Massive ionized outflows in quasars

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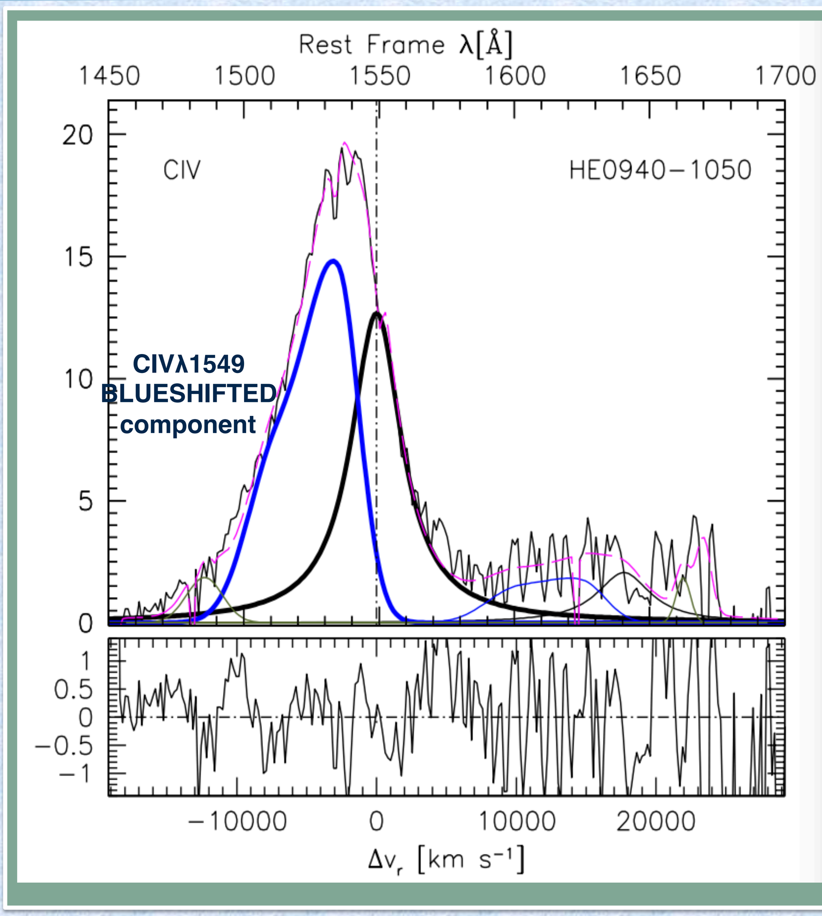
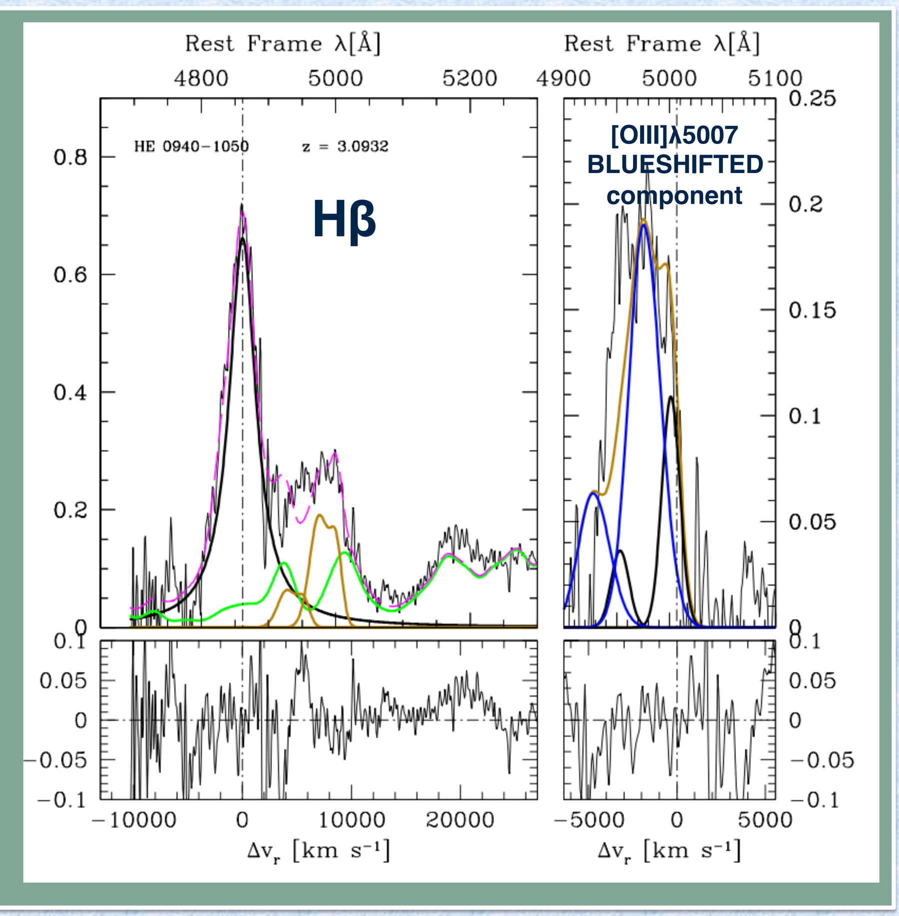
The most luminous quasars in the Hamburg-ESO (HE) survey show, at a high prevalence, CIV λ1549 and [OIII]λλ4959,5007 emission line profiles with high-amplitude blueshifts which indicate outflows occurring over a wide range of spatial scales. We found evidence in favor of the nuclear origin of the outflows diagnosed by [OIII]λλ 4959,5007. The derived ionized gas mass, kinetic power, and radiation thrust are extremely high, and suggest widespread feedback on the host galaxies of very luminous quasars, at cosmic epochs between 2 and 6 Gyr from the Big Bang.

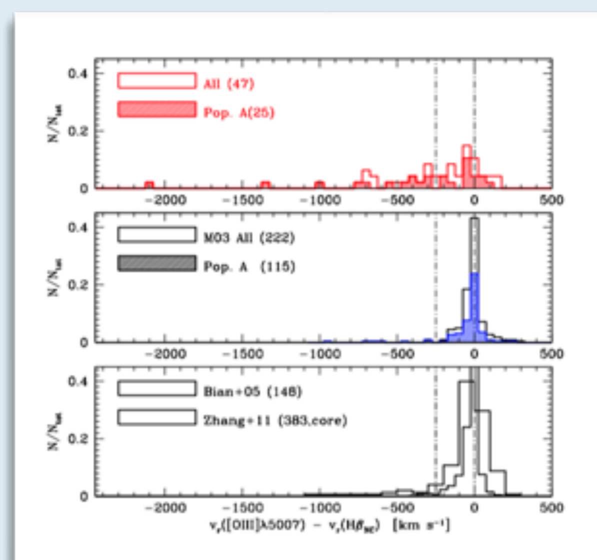


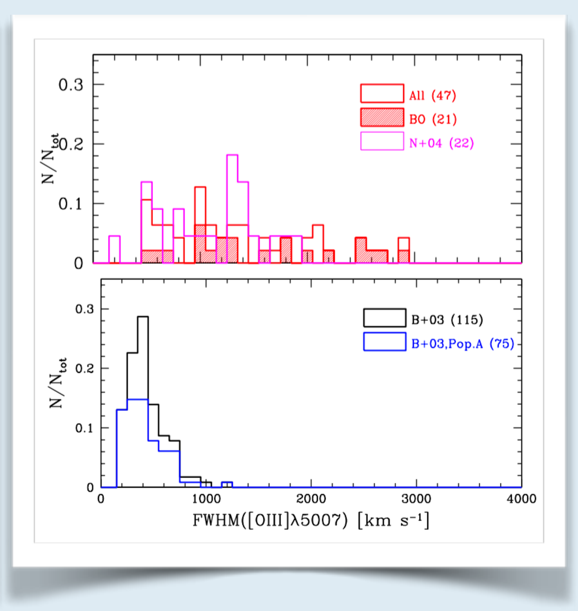
The left panel shows the almost fully blueshifted (with respect to rest frame) CIVλ1549 emission to which the Hβ profile is superimposed (from Sulentic et al. 2017). The right panel shows the Hβ spectral range with an enlargement on [OIII]λλ4959,5007, semi-broad, boxy and blueshifted (not a unique case at high L: e.g., Marziani et al. 2016, Bischetti et al. 2017, and references therein).

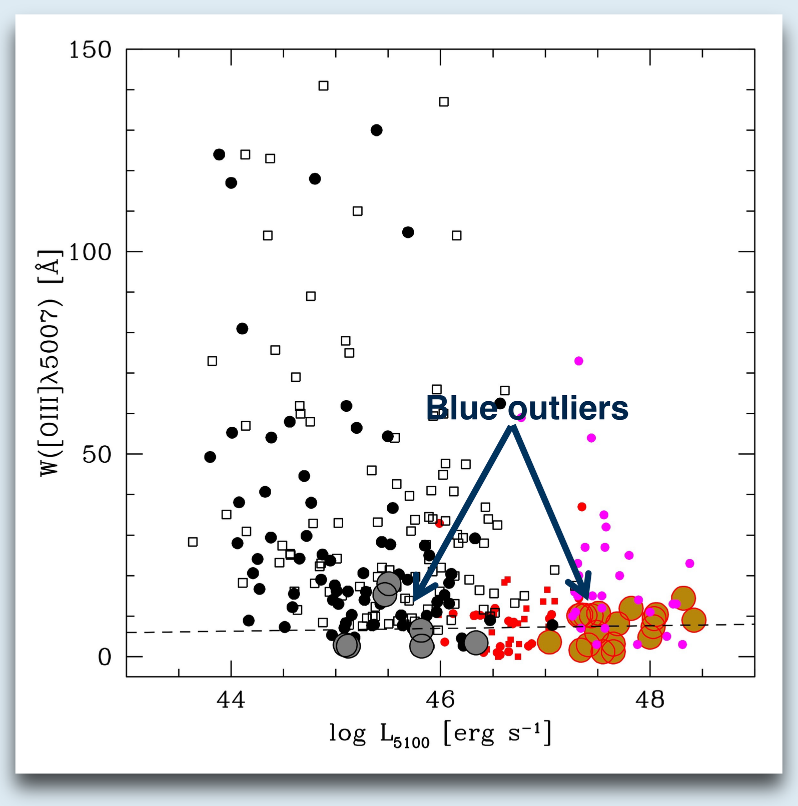


Demographics of ionized outflows

"Large" scale (< few kpc) outflows are traced by the **blue outliers** ([OIII] λ5007 peak shift < -250 km s^{-1}). BOs are rare in low *z samples* (they are real statistical outliers) *but* much more frequent in the high *z* and *L* HE sample. Their [OIII] shift and FWHM distributions are remarkably different from those of low-*z*, low *L* samples (Marziani et al. 2016; histograms aside).

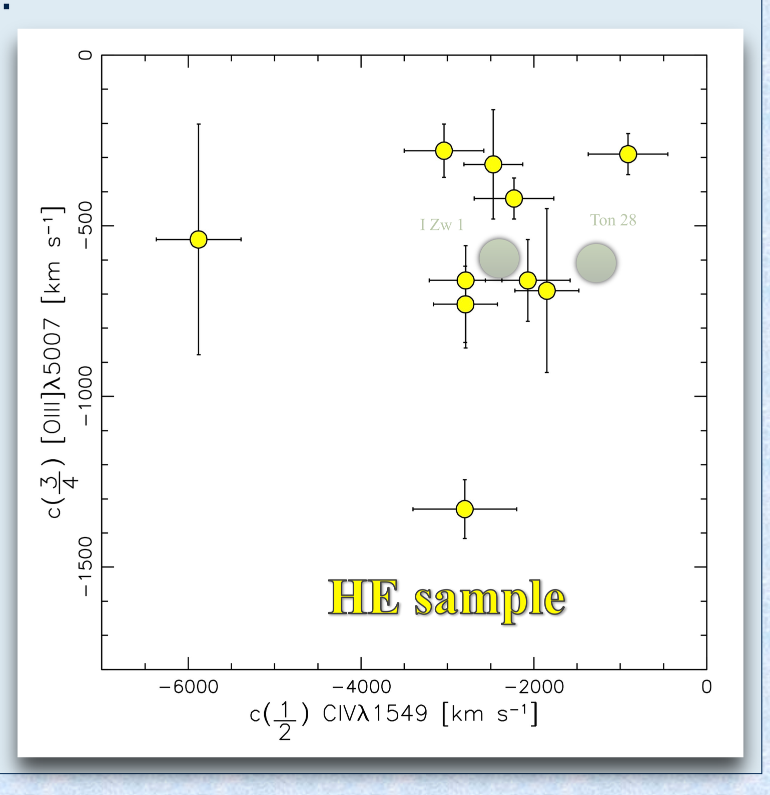






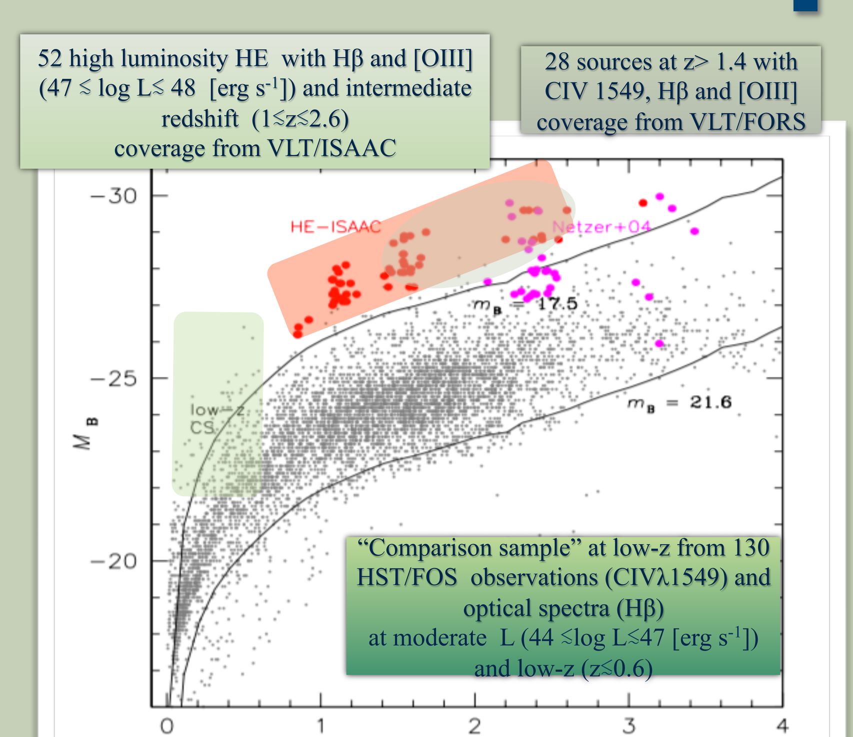
Our samples confirm the [OIII] Baldwin effect for the general quasar population: **W ∝ $L_{5100}^{-0.26\pm0.03}$**, steeper than the "classical" CIV Baldwin effect (which may be entirely due to selection effects). **The absence of a Baldwin effect for the BOs** is consistent with [OIII] emission from gas photoionized by the nucleus. The very high luminosity implies that the [OIII] outflowing nuclear component may "overswamp" narrow-line emission whose dynamics is dominated by the inner bulge of the host galaxy.

The green panel aside explains the high prevalence of blue outliers as a luminosity effect.

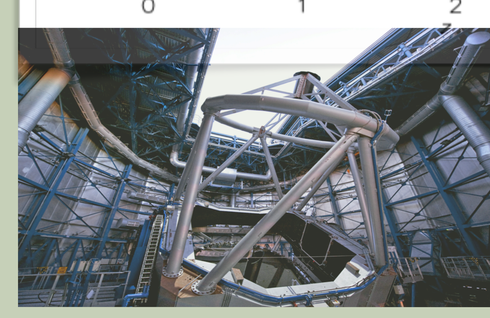


The relation between the CIV and [OIII] blueshifts is such that **all blue outliers show large CIV blueshifts** in our sample. The converse is not true, as expected if [OIII] emission on larger spatial scales is affecting the unresolved [OIII] profile. This is apparently valid also at low-*z* (the grey spots are for two low-*z* NLSy1s).

The samples

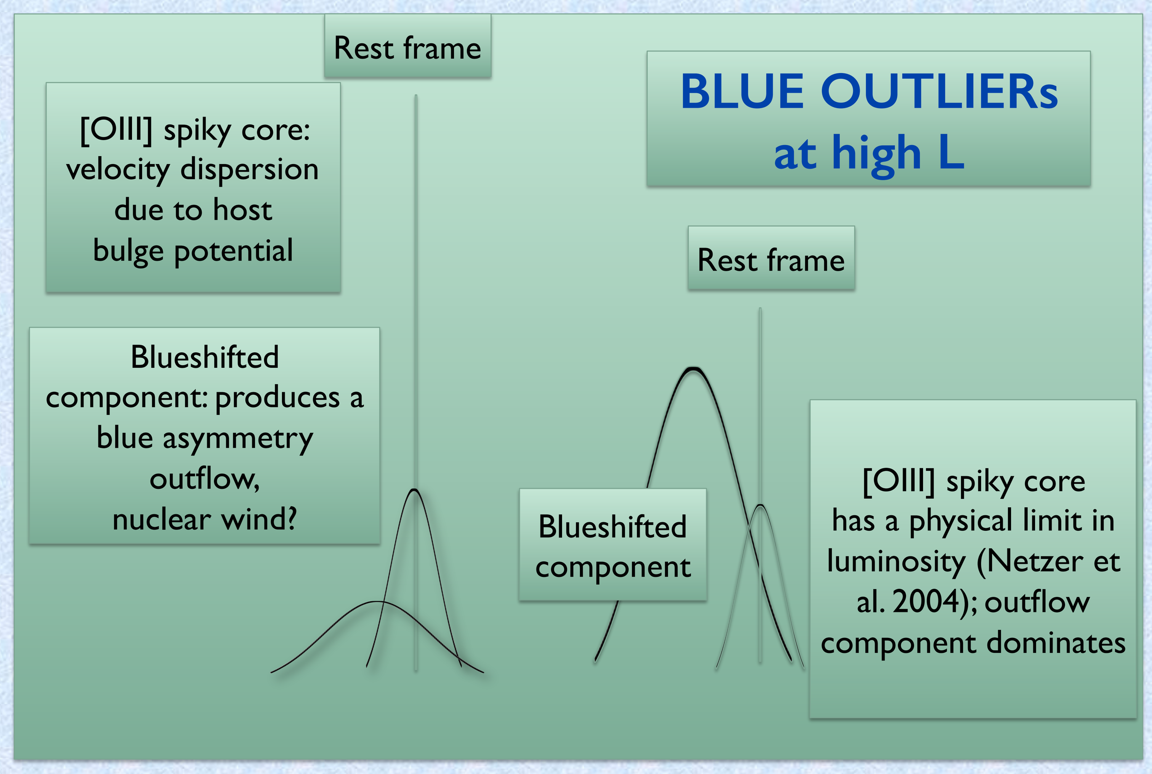


High luminosity Hamburg ESO (HE) quasar sample + lower *z* comparison sample



(Sulentic et al. 2017)

They almost uniformly cover 4 dex in quasar luminosity, and include 80 radio-quiet quasars with both Hβ, CIVλ1549, and [OIII]λλ4959,5007



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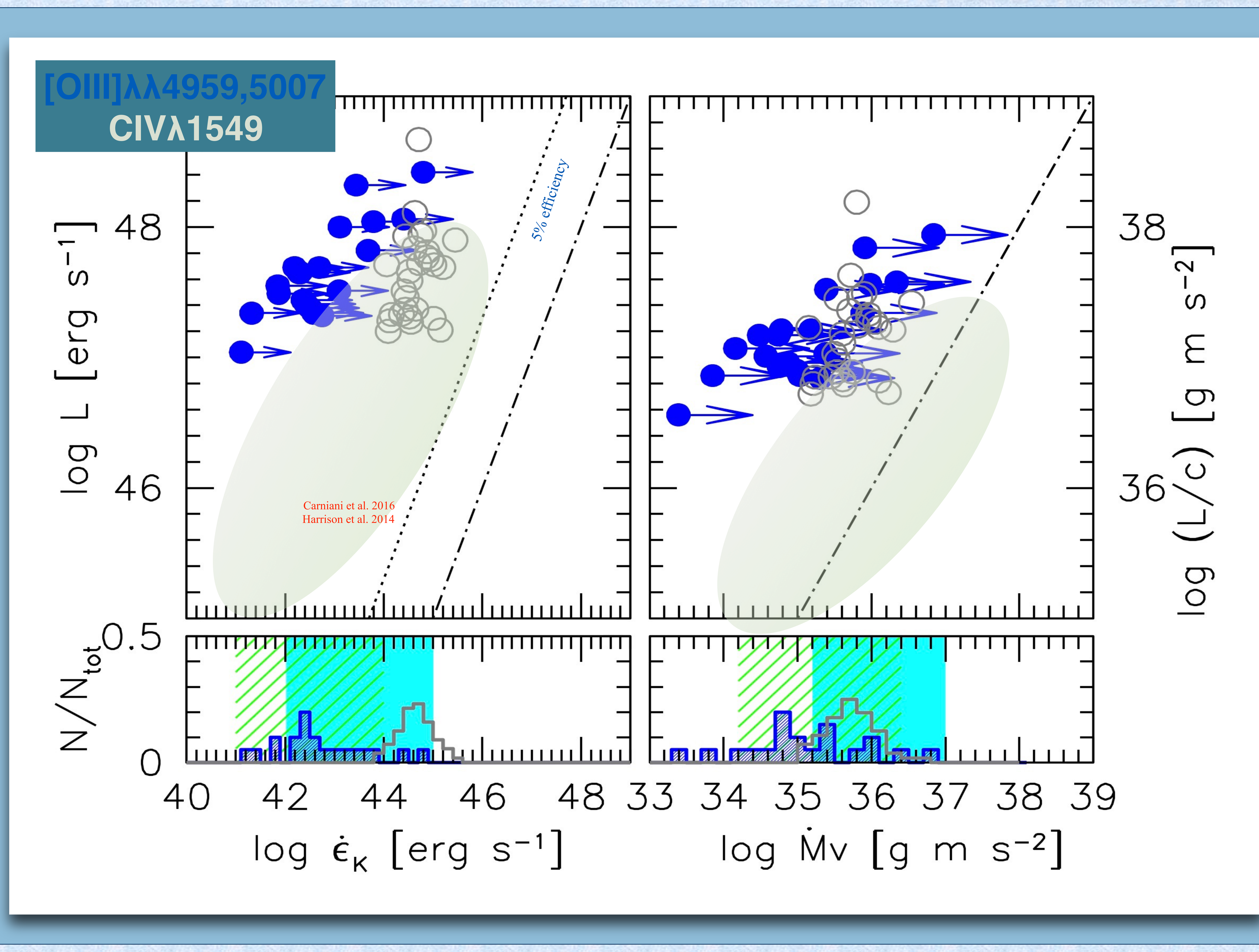

A significant feedback effect

The absence of a Baldwin effect and the relation to the CIV blueshifts suggest that the [OIII] λλ4959,5007 "blue outliers" trace an outflows of nuclear origin, also revealed by CIVλ1549 blueshifted profiles (Marziani et al. 2016; 2016a).

Computing the kinetic power and the thrust is possible under several caveats and assumptions. For [OIII], since there is no spatial resolution, derived values lower limits (blue spots). For CIV, parameters are model dependent. We estimated the black hole mass and Eddington ratio of each quasar, and assumed an emitting region radius $r_{CIV} \propto L^b$ (Kaspi et al. 2007) from which we derived the local escape velocity. We then computed the ionized gas terminal velocity above escape velocity considering that the gas at r_{CIV} is still being accelerated by radiation forces (following Netzer & Marziani 2010).

The ionized gas mass, kinetic power, and thrust derived from the [OIII]λ5007 and CIVλ1549 shift and luminosity are extremely high because they ultimately depend on line luminosity. The total energy provided by the outflow over ~10^8 yr is comparable to the internal gravitational energy of a massive spheroid.