THE WISSH SURVEY:
REVEALING ULTRA-MASSIVE BLACK-HOLES
&
POWERFUL WINDS IN THE MOST LUMINOUS QUASARS

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The WISSH quasars project

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G. Cresci, A. Marconi INAF Arcetri
… and many others

WISSH

Looking for AGN feedback in action: where to observe?

Theory
&
Observations

→ The more luminous is the AGN
the higher is the outflow momentum rate $\dot{M}v \sim 20\text{-}50 L_{bol}/c$

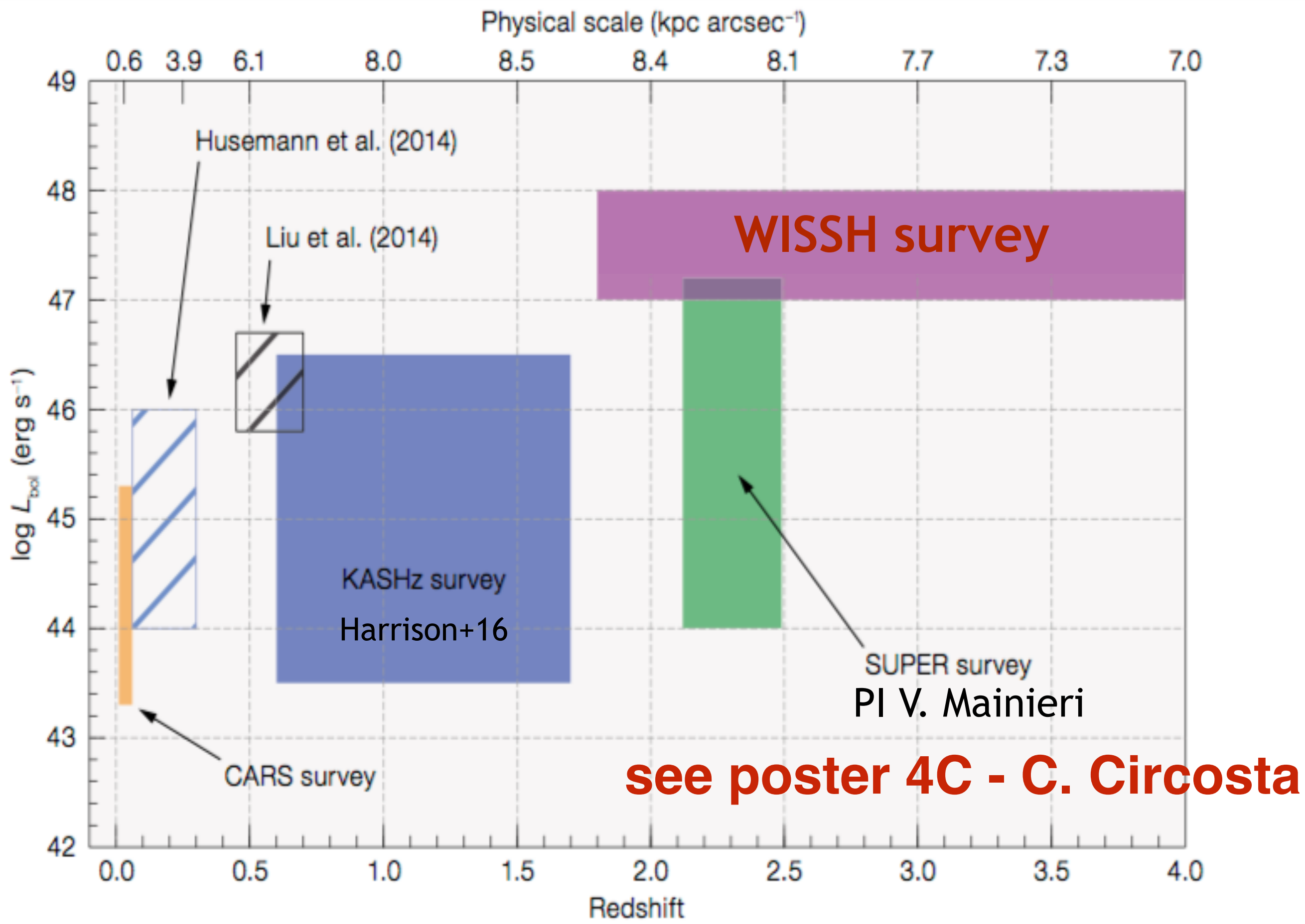
e.g. Menci+08, Faucher-Giguère&Quataert 2012,
Zubovas&King 2012, Cicone +14, Feruglio+ 15

The most luminous quasars are the best targets to hunt for powerful AGN-driven outflows

—> Sampling LARGE areas to collect the most luminous AGN

The Wide-field Infrared all sky Survey WISE (3.4, 4.6, 12 and 22μm)
can be the answer…

The WISSH Quasars survey



WISSH Quasars

Sample of 86 WISE/SDSS Selected Hyper-luminous (WISSH) quasars

- SDSS DR7 broad-line Quasars at z >1.5 with WISE(22μm) > 3mJy
- L_{Bol} > 2 x 10^{47} erg s^{-1}

WISSH Tasks

- Probing widespread presence of outflows from different gas phases/distances
- Constraining the properties of the central engine
- Studying the ISM and SFR of the quasars host galaxies

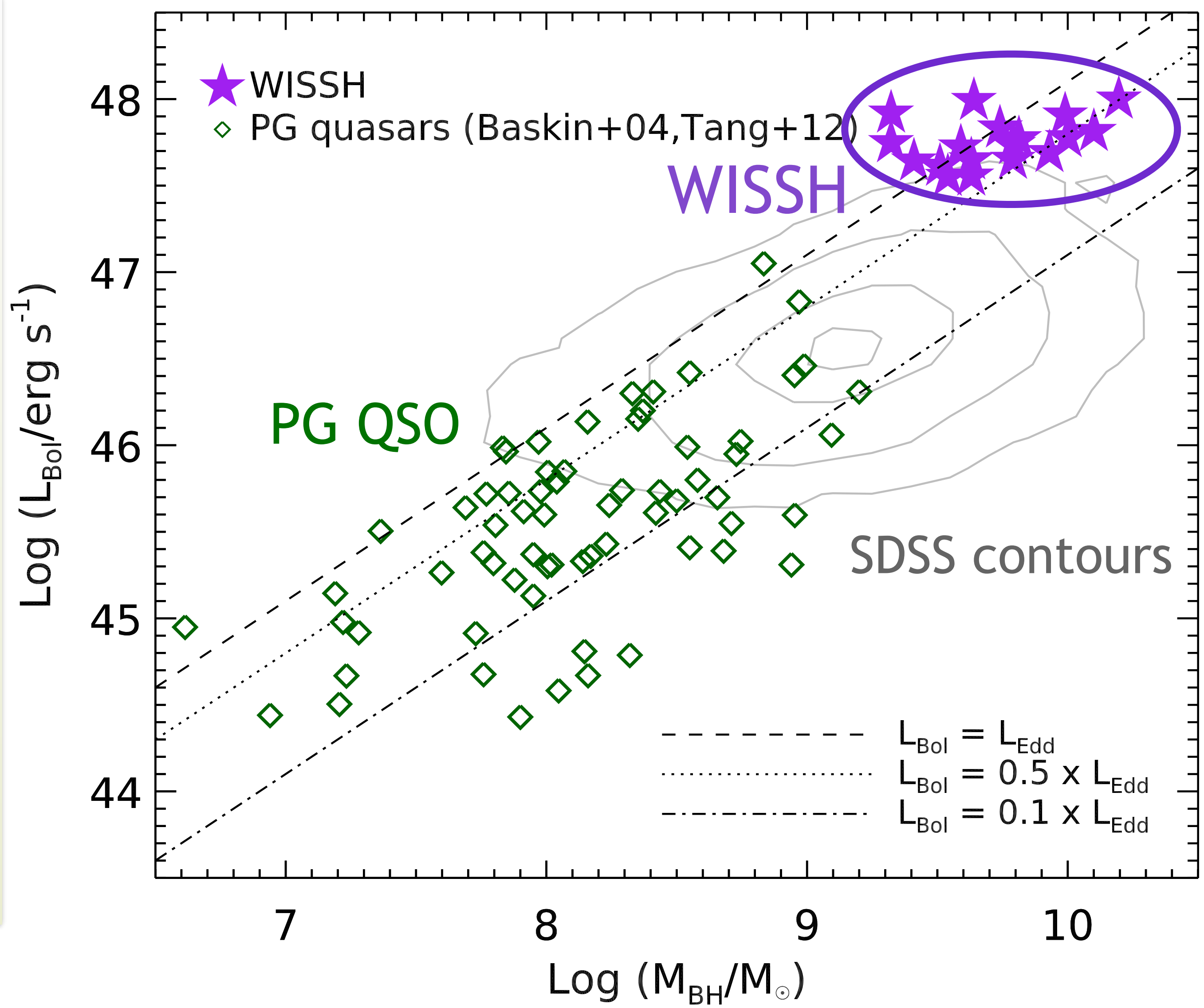
Extensive multi-λ observing program: panchromatic view of Hyper-Lum QSOs

Proprietary data: LBT/LUCI, SINFONI, X-shooter, XMM & Chandra, ALMA, Noema
Public data: Herschel, WISE, 2MASS, SDSS

SMBH mass from Hβ emission line

LBT/LUCI campaign (36 targets):
initial sample of 18 WISSH quasars

- FWHM(Hβ) 3,000-8,000 km/s
- Hβ-based SMBH masses
  from ~ 2×10^9 M⊙
  up to ~ 2×10^{10} M⊙
- LBol from multi-component broad-band (MID-IR to UV) SED fitting (Duras et al. in prep)
- High accretion rates 0.4 < λEdd < 3

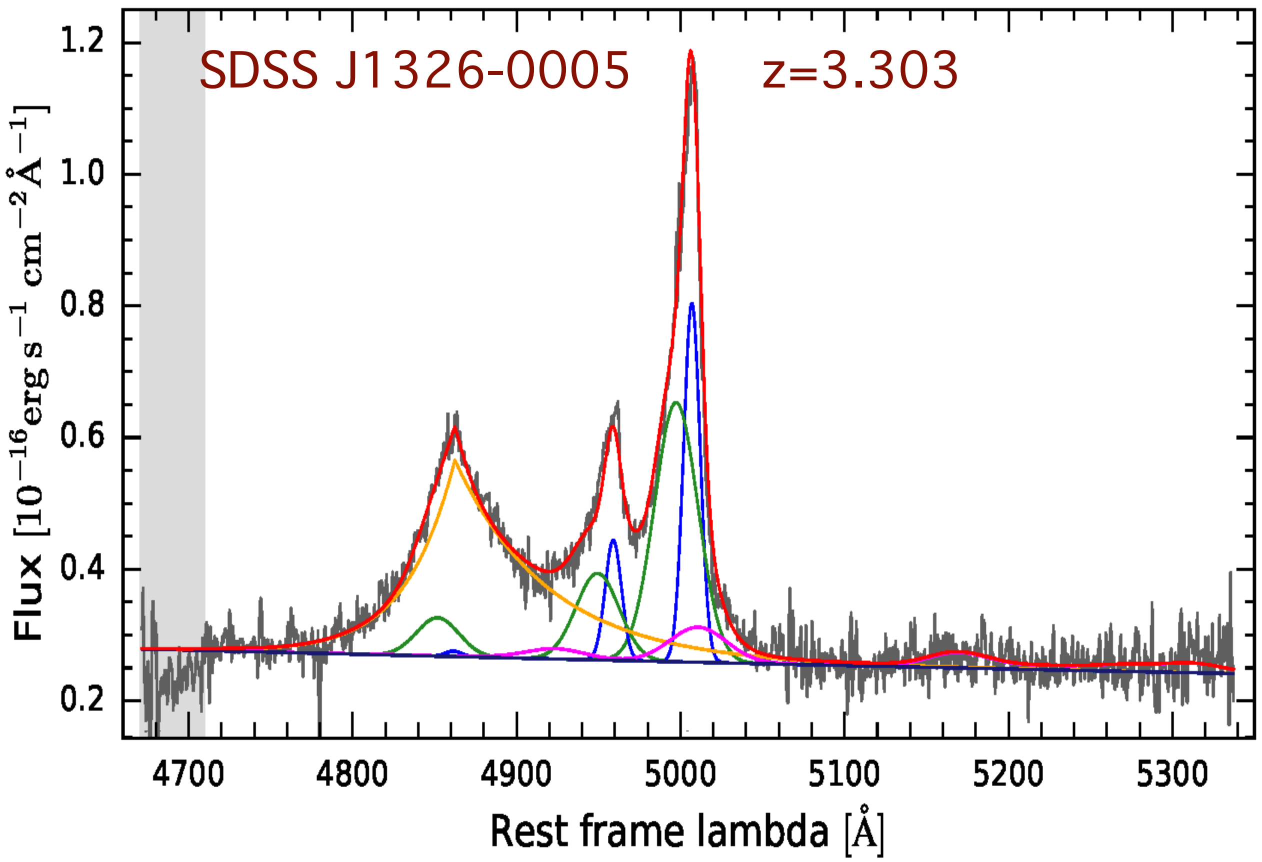


(Vietri et al. 2018, arXiv 1802.03423)

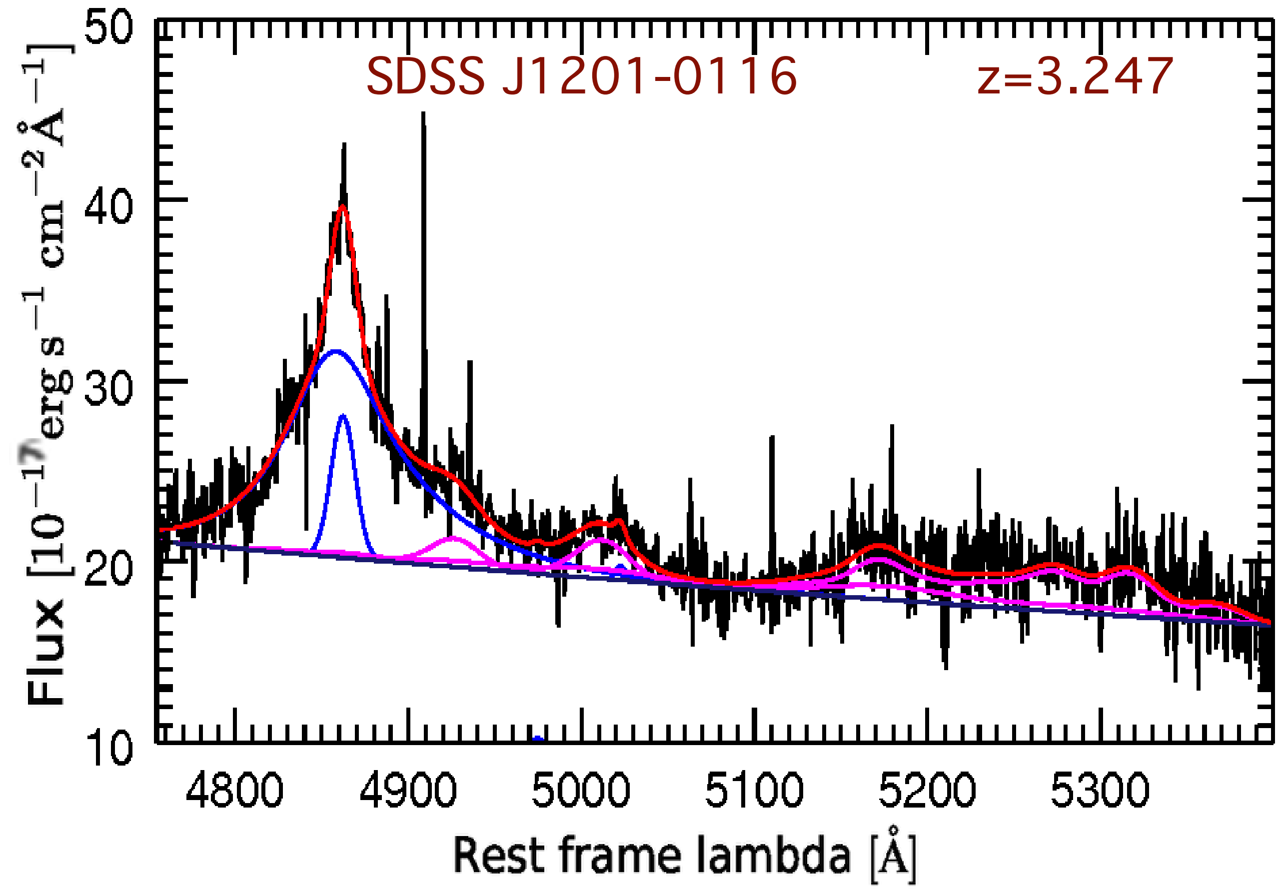
Opportunity of collecting high-mass, highly accreting SMBHs at the peak of the quasar number density

NIR spectra of The WISSH Quasars

30% prominent broad [OIII] emission

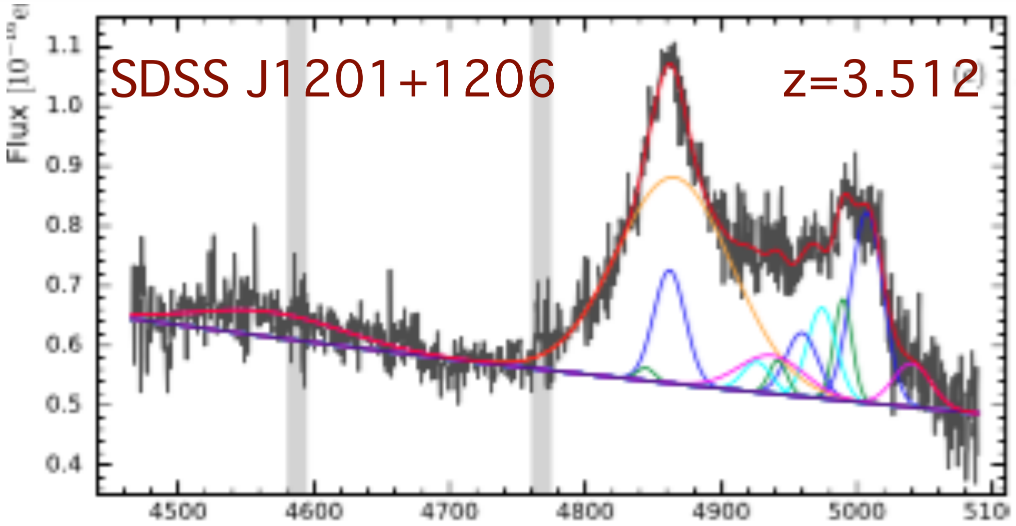


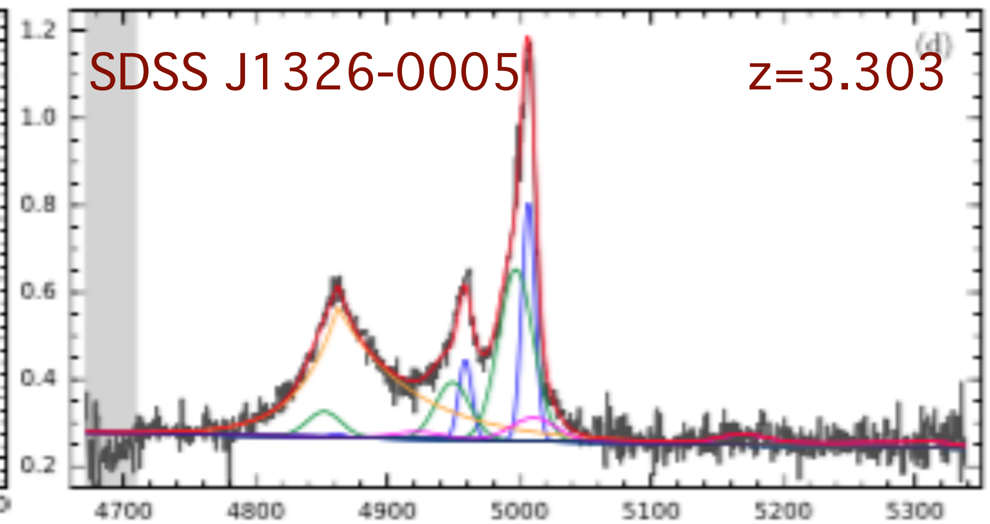
70% weak/lack of [OIII] emission



- Very complex spectra
- Narrow [OIII] emission weak or absent in all of them
- If present, [OIII] shows broad blue-shifted profiles (in 6/18 quasars) indicative of outflows
- Strong, complex FeII emission

POWERFUL [OIII] OUTFLOWS IN WISSH QUASARS





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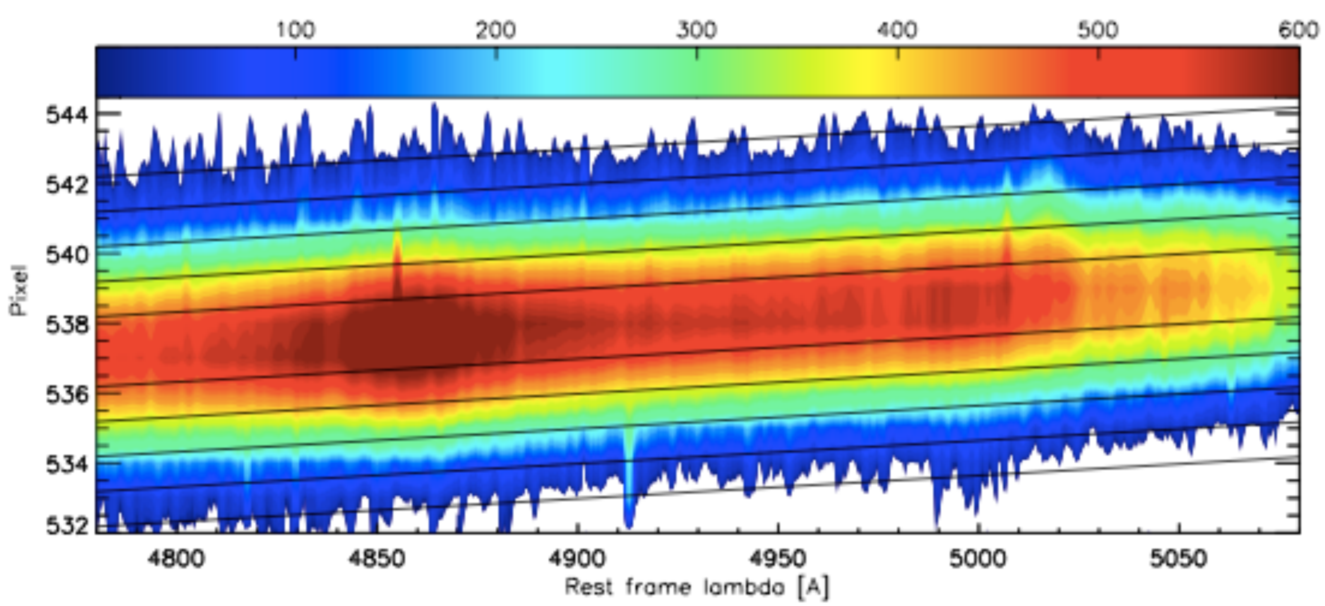


Very broad blue-shifted [OIII] lines

$FWHM_{[OIII]}$ ~ 1200 -2200 km s^{-1}

Strong [OIII] lines observed so far

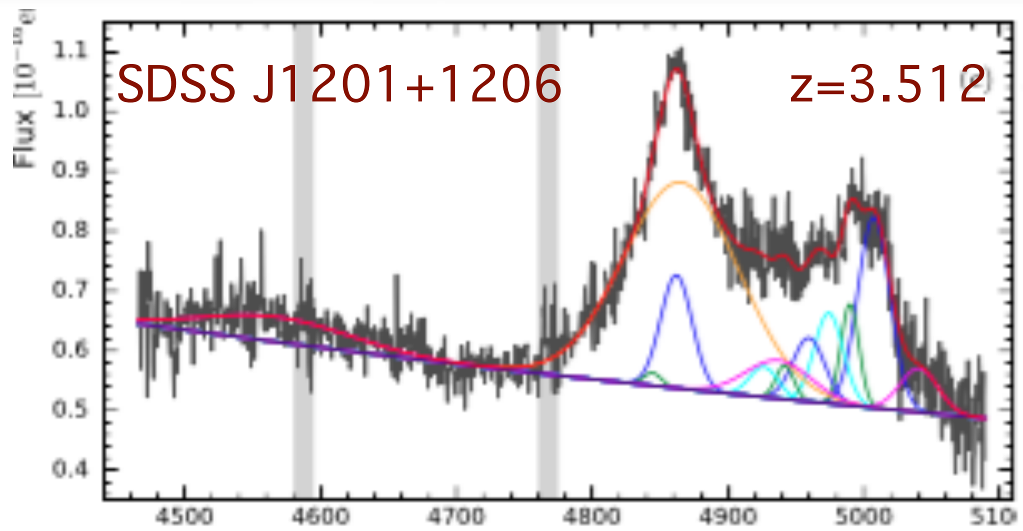
$L_{[OIII]} > 10^{44}$ erg s^{-1}

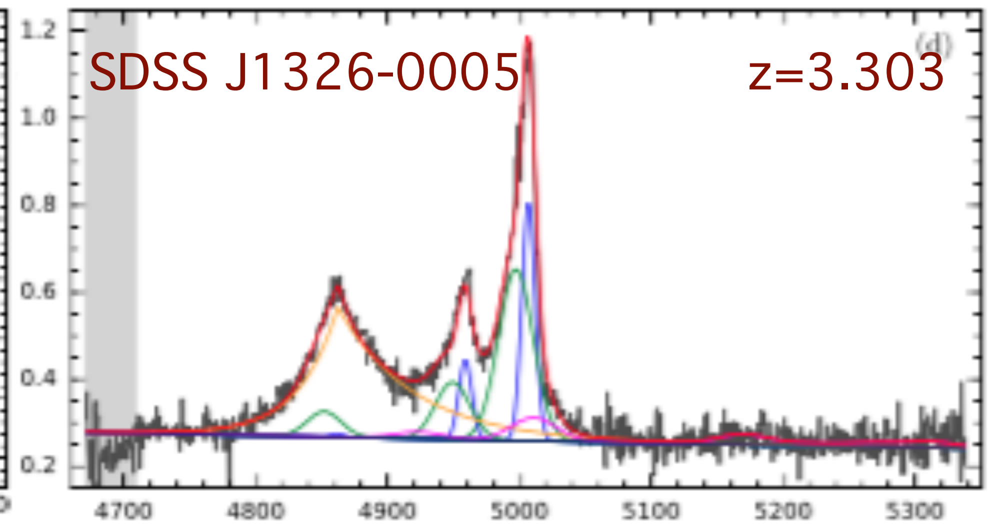
Fast [OIII] emission v(max) ~ 1400 -3000 km s^{-1}

up to ~ 7 kpc

*Bischetti, Piconcelli, **Vietri** + 2017, A&A, 598, A122*

Powerful [OIII] outflows in WISSH Quasars





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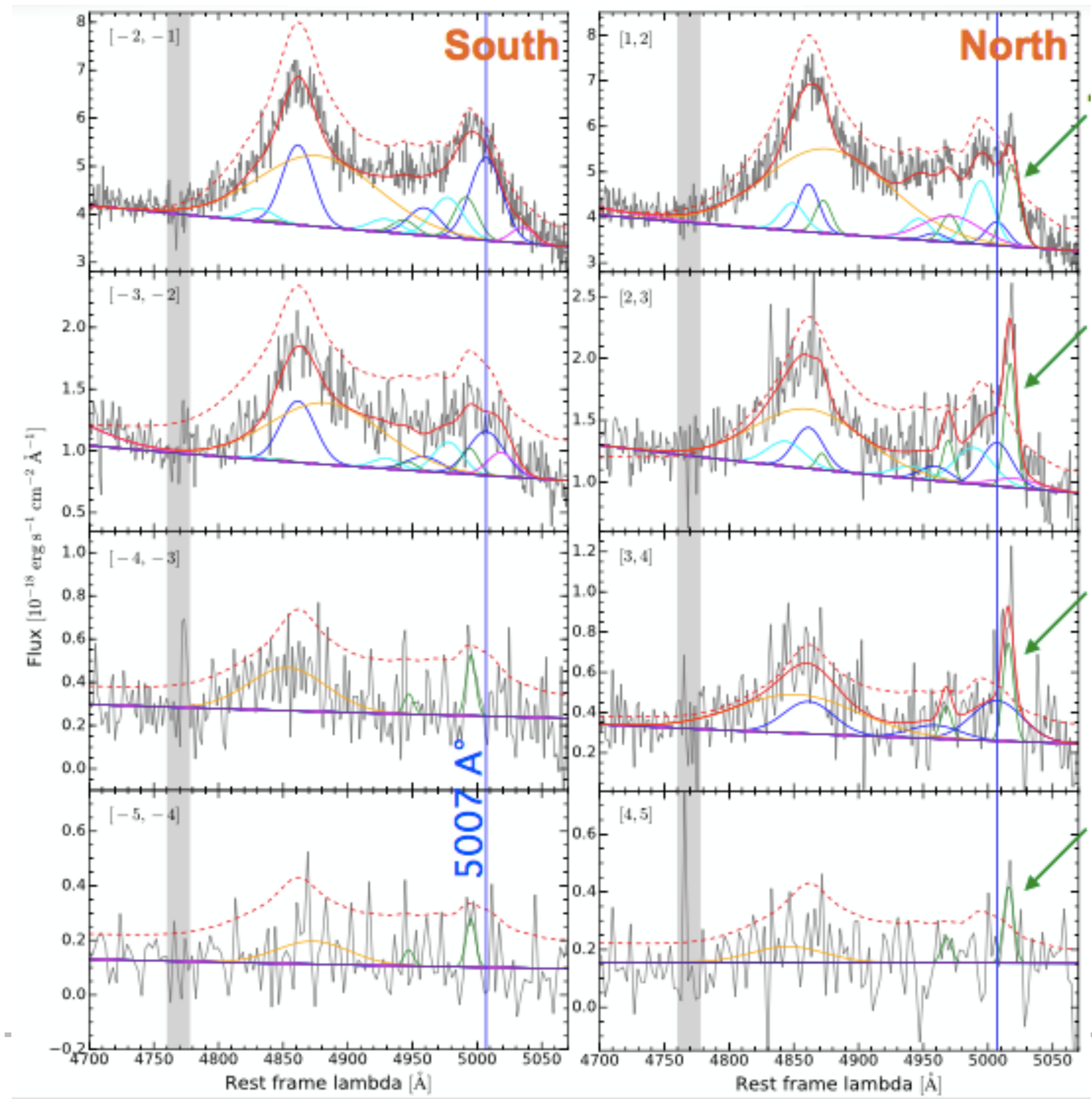

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Such a scenario can be likely interpreted as a Bipolar outflow up to 7 kpc

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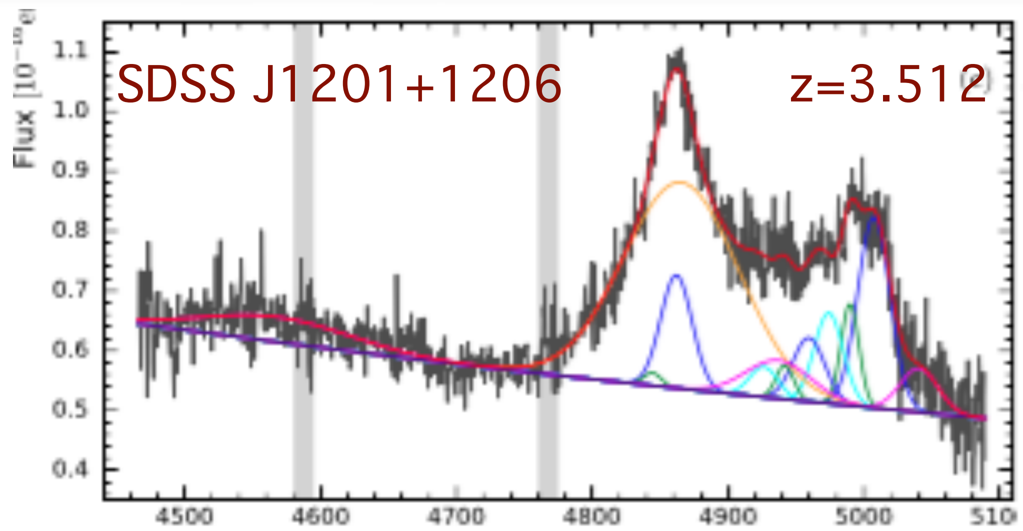

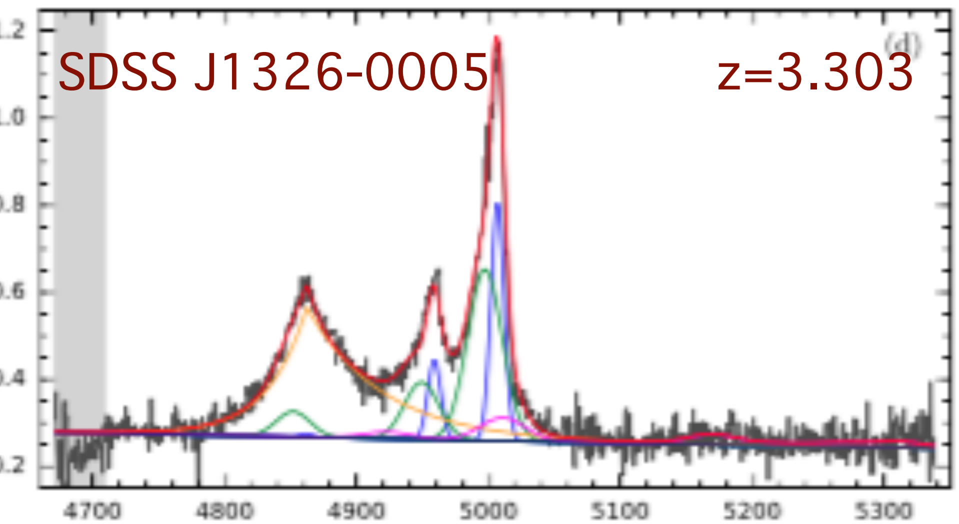

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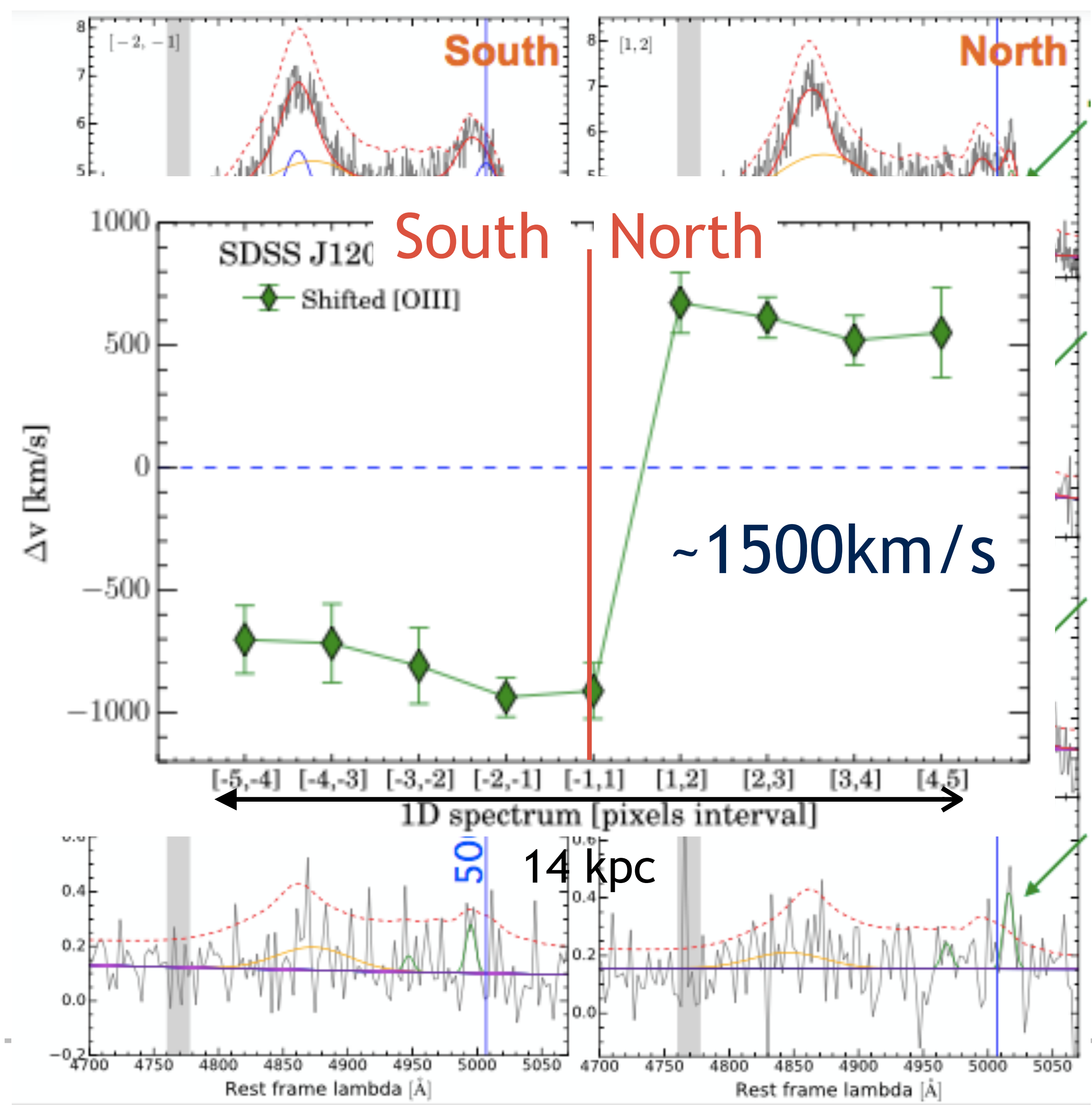

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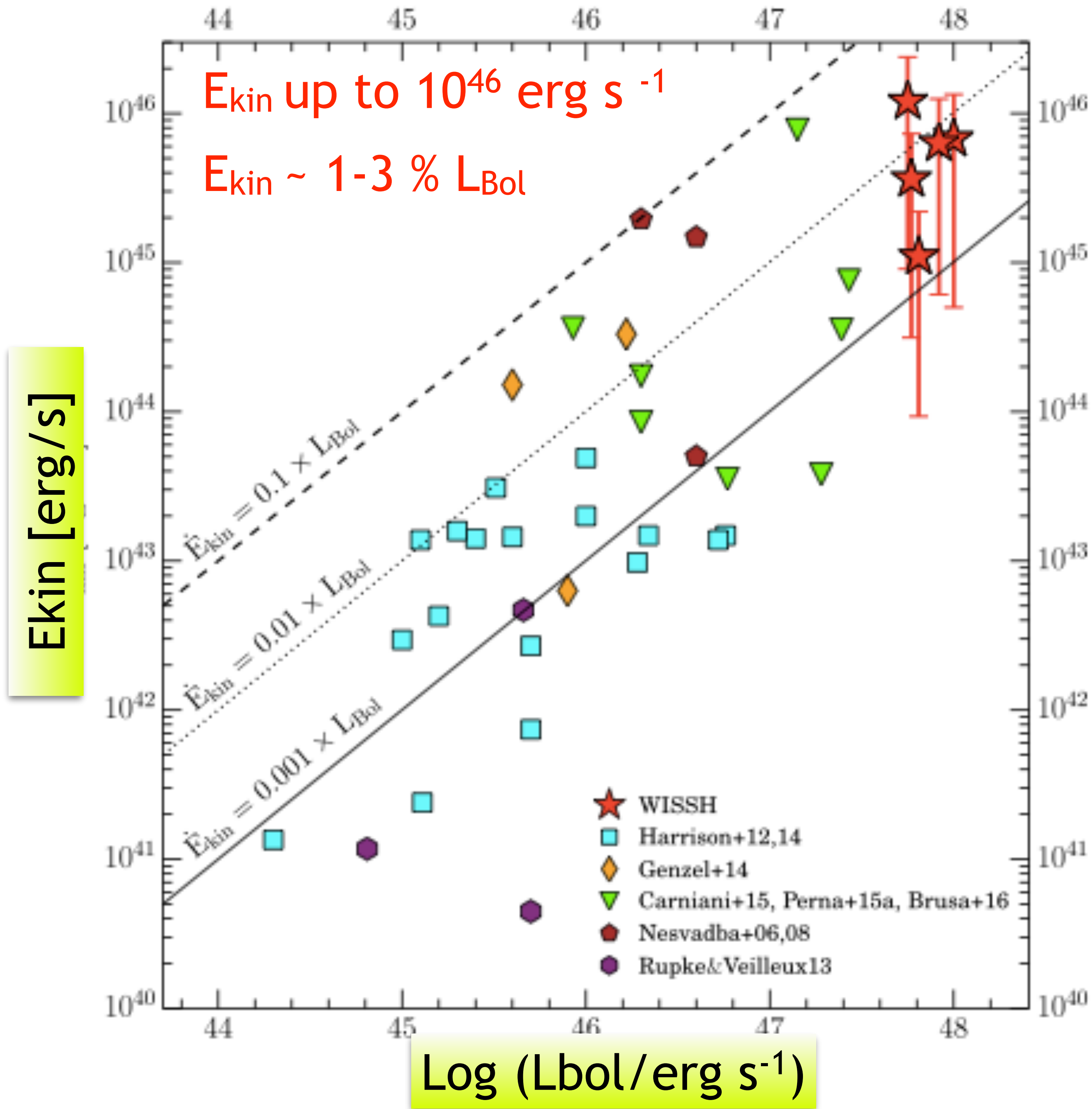


$$L^{broad}_{[OIII]} \longrightarrow M_{ion}$$

$$\dot{M} \sim \frac{3\, M_{ion}\, v_{max}}{R}$$

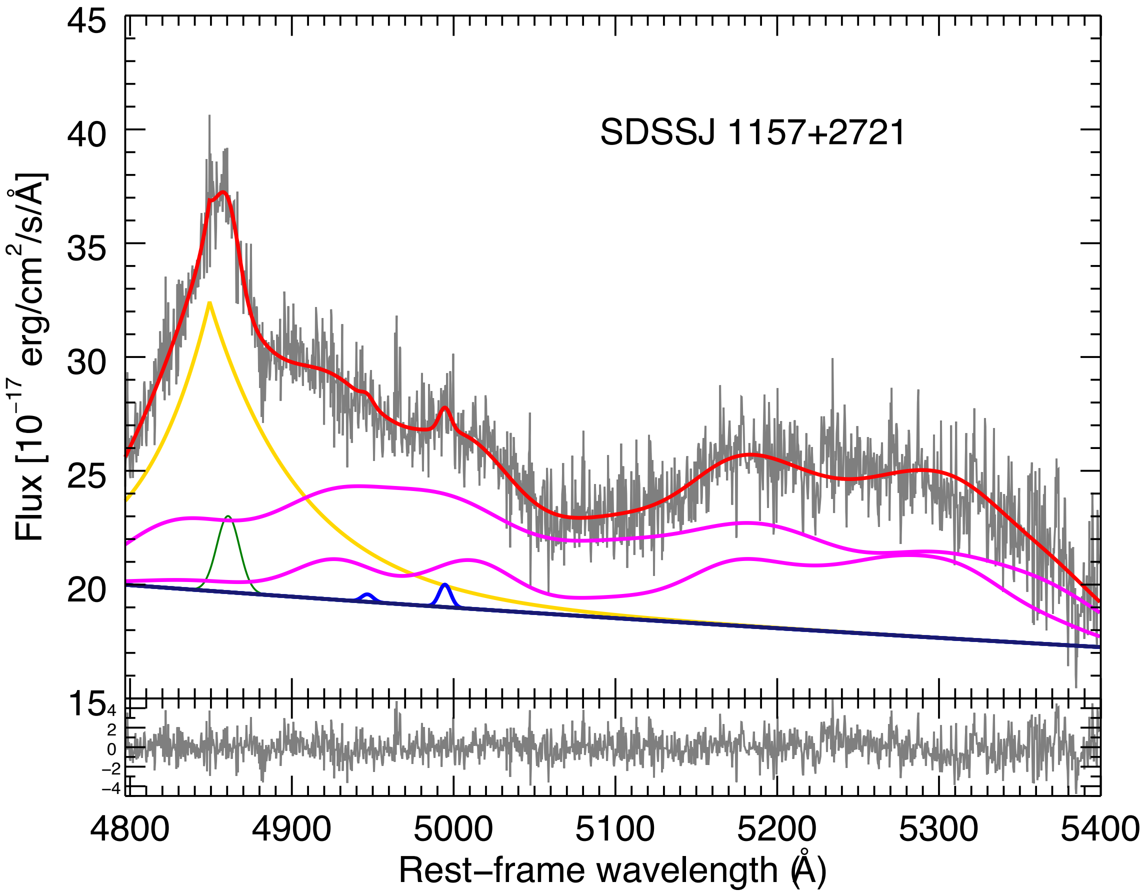
$$\dot{E}_{kin} = \frac{\dot{M} v_{max}^2}{2}$$

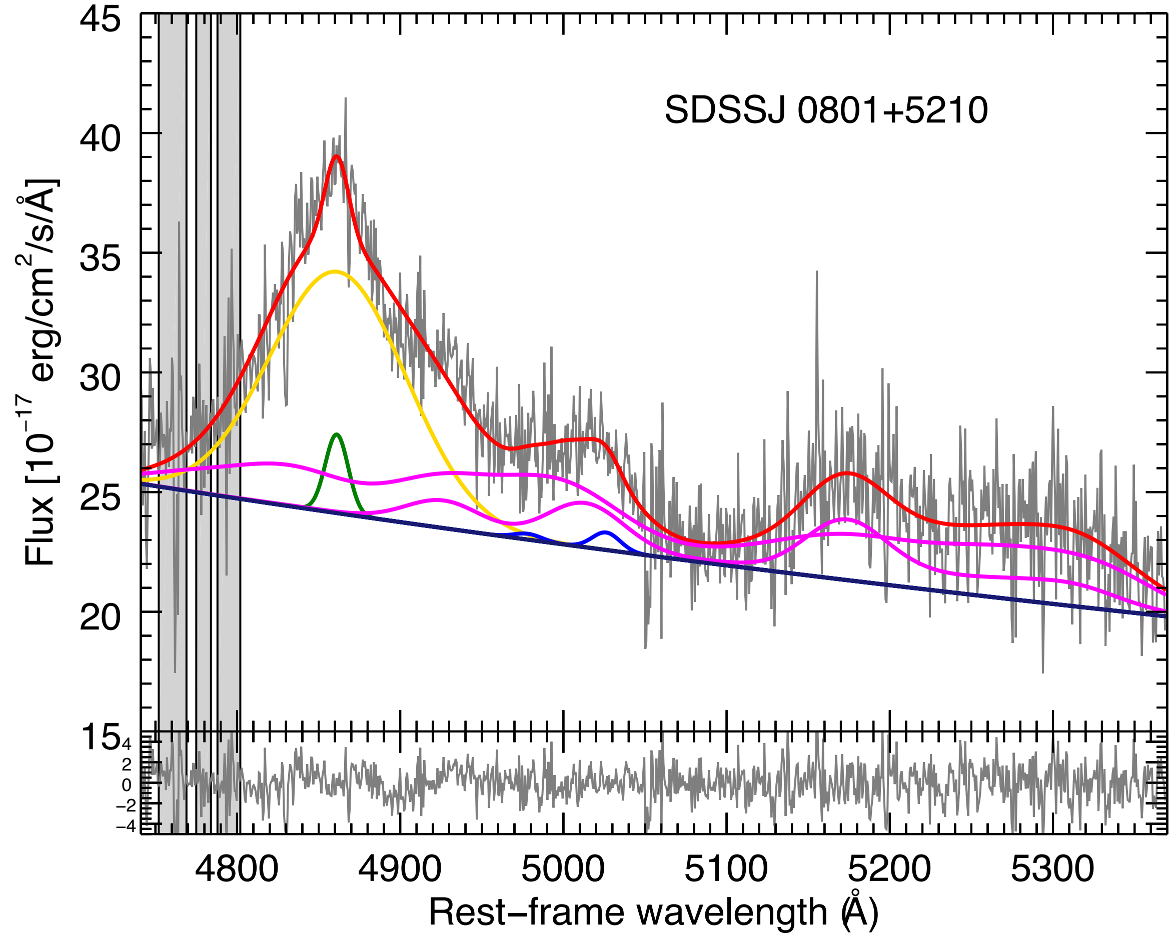
*Bischetti, Piconcelli, **Vietri** + 2017, A&A, 598, A122*

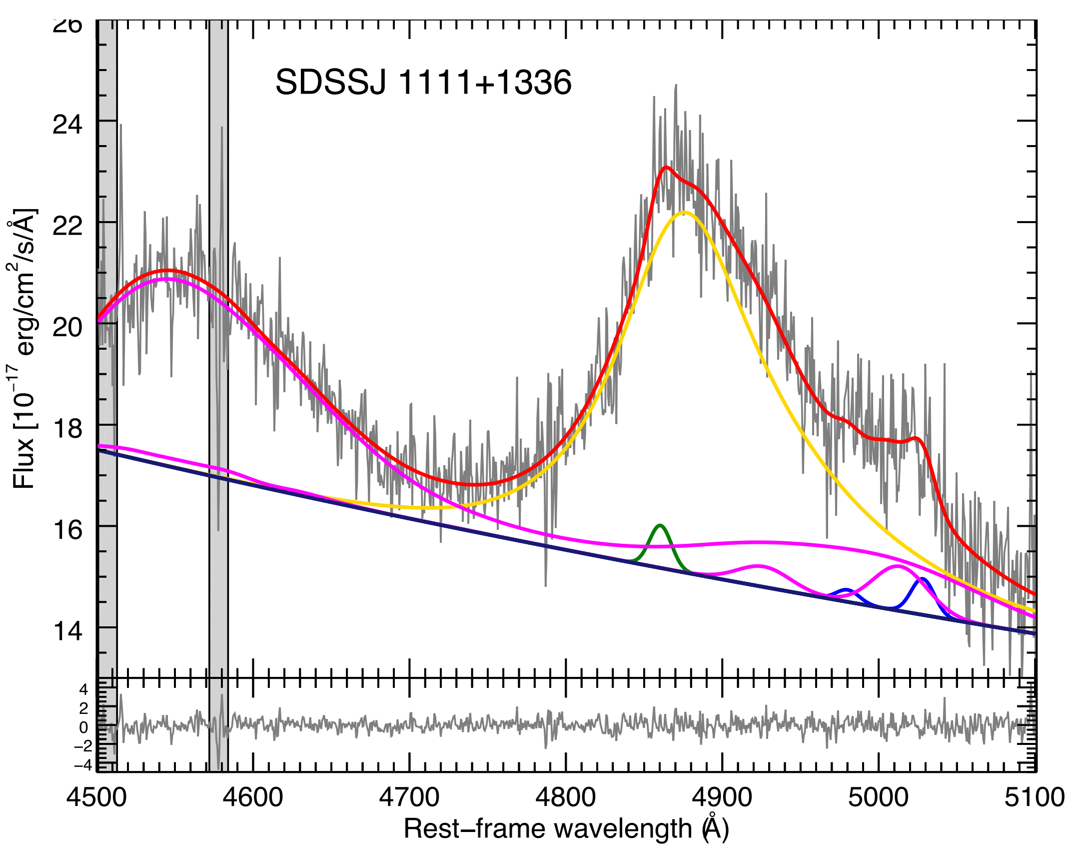
WISSH quasars allow to reveal extremely powerful outflows

Lack of [OIII] in WISSH Quasars?

70% weak/lacks of [OIII] emission



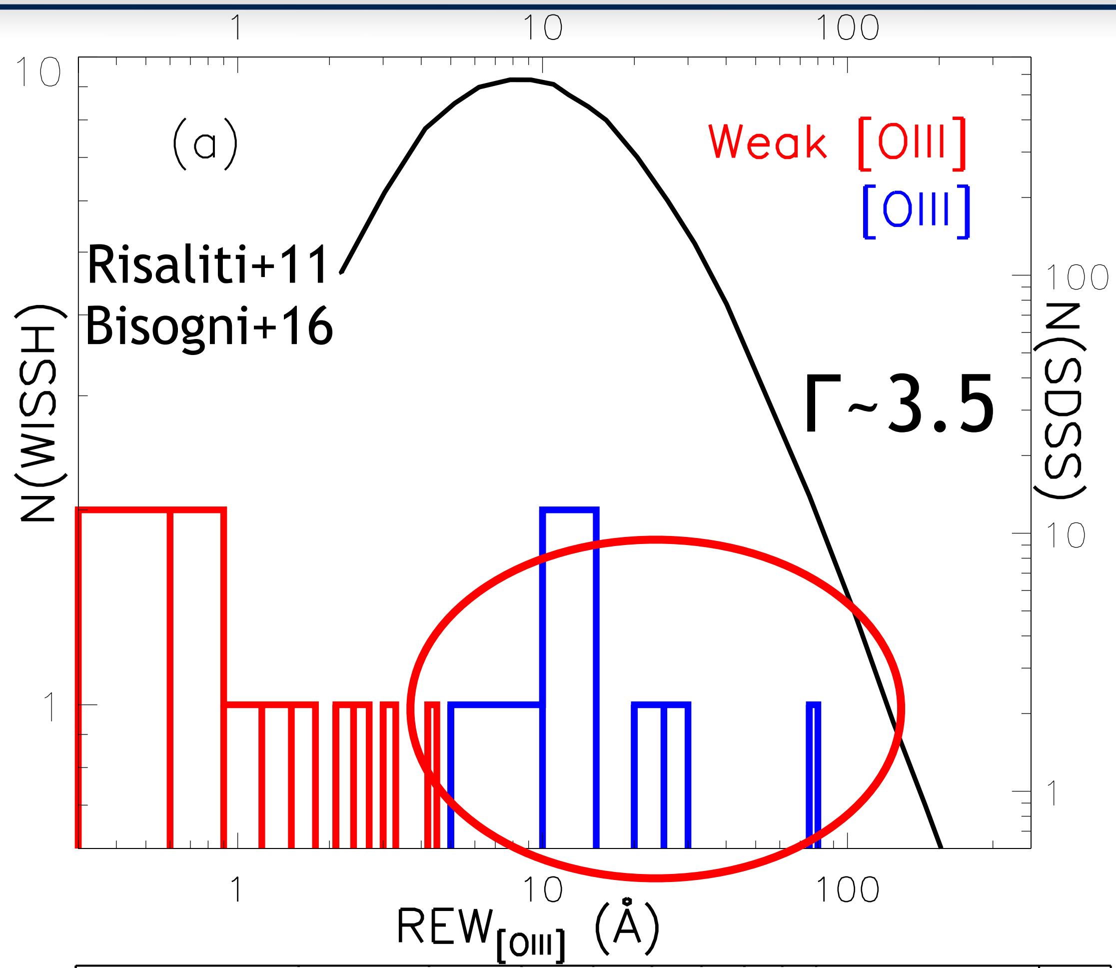




Strong, complex FeII emission

Weak [OIII] emission line? Iron residual?

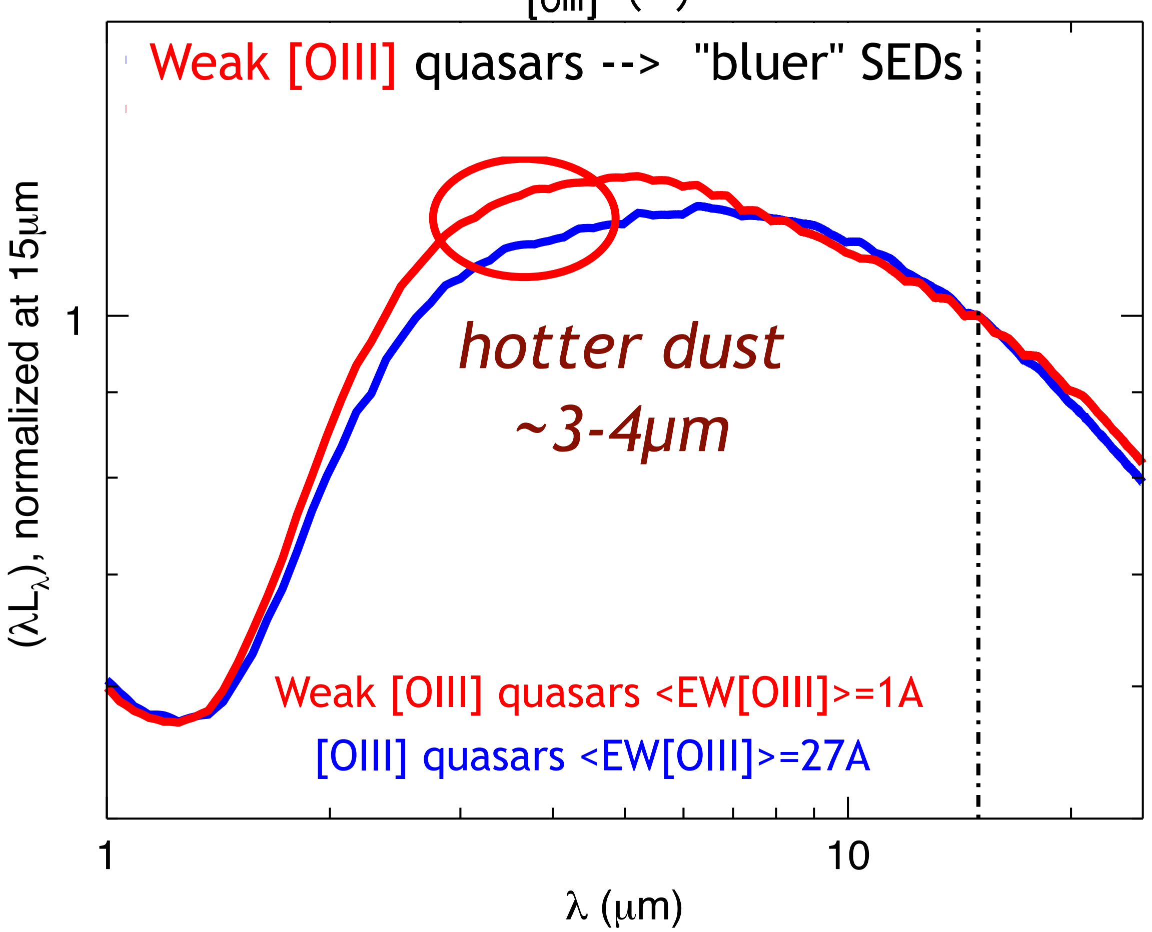
[OIII] DICHOTOMY

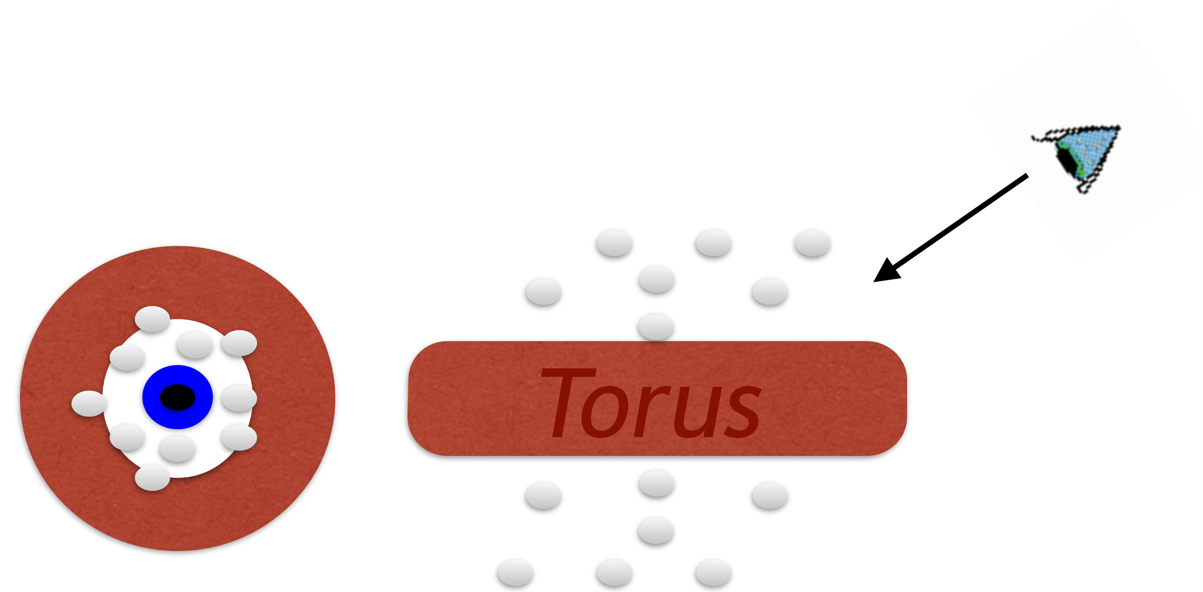


EW[OIII],obs = EW[OIII]/cosθ

the higher EW[OIII] the higher inclination

WISSH: θ~25-70°



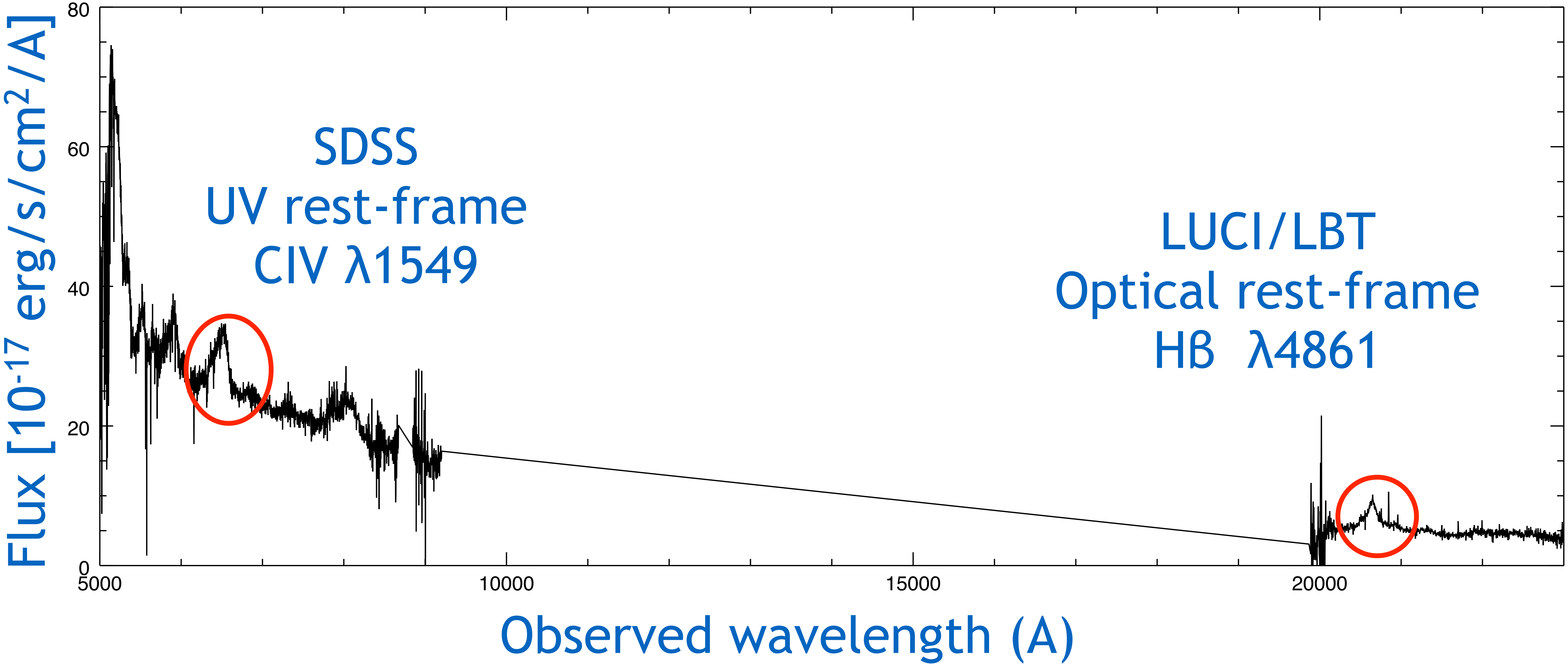


Weak [OIII] sample intrinsic distribution
[OIII] sample high inclination
(partial view of the inner, hotter dust?)

(Vietri et al. 2018, arXiv 1802.03423)

BLR winds via CIV emission line

SDSSJ1201-0116

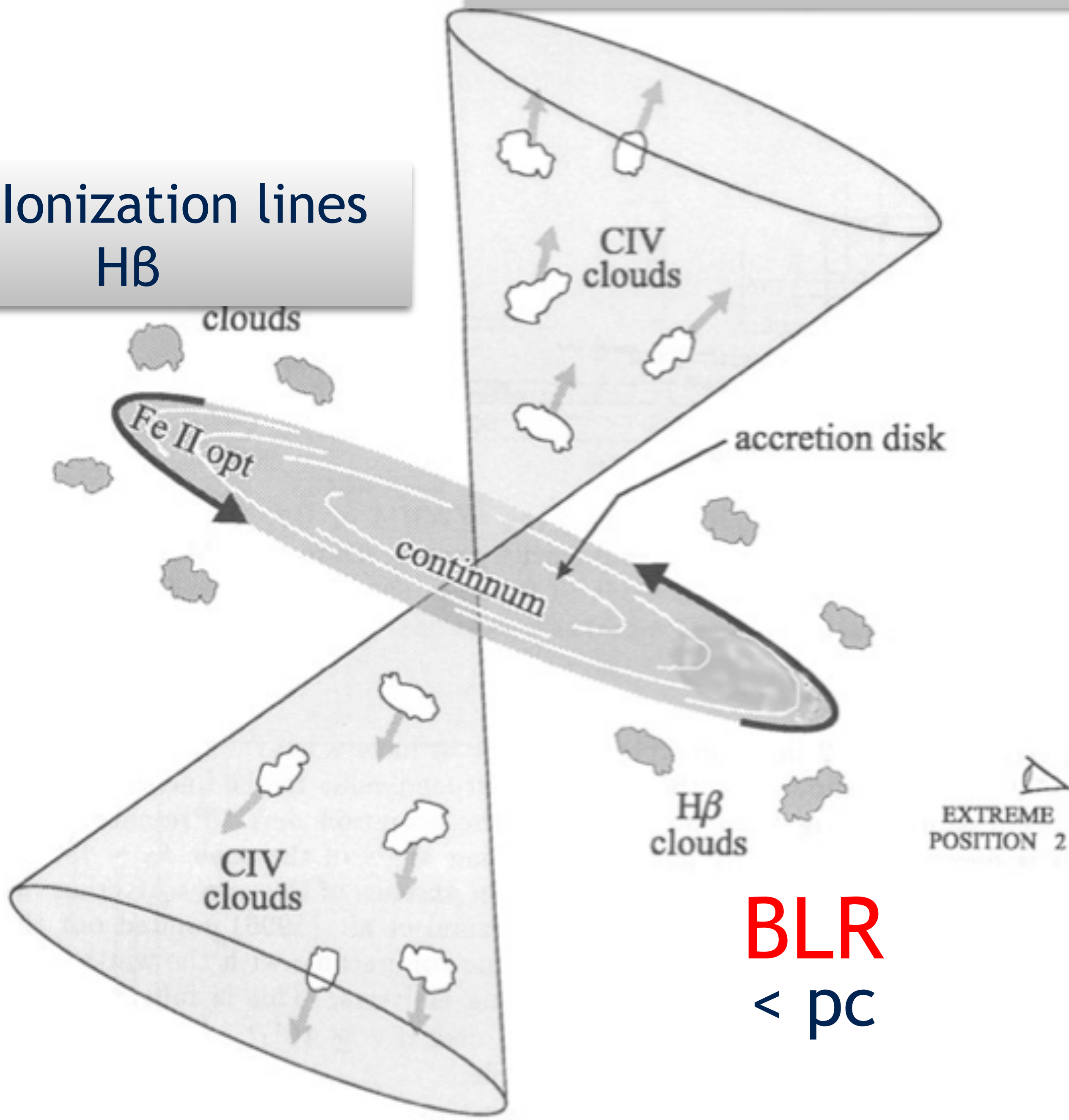


BLR winds via CIV emission line

BLR winds traced by CIV(SDSS)-Hbeta(LBT) velocity shift

High ionization lines
CIV

Low Ionization lines
Hβ



BLR
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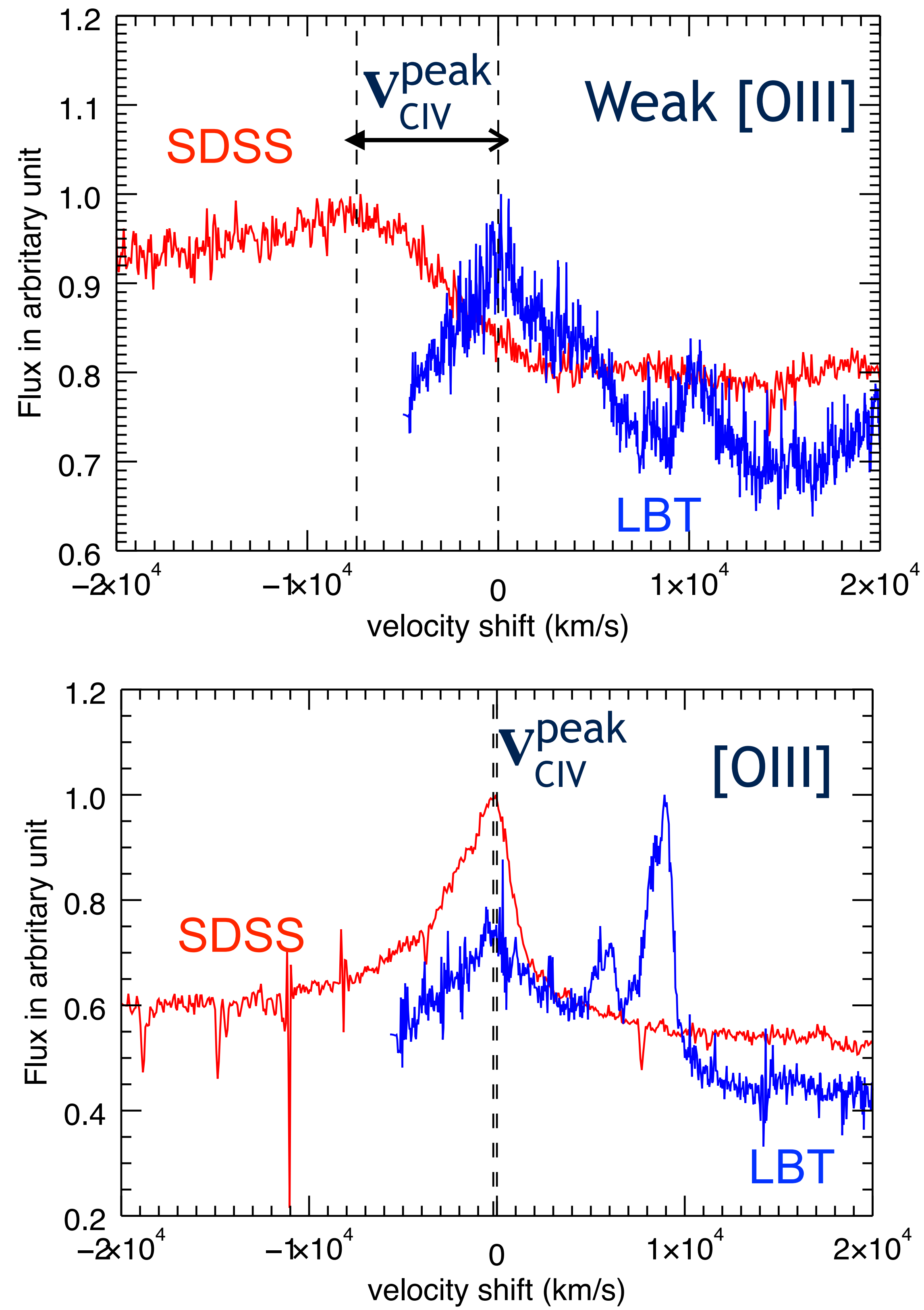

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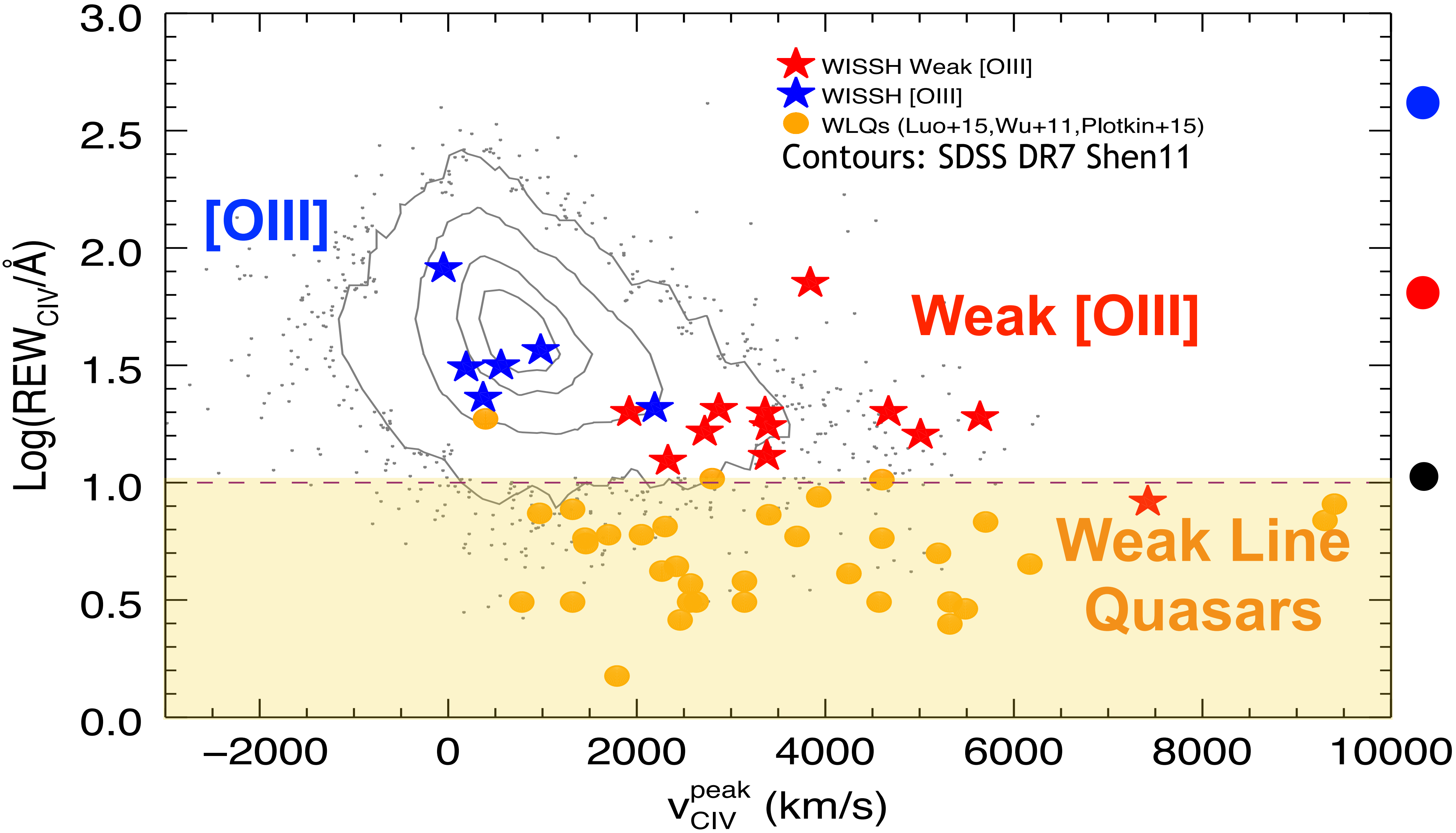


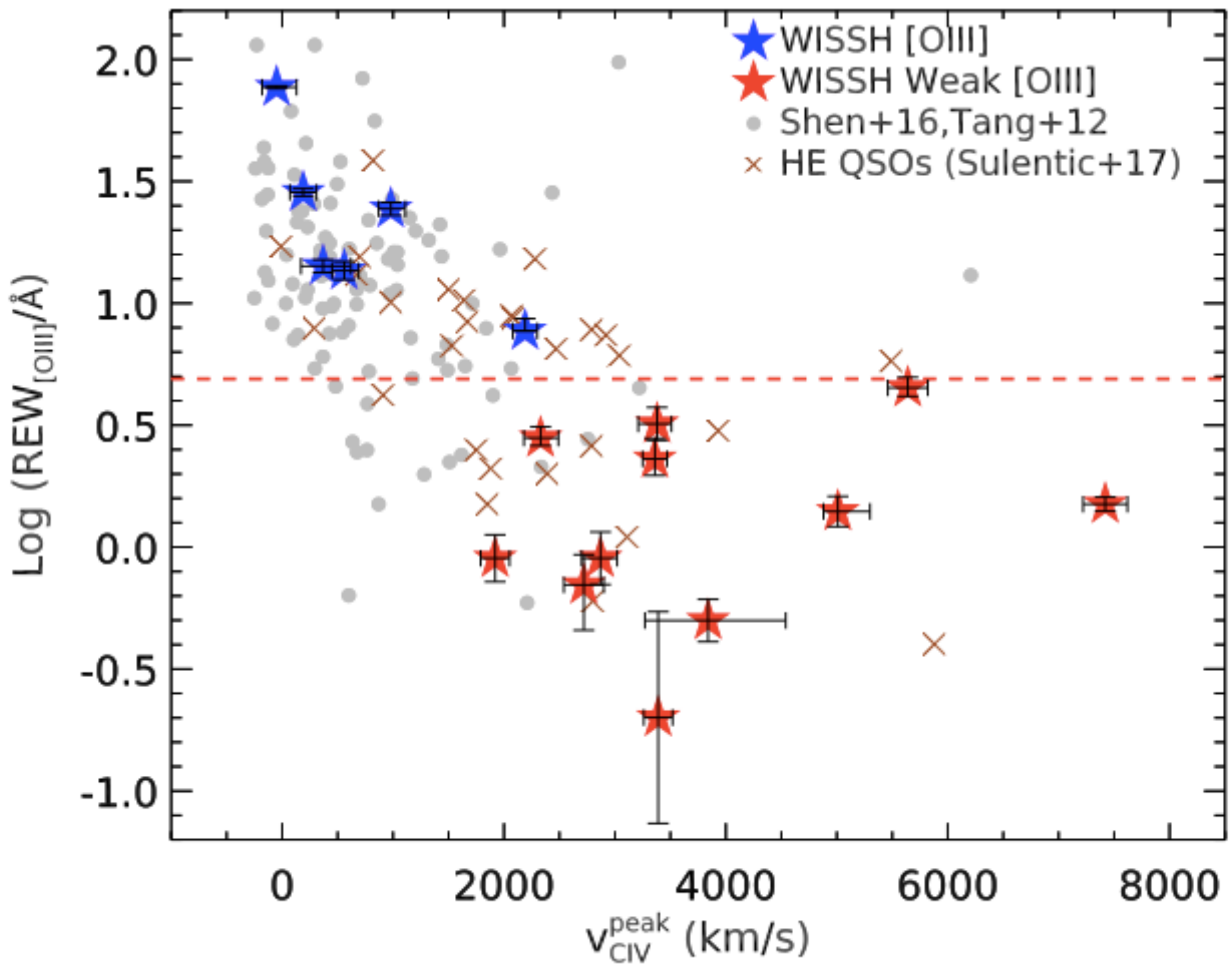
- Strong [OIII] - Weak CIV shifts
- Weak [OIII] - Strong CIV shifts
- Shifts comparable with Weak Line Quasars

1% SDSS QSOs EW(CIV) < 10A

WISSH QSOs also very effective in collecting the strongest CIV winds

(Vietri et al. 2018, arXiv 1802.03423)

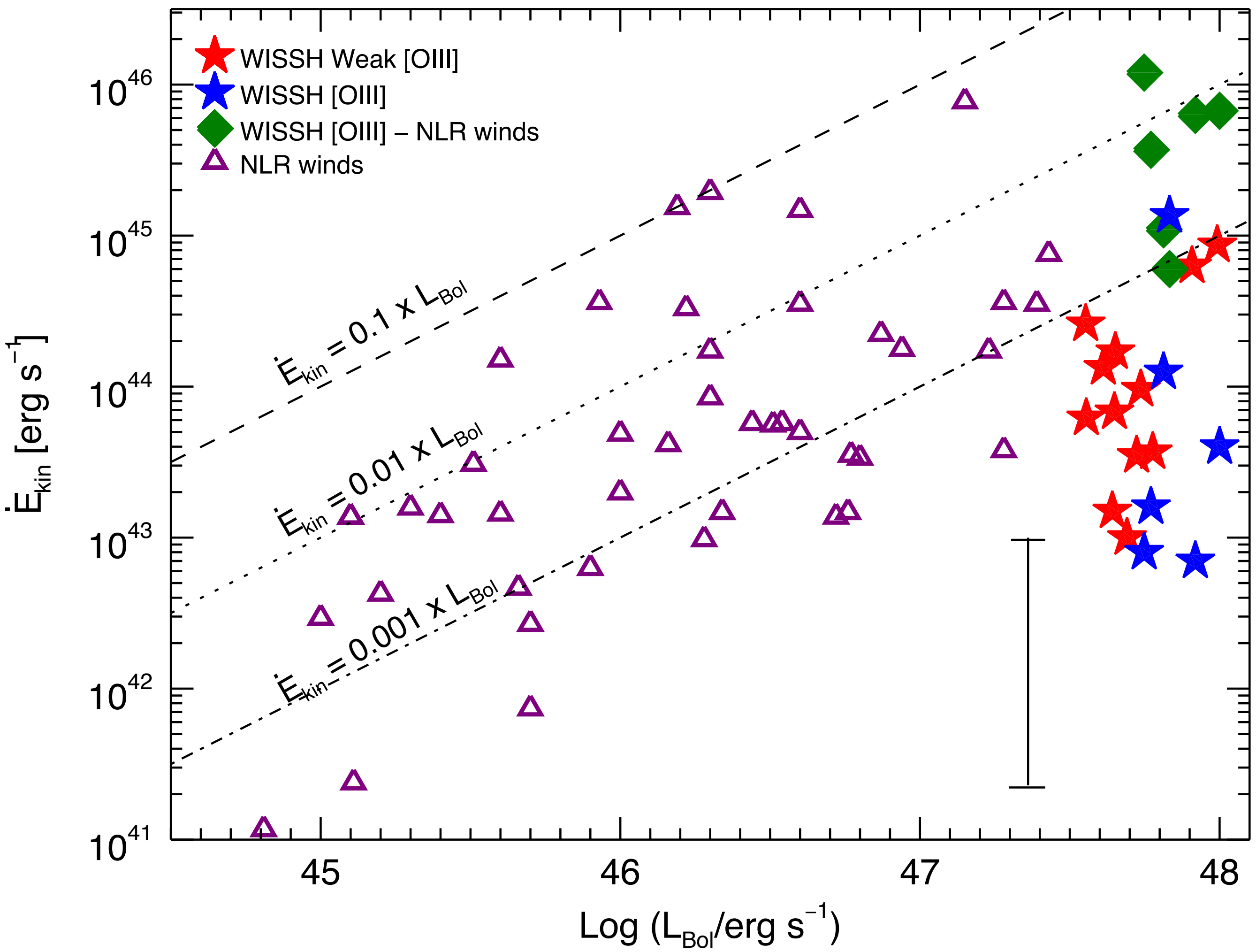
BLR(CIV) – NLR([OIII]) WINDS DICHOTOMY

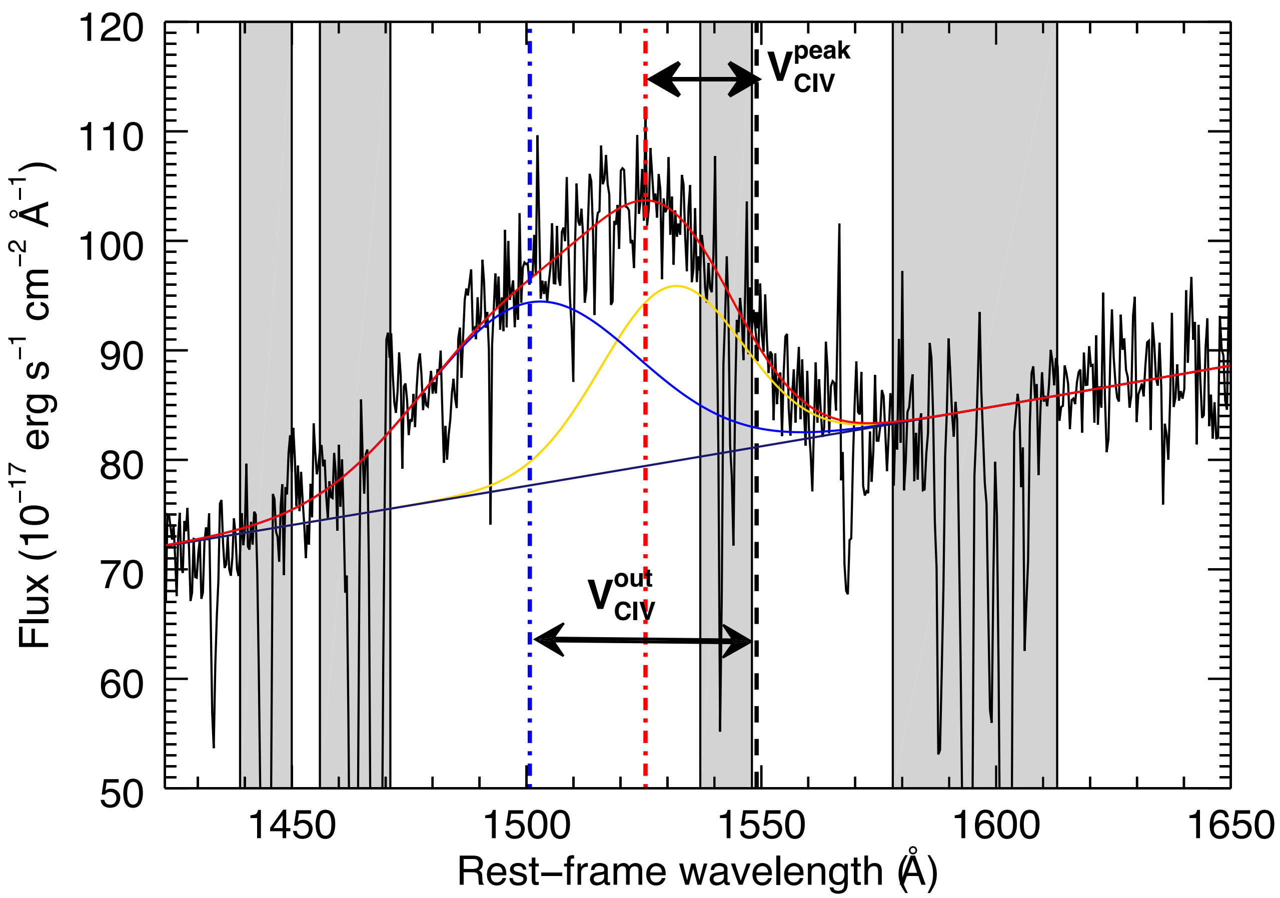


(Vietri et al. 2018, arXiv 1802.03423)

Discovery of a dichotomy:
CIV vshift > 2000 km/s if weak/no [OIII]
CIV vshift < 2000 km/s if [OIII]

BLR WINDS VIA CIV EMISSION LINE





From Marziani+15

$$\dot{M}^{ion}_{out} \propto L_{45}(CIV)\ (Z_5)^{-1}\ n_9^{-1}\ r_1^{-1}\ v$$

$$\dot{E}_{kin} = \frac{1}{2}\dot{M}^{ion}_{out} \times v^2\ (erg s^{-1})$$

$\dot{M}_{out}$ up to 30 $M_\odot$ yr^{-1}

$\dot{E}_{kin}$ up to 10^{45} erg s^{-1}

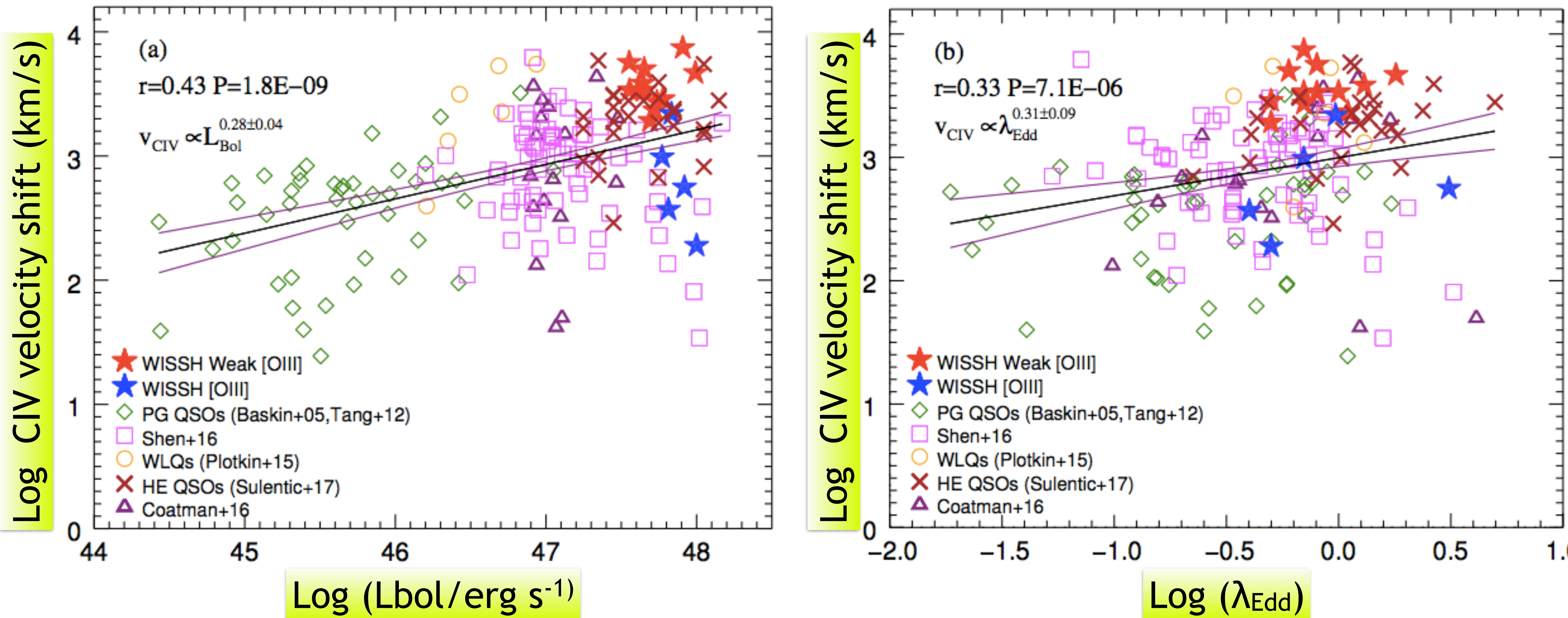
(Vietri et al. 2018, arXiv 1802.03423)

Take into account for a complete census of strong AGN-driven outflows

Evaluate their effects of depositing energy and momentum into the ISM

What is the Driver of BLR winds?

Sample of 147 QSOs with Hβ SMBH mass



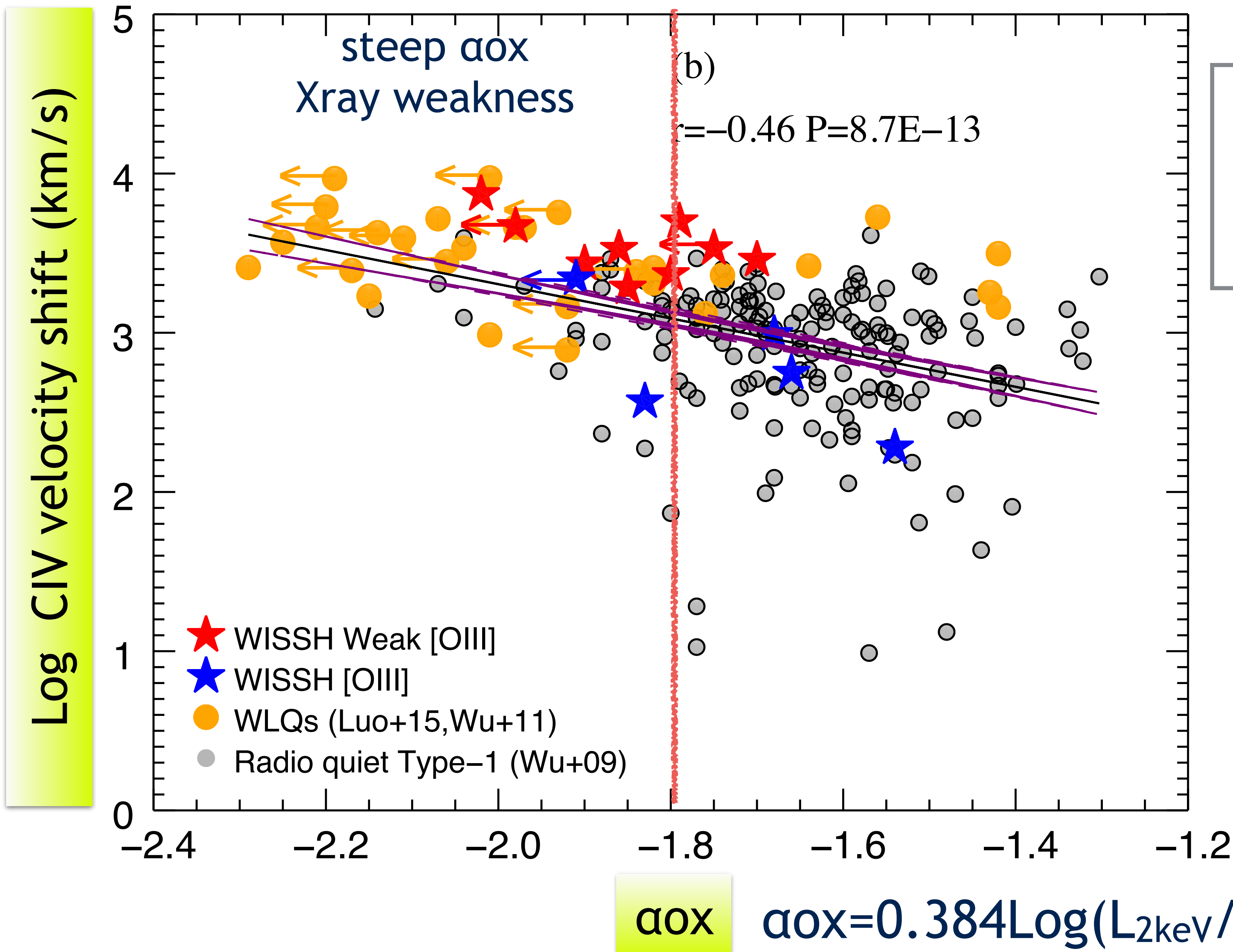
As expected for radiatively driven winds

Log V_{out} ∝0.25 Log L_{Bol}

(Vietri et al. 2018, arXiv 1802.03423)

What is the Driver of BLR winds?

Is the shape UV-X ionizing continuum the physical driver of the BLR winds?



$\alpha ox = 0.384 Log(L_{2keV}/L_{2500A})$

Well known anti-correlation:

$\alpha ox - L_{UV}$

Vignali+2003
Lusso+2010
Lusso & Risaliti 2016

steep αox/high L_{Bol} as primary driver of the CIV blueshifts

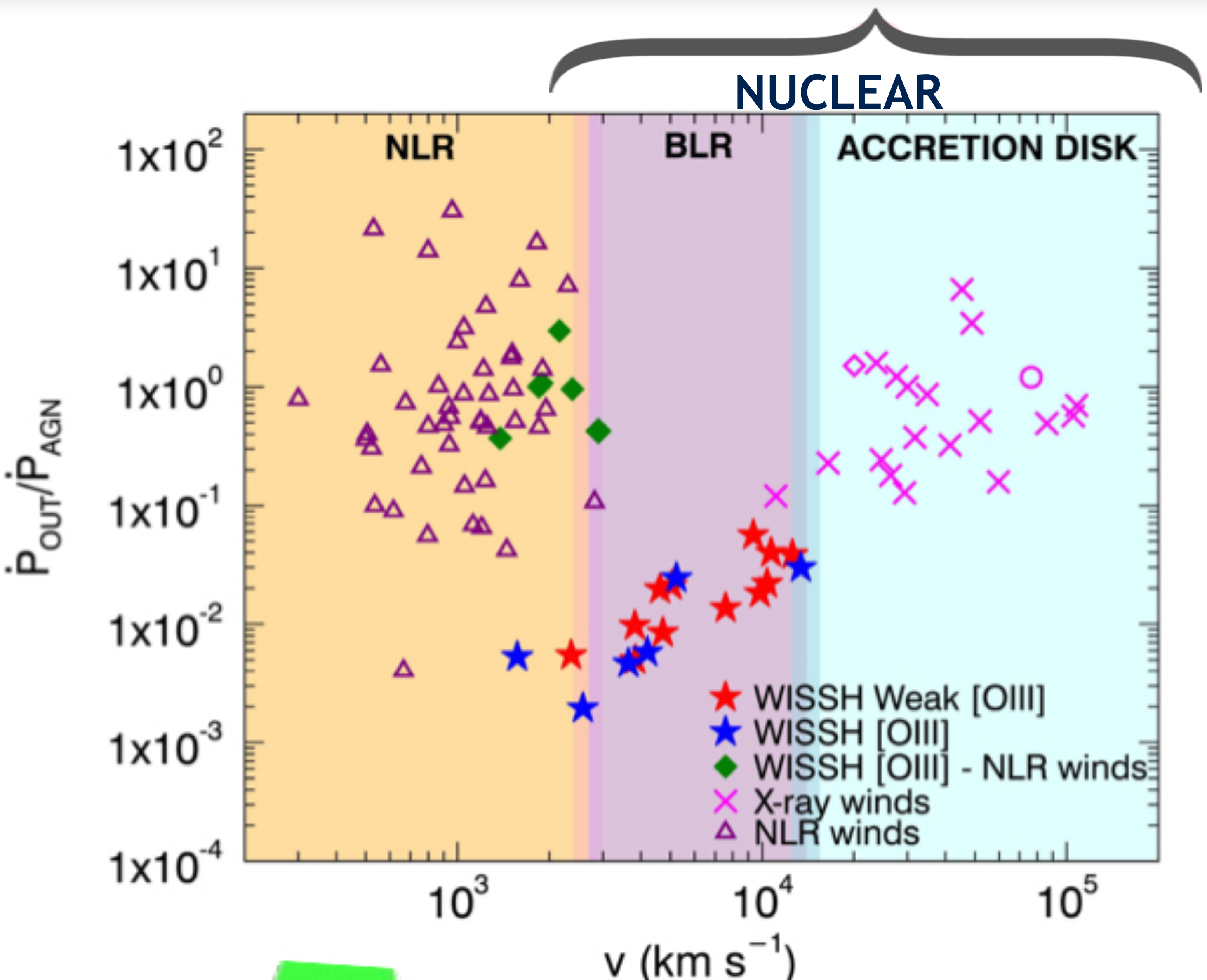
Strong X-ray radiation can easily overionize the material and hamper an efficient line-driving mechanism

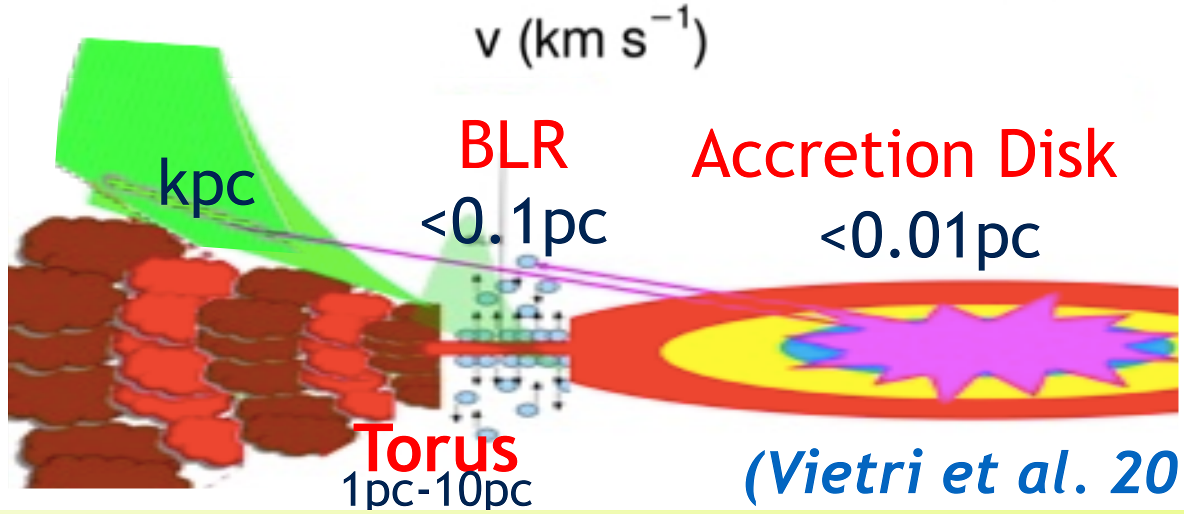
(Vietri et al. 2018, arXiv 1802.03423)

Census of AGN driven winds

$\dot{P}_{out}=\dot{M}_{out} * v_{out}$

$\dot{P}_{AGN}=L_{AGN}/c$





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Outflow velocity distribution as a proxy of the distribution in radial distance from the AGN

Momentum load for nuclear winds may reflect the covering factor of outflowing gas

Conclusions

The WISSH sample
86 Hyper-luminous, Type 1 quasars with $L_{Bol} > 10^{47}$ erg/s at $1.5 < z < 4.5$

WISSH: Revealing widespread presence of outflows in the most luminous quasars

Results from LUCI/LBT(Optical) - SDSS(UV) data (18 targets)

Ultramassive (up to 2×10^{10} M⊙) - Highly Accreting SMBH at z~3

Powerful massive kpc scale ionized winds

SINFONI IFU spectrocopy follow-up is on-going

Discovery High-velocity (3000-8000 km/s) BLR winds

High luminosity as a key ingredient (70% of the WISSH)
Radiatively driven BLR winds ($v \propto L_{Bol}^{(1/4)}$)
BLR winds as powerful as NLR winds

dichotomy of BLR(CIV) - kpc-scale [OIII] winds

CIV vshift > 2000 km/s if weak/no [OIII]
CIV vshift < 2000 km/s if [OIII]
Inclination likely play a major role

Physical driver of CIV winds

steep α_{ox} and large L_{Bol}

(Vietri et al. 2018, arXiv 1802.03423)