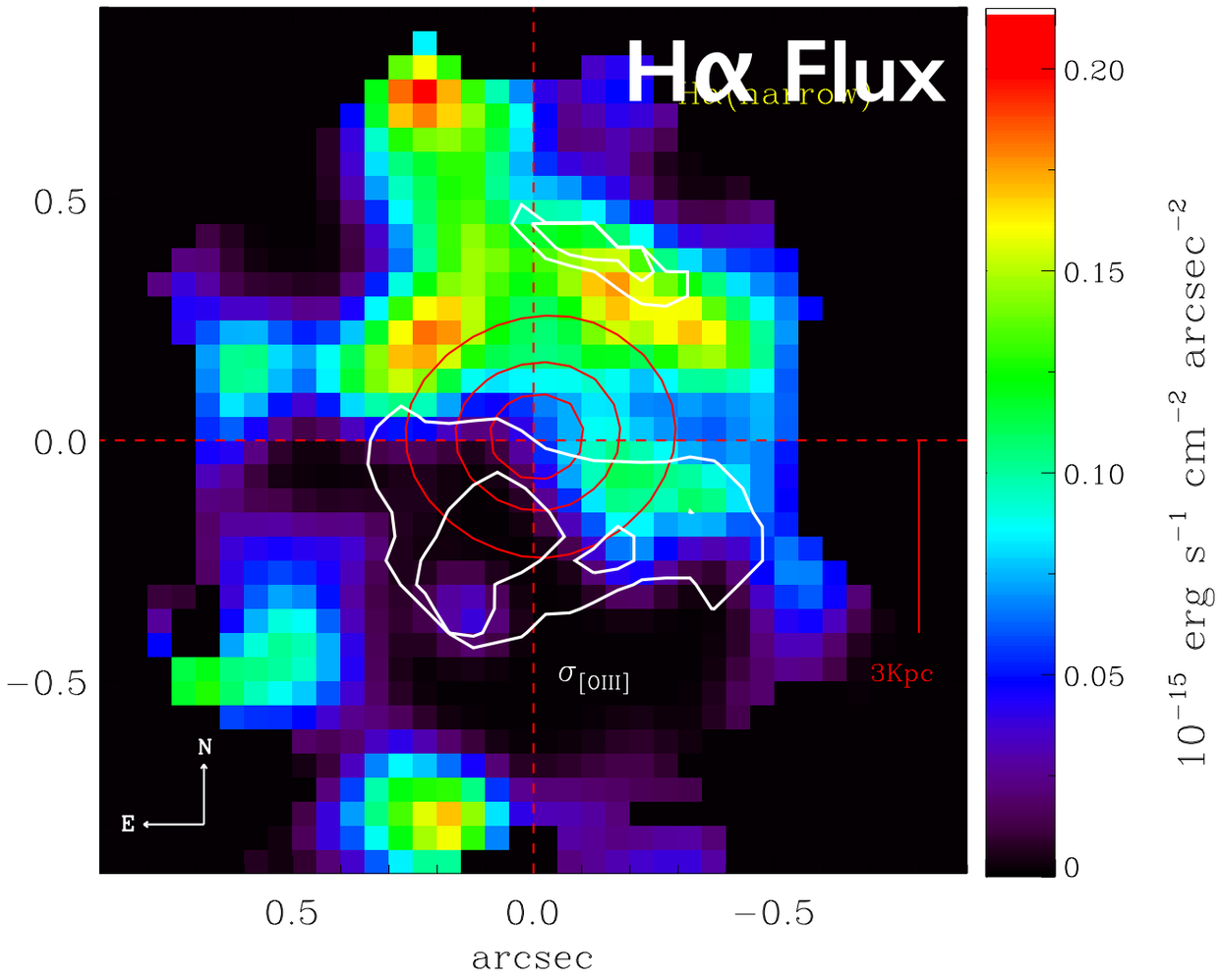


Liu+2013a,b, Wylezalek+2016a, Obied+2016

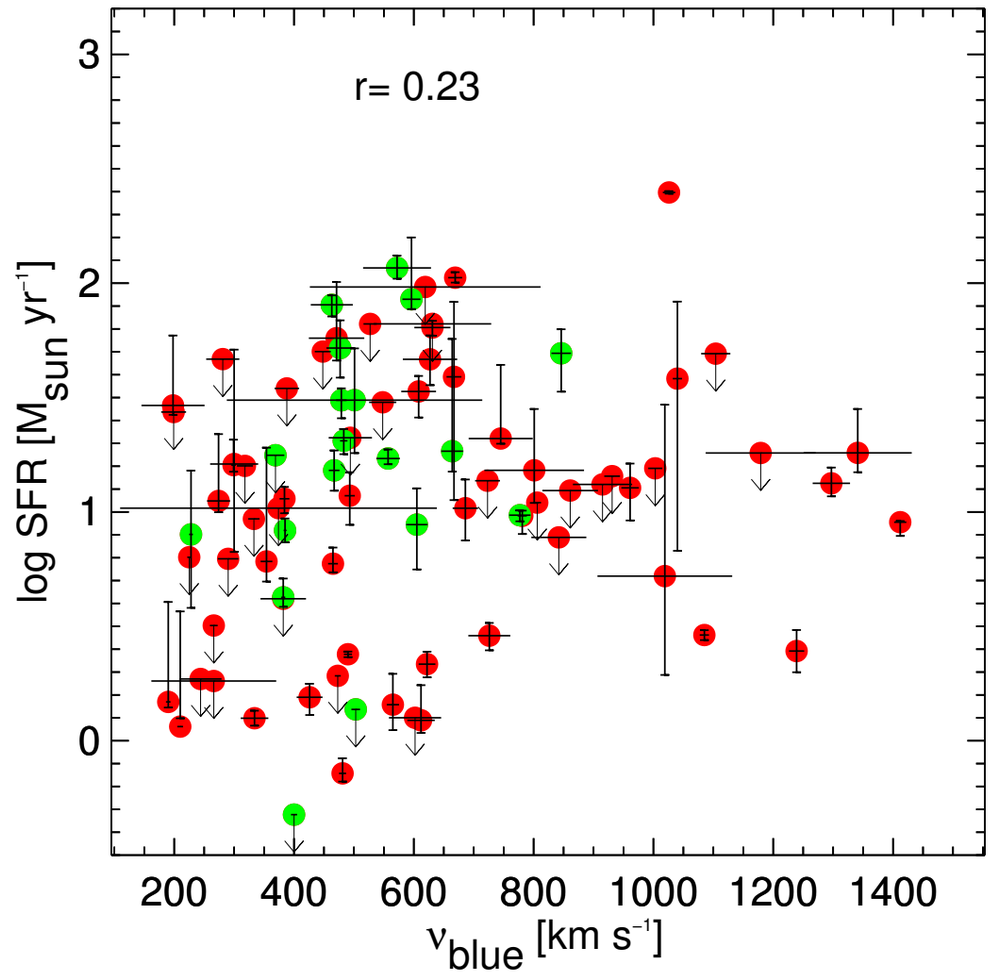
# OBSERVATIONAL EVIDENCE

## LOCAL EVIDENCE




Cano-Diaz+2012

## GLOBAL EVIDENCE?

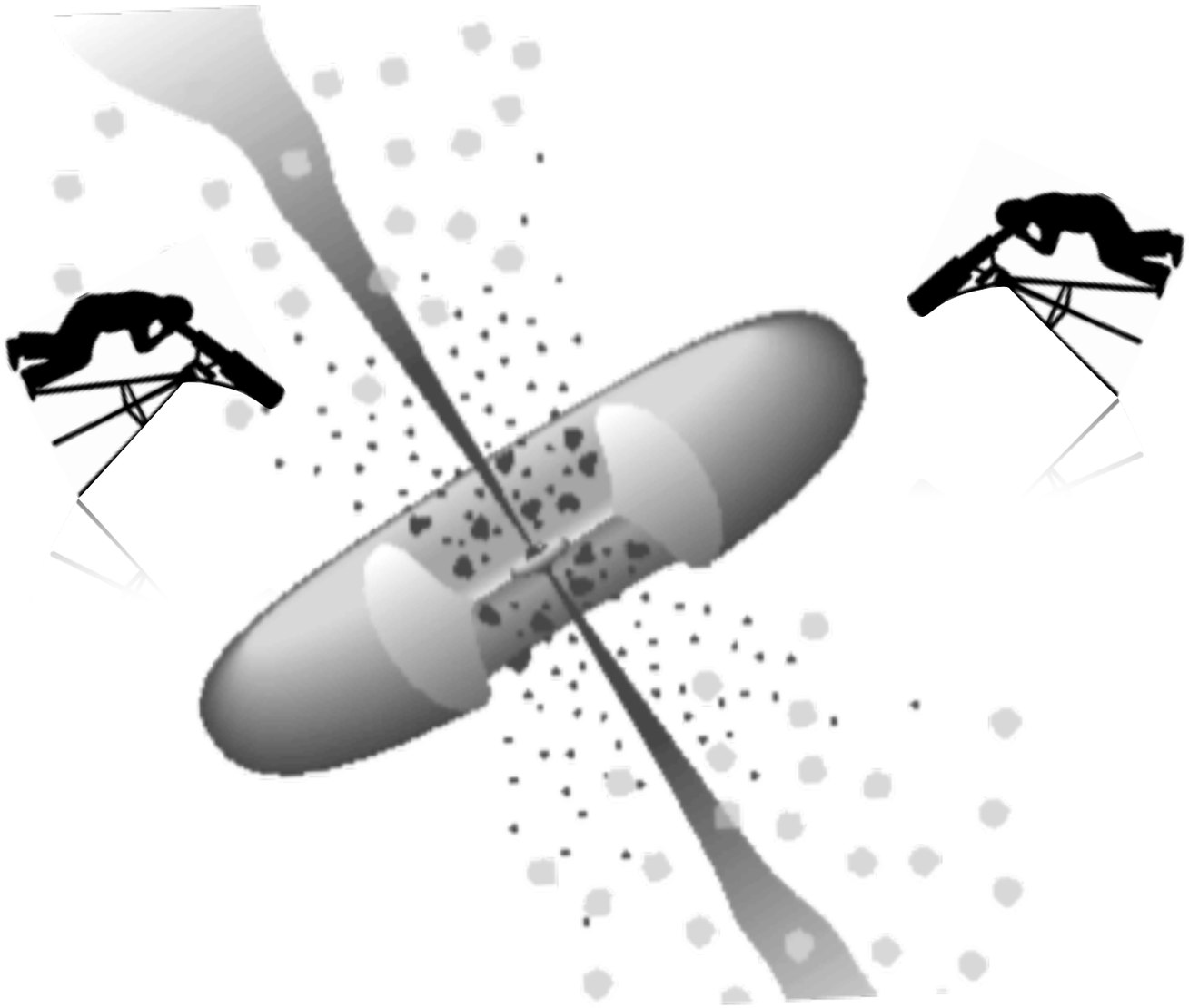



Balmaverde+2015

# 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

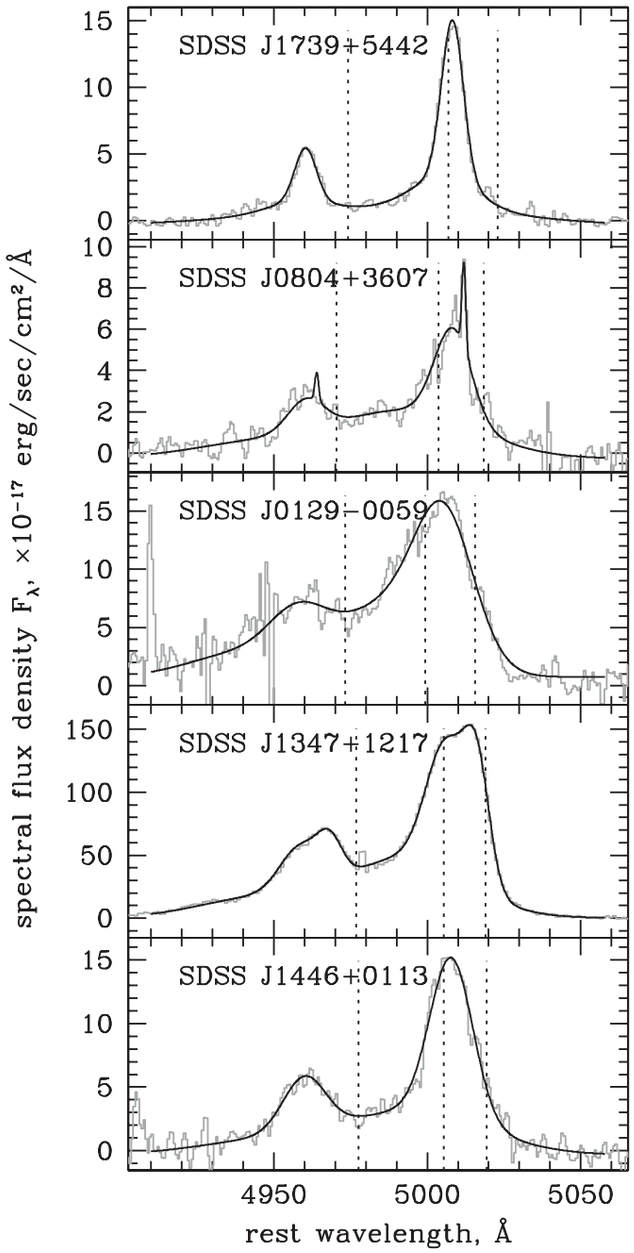
STELLAR MASS

# SAMPLE SELECTION

## OUTFLOW STRENGTH

[OIII] emission line at 5007Å

velocity width to quantify outflow strength



# SAMPLE SELECTION

## OUTFLOW STRENGTH

[OIII] emission line at 5007A

velocity width to quantify outflow strength

## STAR FORMATION RATE

far-IR emission

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## STELLAR MASS

NEAR-IR IMAGING DATA

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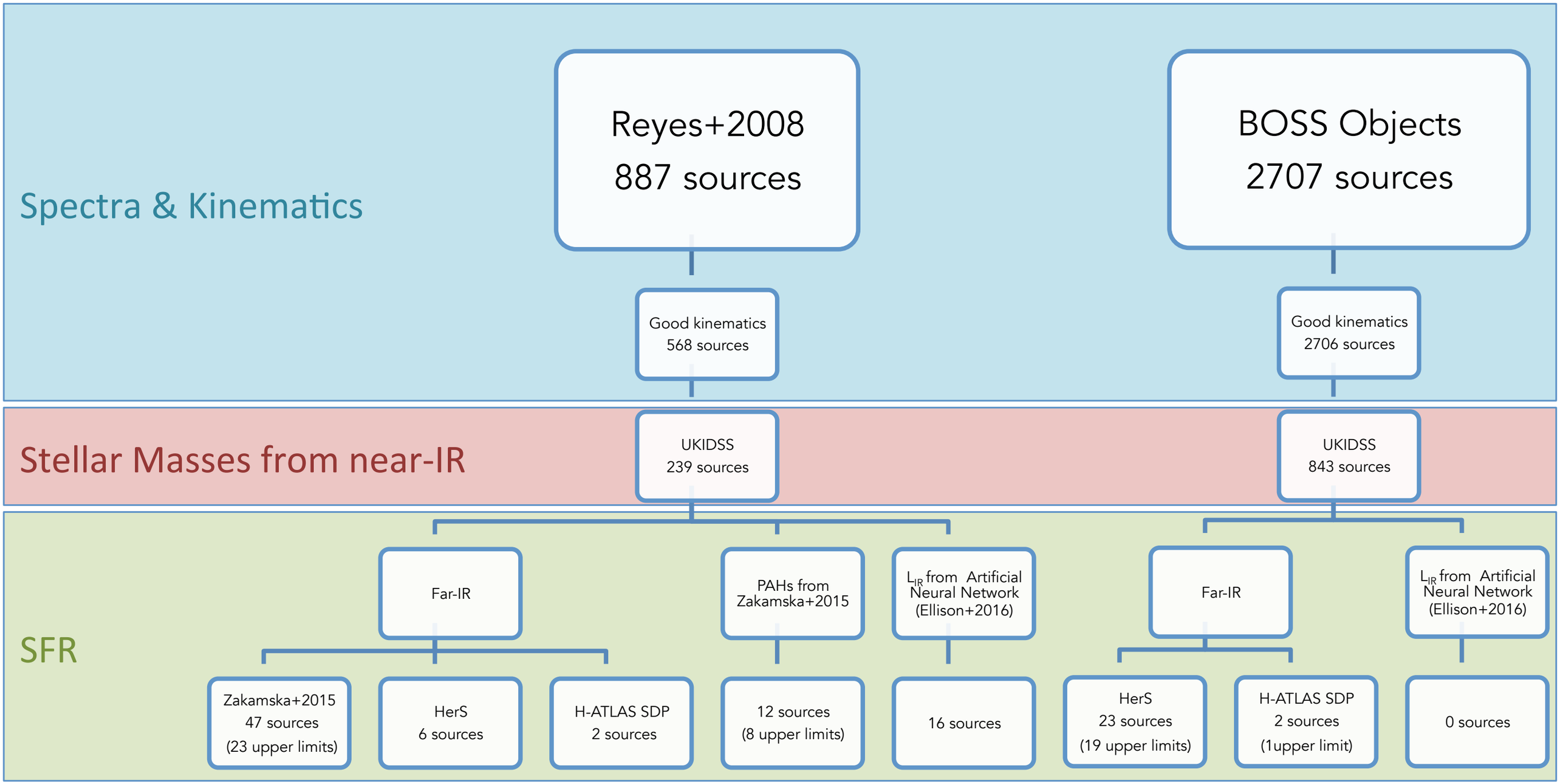

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## OUTFLOW STRENGTH

[OIII] emission line at 5007A

velocity width to quantify outflow strength

## STAR FORMATION RATE

far-IR emission

## STELLAR MASS

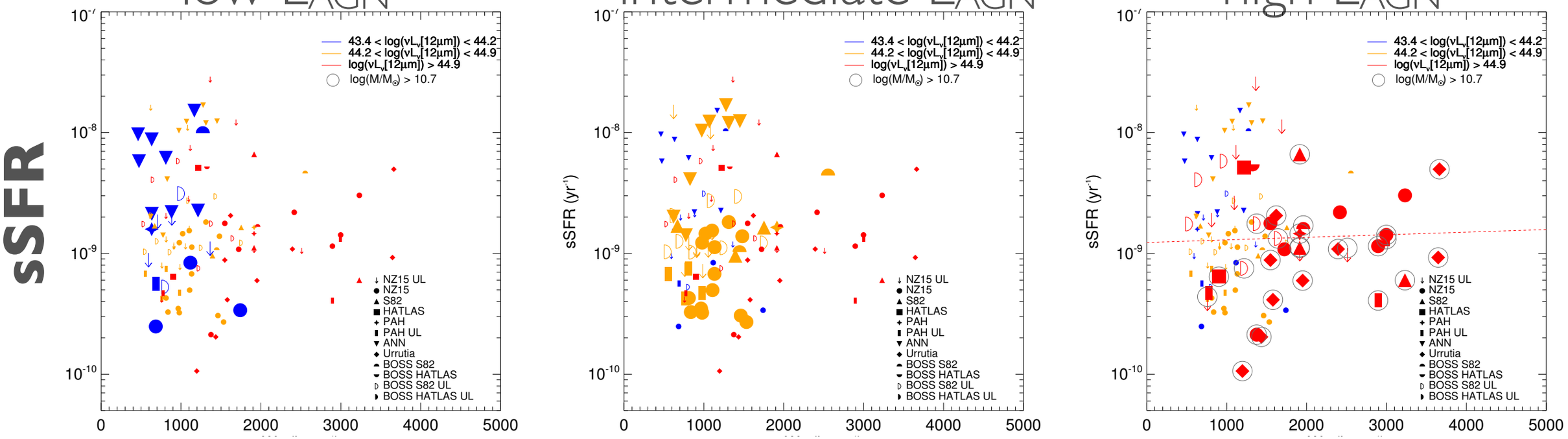
NEAR-IR IMAGING DATA

specific star formation rate sSFR

# sSFR VS. VELOCITY WIDTH

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

low $L_{AGN}$ | intermediate $L_{AGN}$ | high $L_{AGN}$




Wylezalek+2016b (in prep.)

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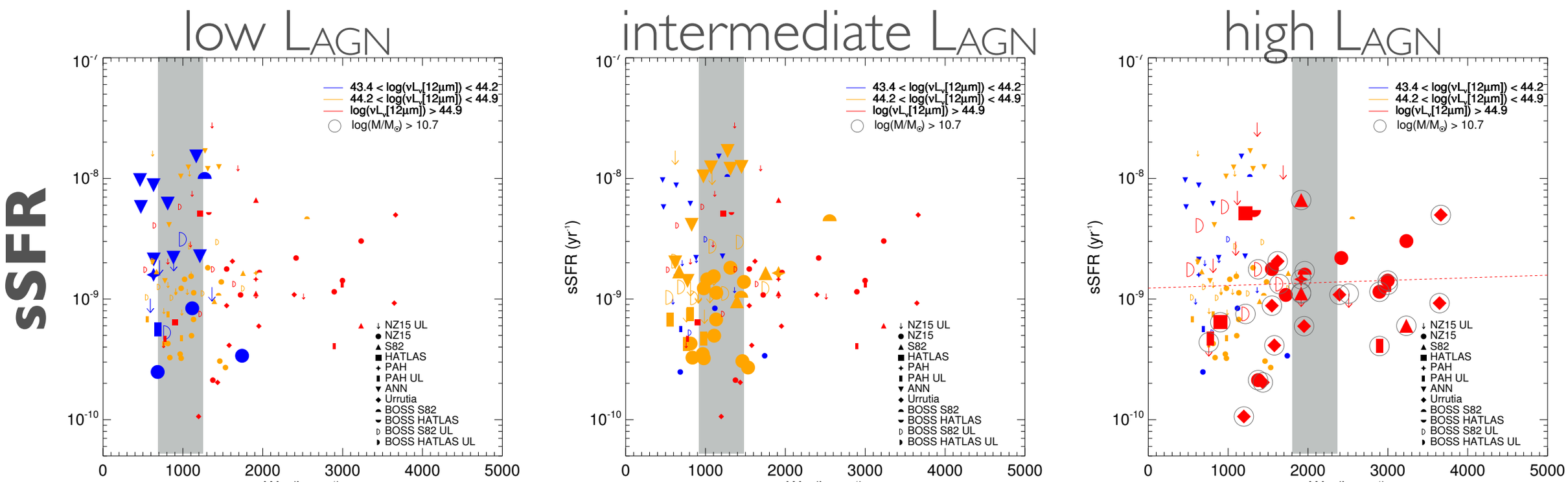
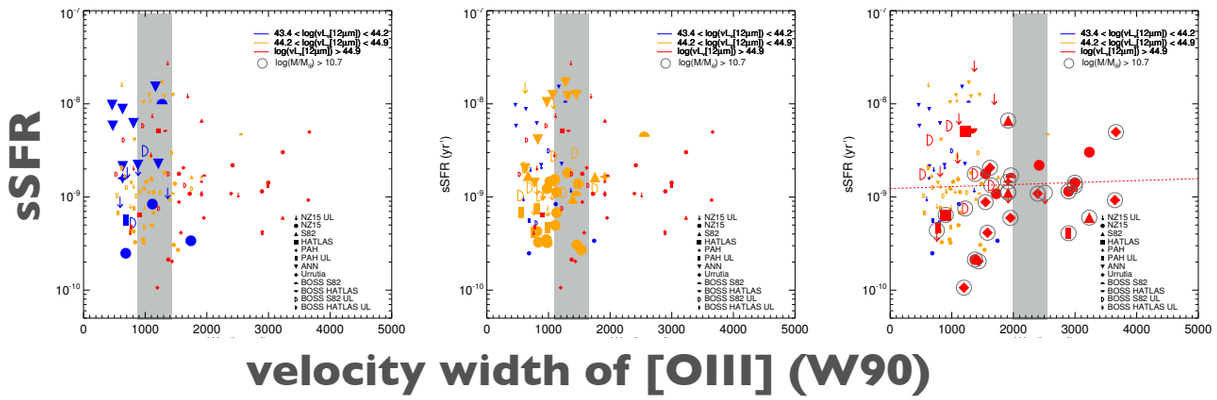



Wylezalek+2016b (in prep.)

# sSFR VS. VELOCITY WIDTH

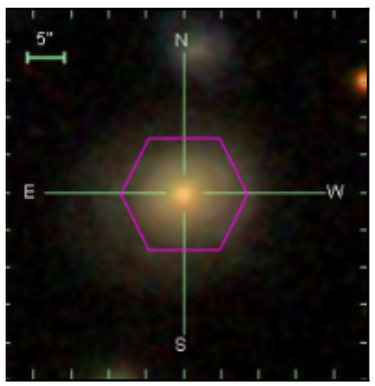
- No dependence of sSFR as a function of [OIII] velocity width (i.e. outflow strength)
- Increase of velocity width with AGN power
- threshold for AGN feedback (need enough power to launch wind that can overcome the galaxy potential)

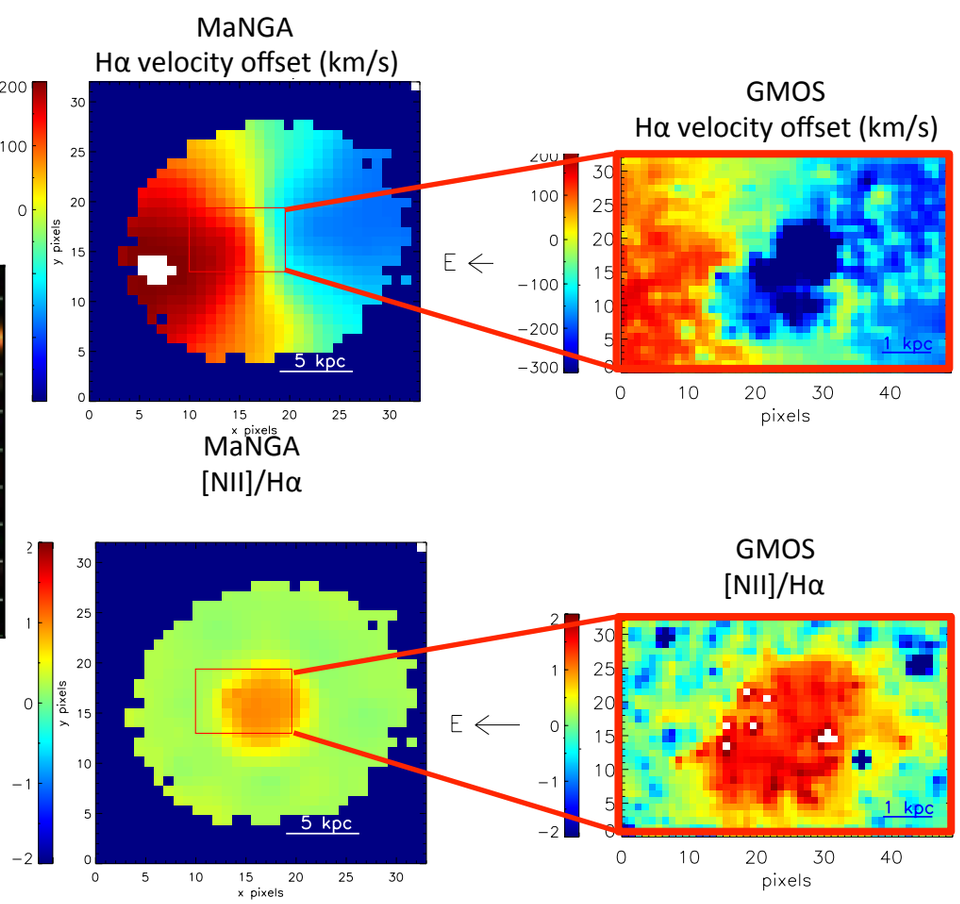


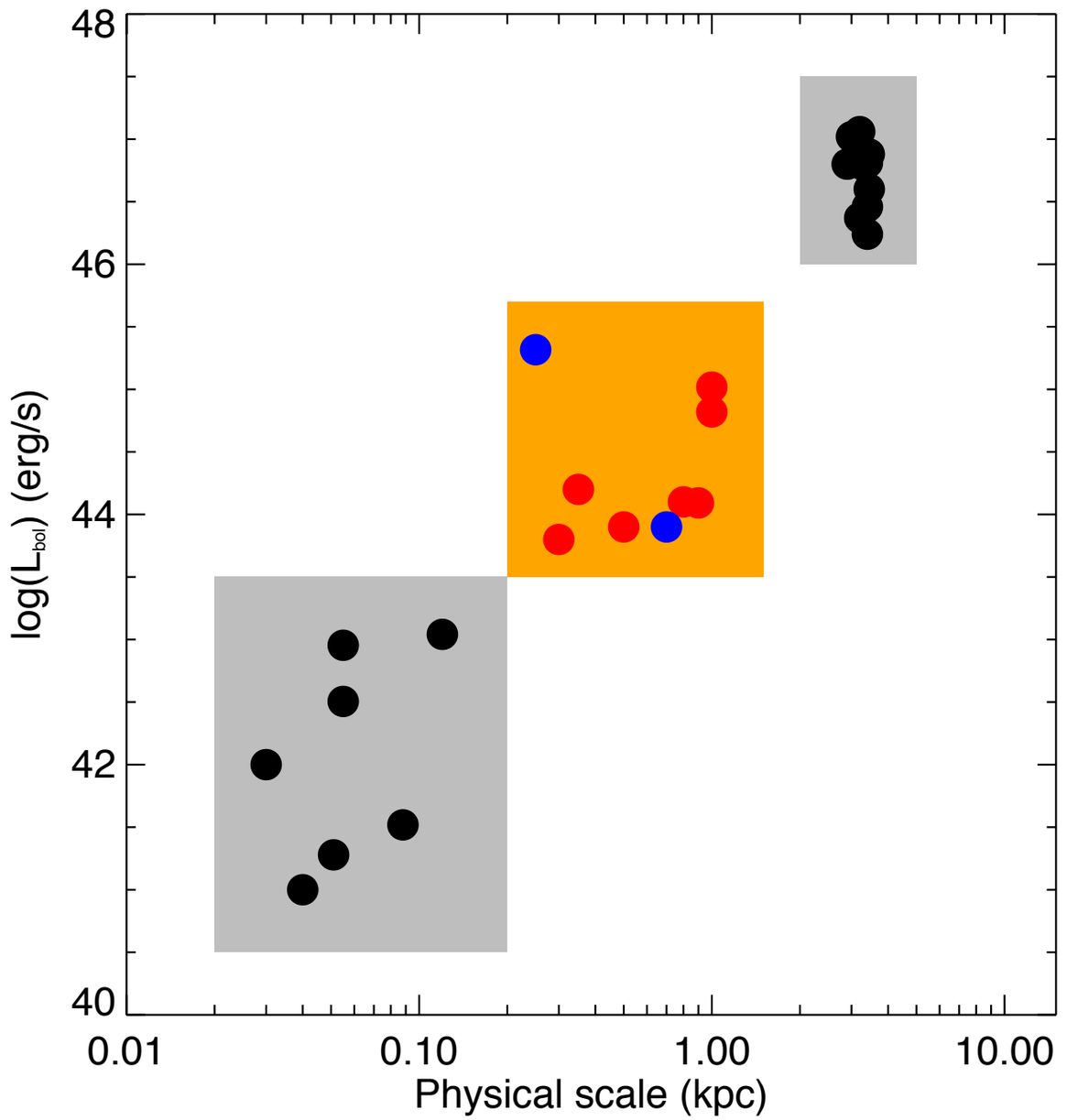

Wylezalek+2016b (in prep.)

# FEEDBACK THRESHOLD WITH MANGA/GMOS

Object 1




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

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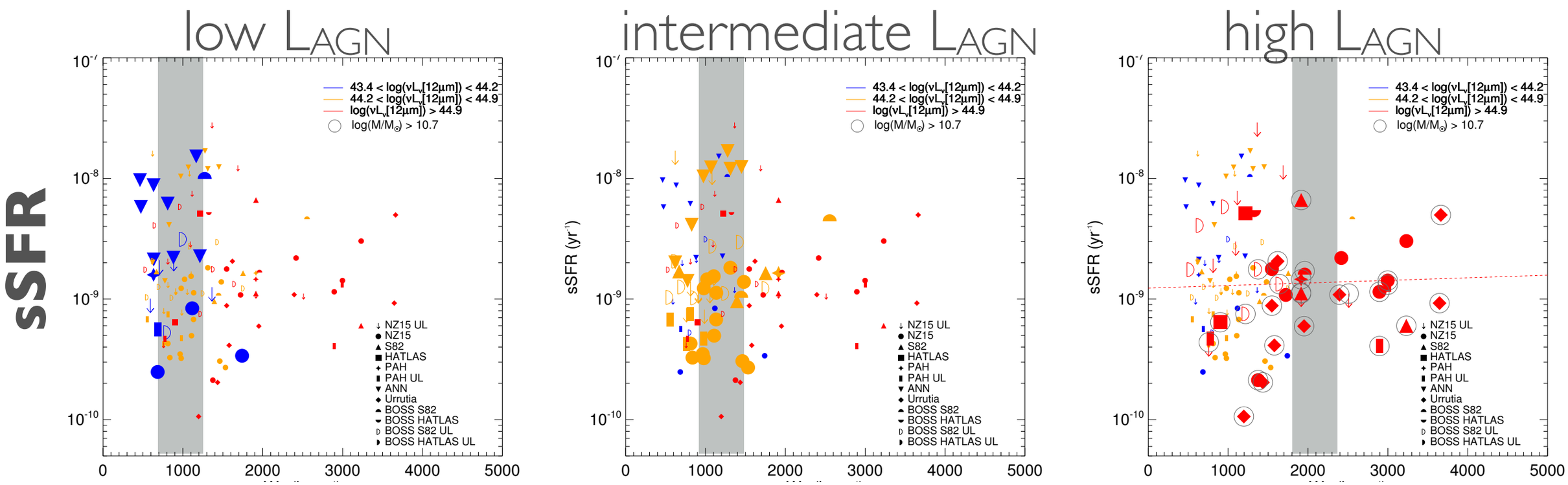


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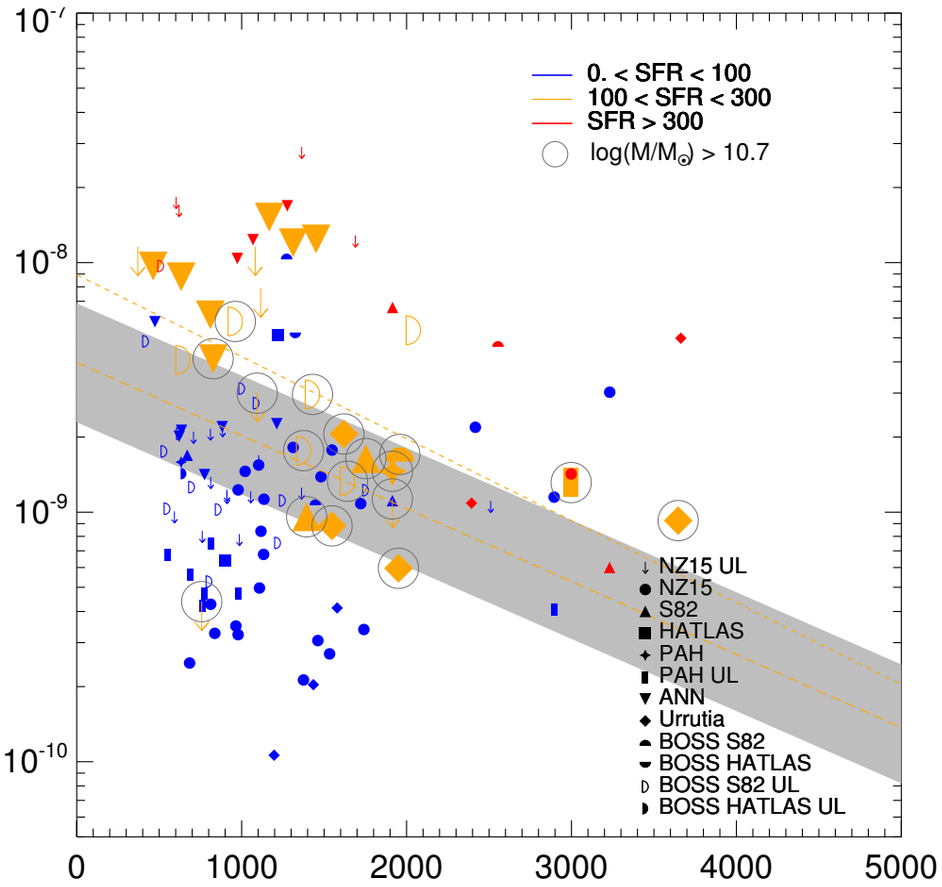
# BUT

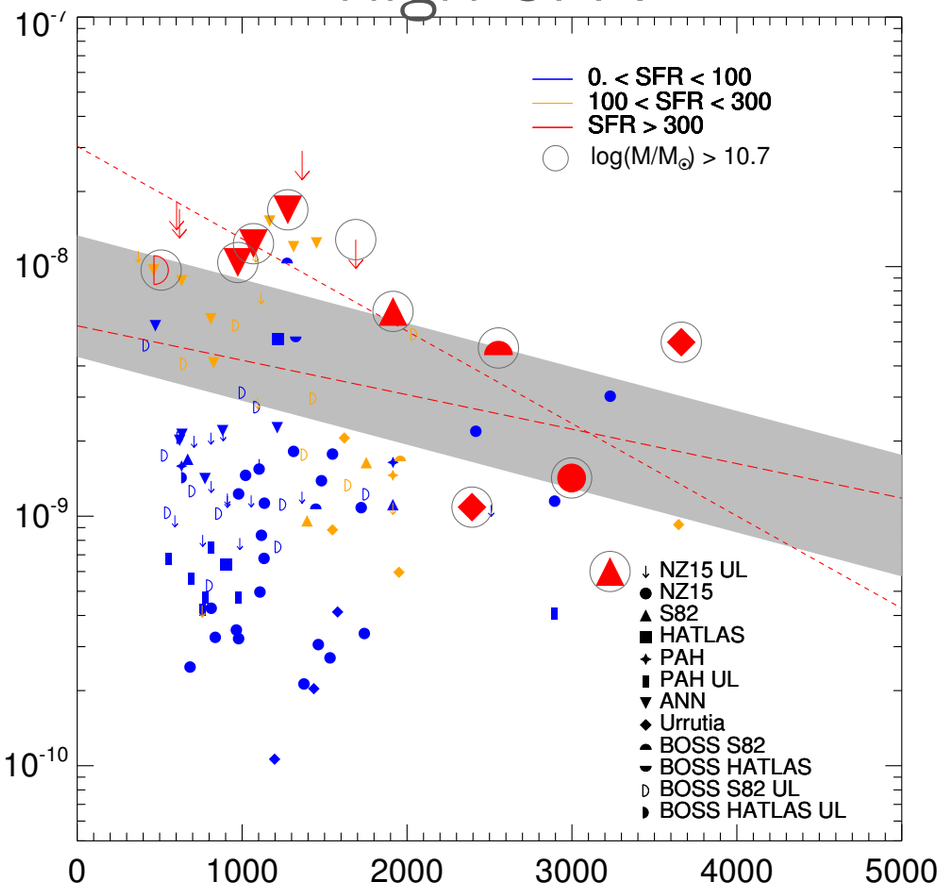
# sSFR VS. VELOCITY WIDTH

Strong negative correlation between sSFR and velocity width at high SFRs

intermediate SFR




high SFR




**velocity with of [OIII] (W90)**

Wylezalek+2016b (in prep.)

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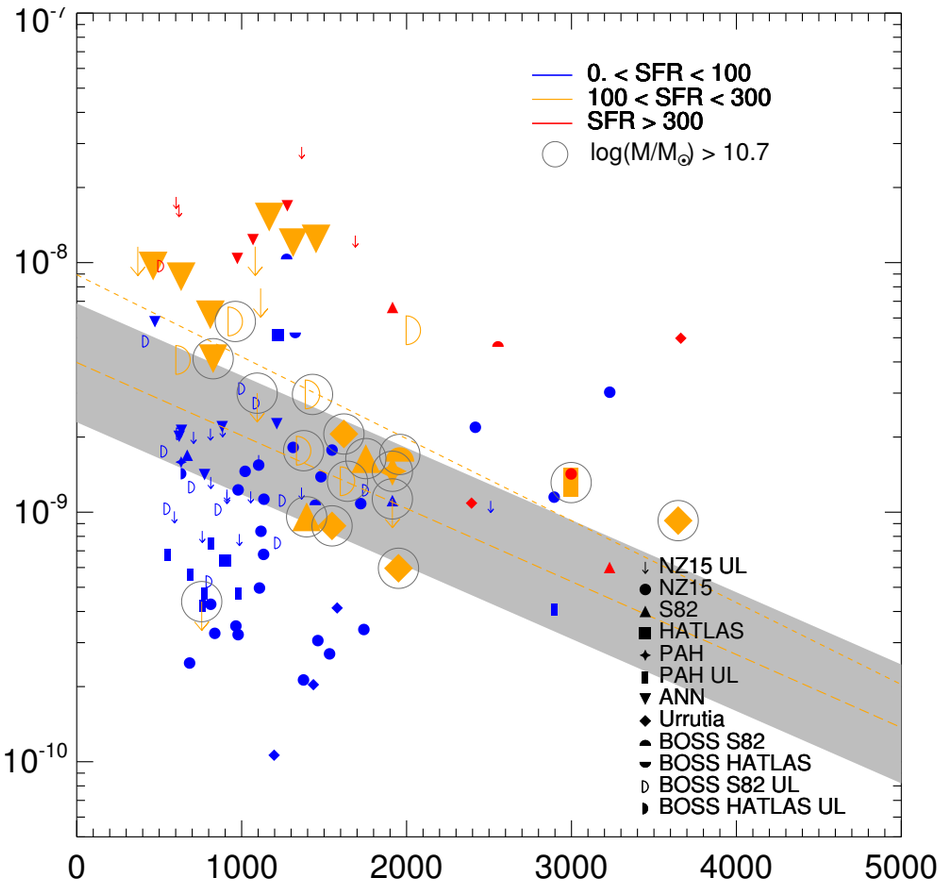


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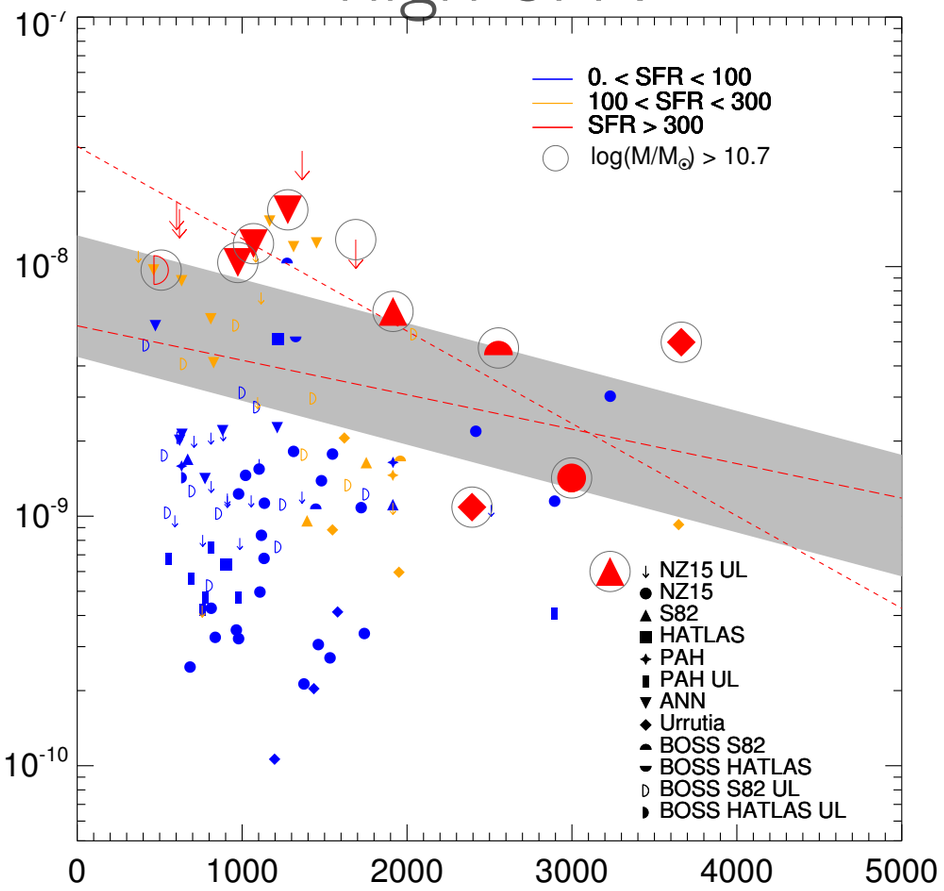
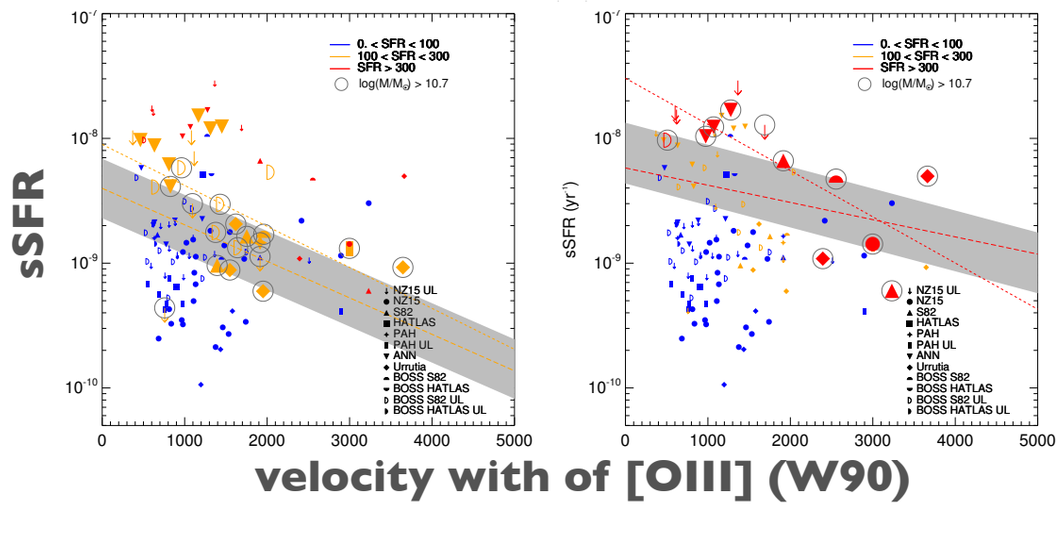



**velocity with of [OIII] (W90)**

Wylezalek+2016b (in prep.)

# sSFR VS. VELOCITY WIDTH

- negative correlation between sSFR and velocity width at high SFRs
- coupling between wind+gas is potentially strongest
- relative signatures of AGN feedback
- decrease of sSFR driven by increase in stellar mass
- effect of galaxy potential negligible




Wylezalek+2016b (in prep.)

# 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

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