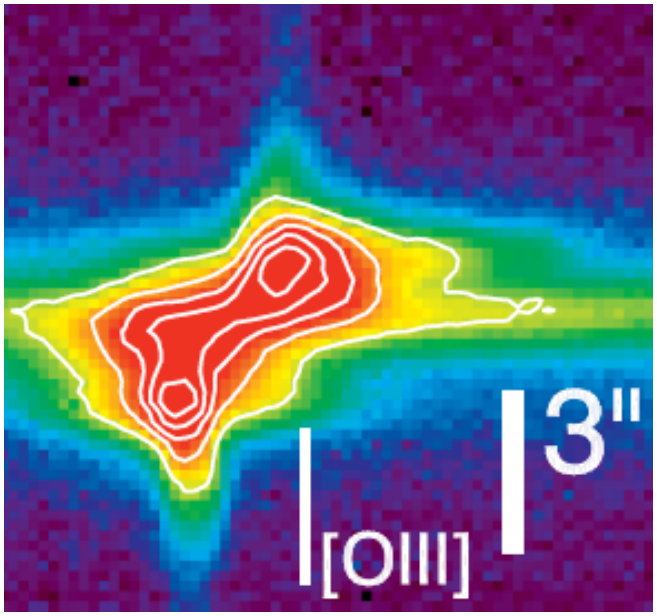
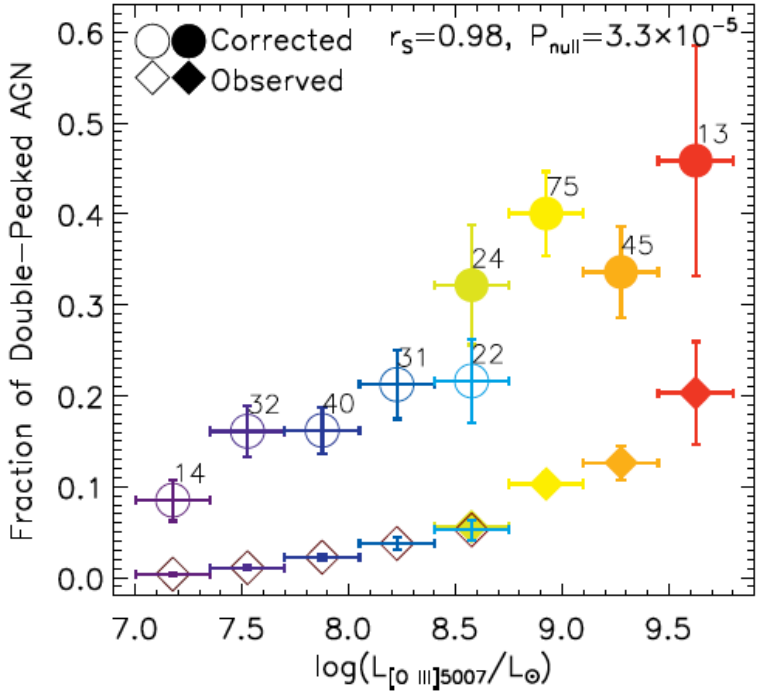
A high fraction of double-peaked narrow emission lines in powerful AGN





Xin Liu, **Yang Lyu**, Yue Shen (UIUC/NCSA)

Jenny Greene, Michael Strauss (Princeton)

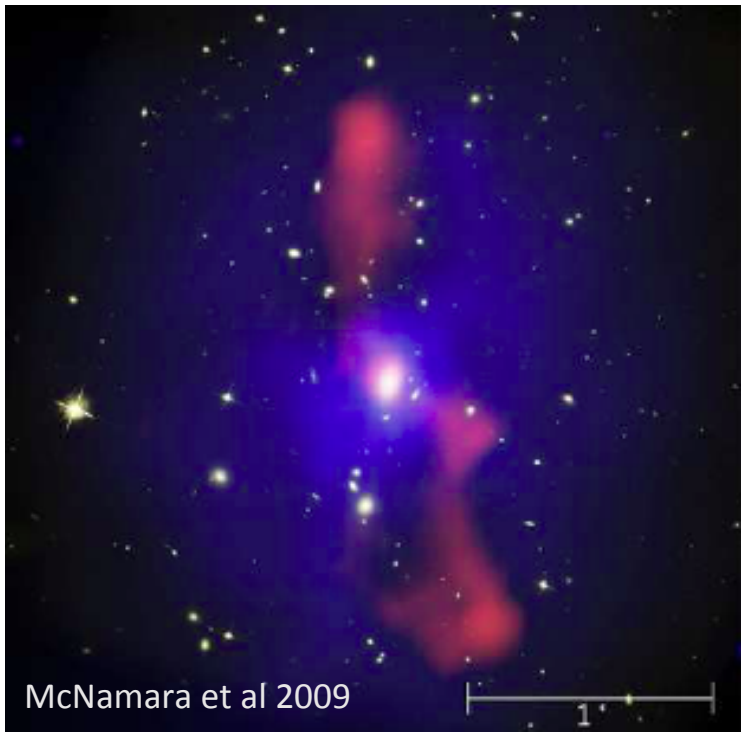
AGN Winds 2017

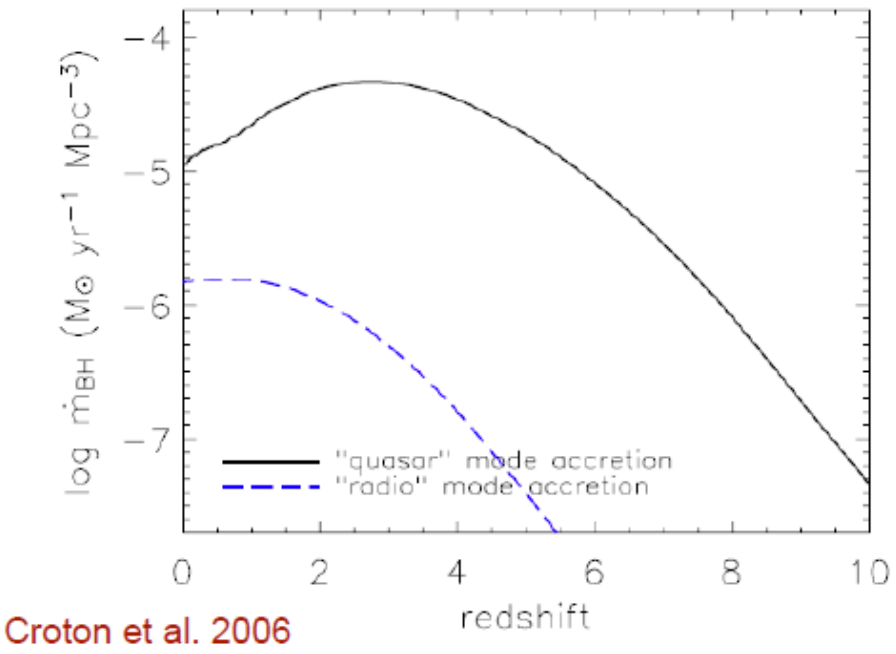
Do NLR outflows correlate with AGN luminosity?

(frequency, max velocity)

AGN feedback – radio/kinetic mode

- low accretion rates (e.g., Fabian 2012 ARAA)
- keeping the gas hot, but unimportant for the overall BH mass budget





Croton et al. 2006

AGN feedback – quasar/radiative mode

- Eddington-limited accretion
- quasars should have had a significant impact
  - energy

$$E_{\rm gal} \approx M_{\rm gal}\sigma^2 \qquad M_{\rm BH} \approx 1.4\times10^{-3} M_{\rm gal}$$

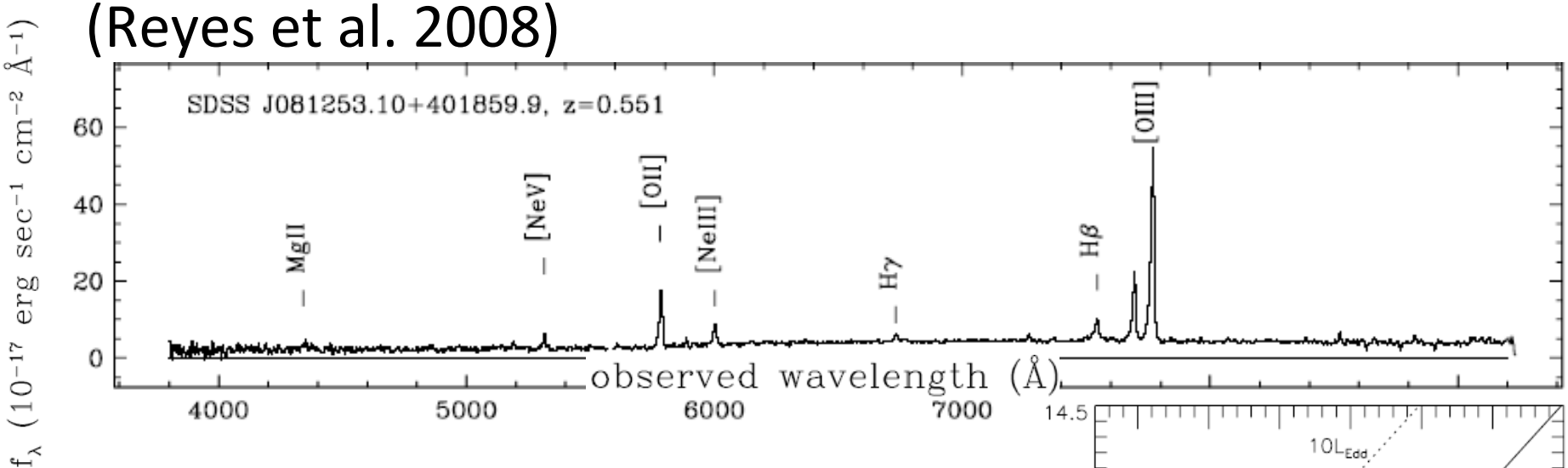
$$E_{\rm BH} = \ 0.1 M_{\rm BH} c^2 \qquad E_{\rm BH}/E_{\rm gal} \approx 1.4\times10^{-4}(c/\sigma)^2$$

$$\sigma < 400\,{\rm km\,s^{-1}} \qquad \text{so } E_{\rm BH}/E_{\rm gal} > 80$$

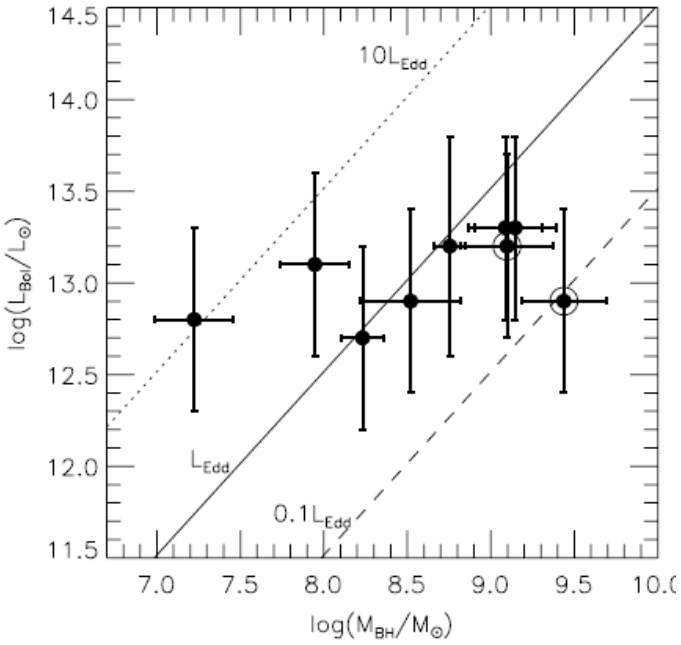
  - momentum
  - most effective at z~2
  - gas rich, dusty → absorption/extinction → obscured quasars

Luminous, obscured, radio-quiet quasars

- as abundant as unobscured quasars, at least at z~0.5 (Reyes et al. 2008)

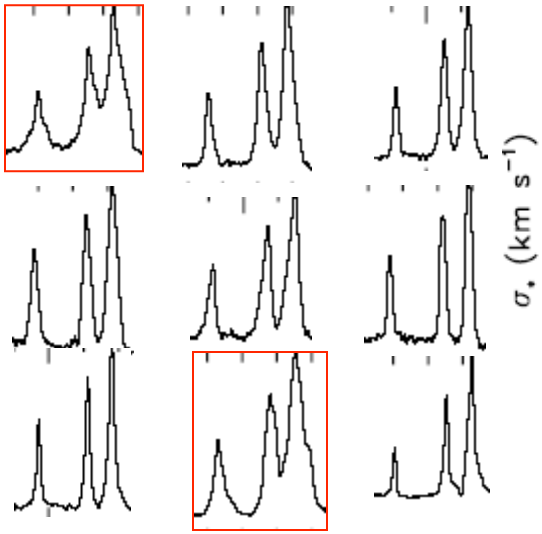


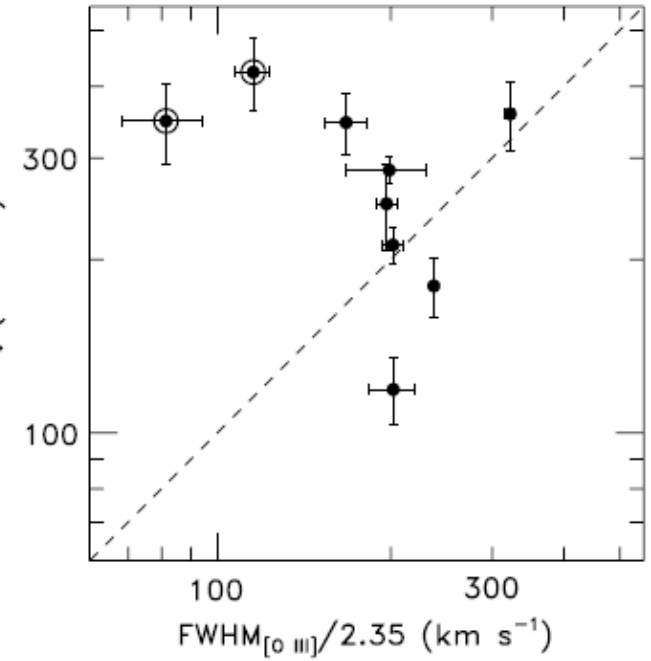
- the most luminous population at z~0.5, L_{bol}~10^{46} erg/s
- Eddington ratio ~ 1, M_*~10^{10} M_{sun} (Liu X. et al. 2009)

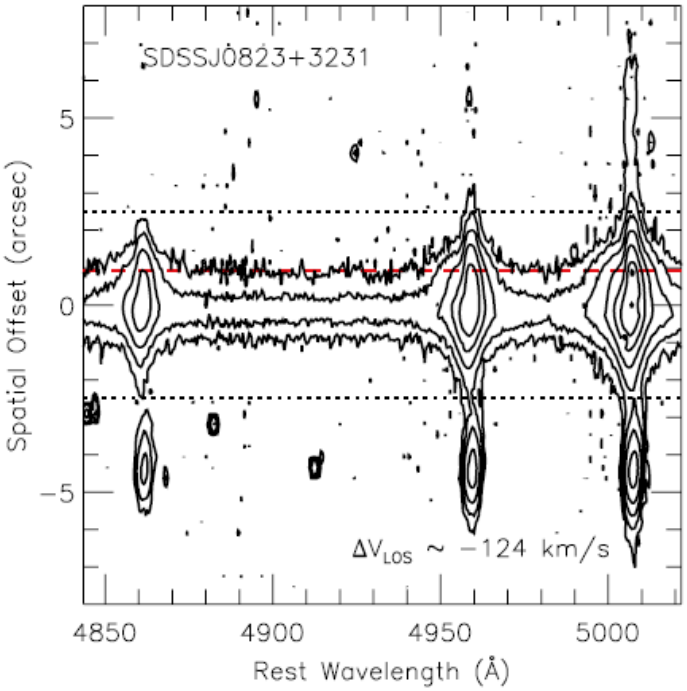


Dramatic [O III] emission seen in slit spectra

- host galaxy and ionized gas properties (Liu X. et al. 2009)

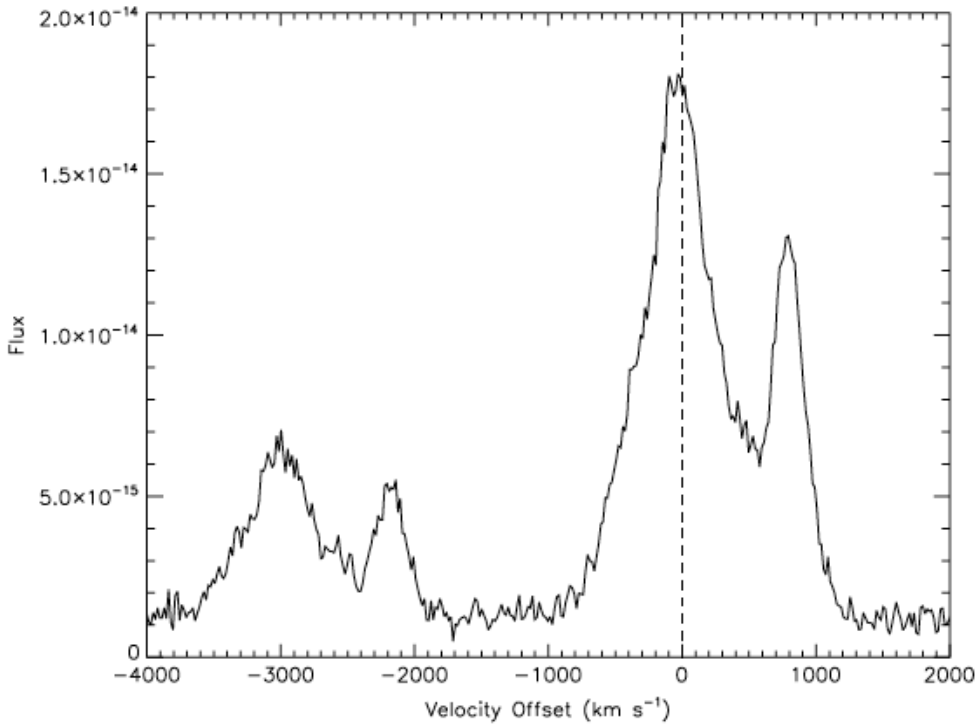






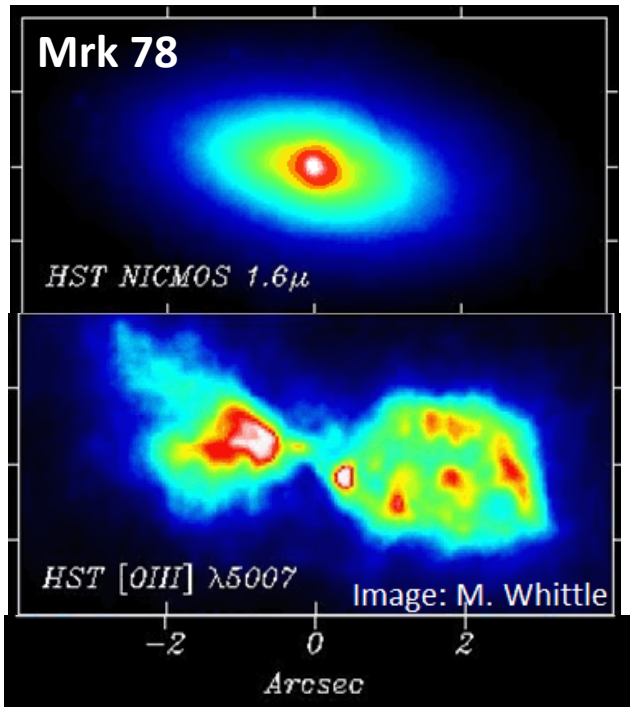
- need 2D kinematics and excitation diagnostics to understand the nature/origins of gas

Double peaked [O III] as NLR outflows – resolved spectra

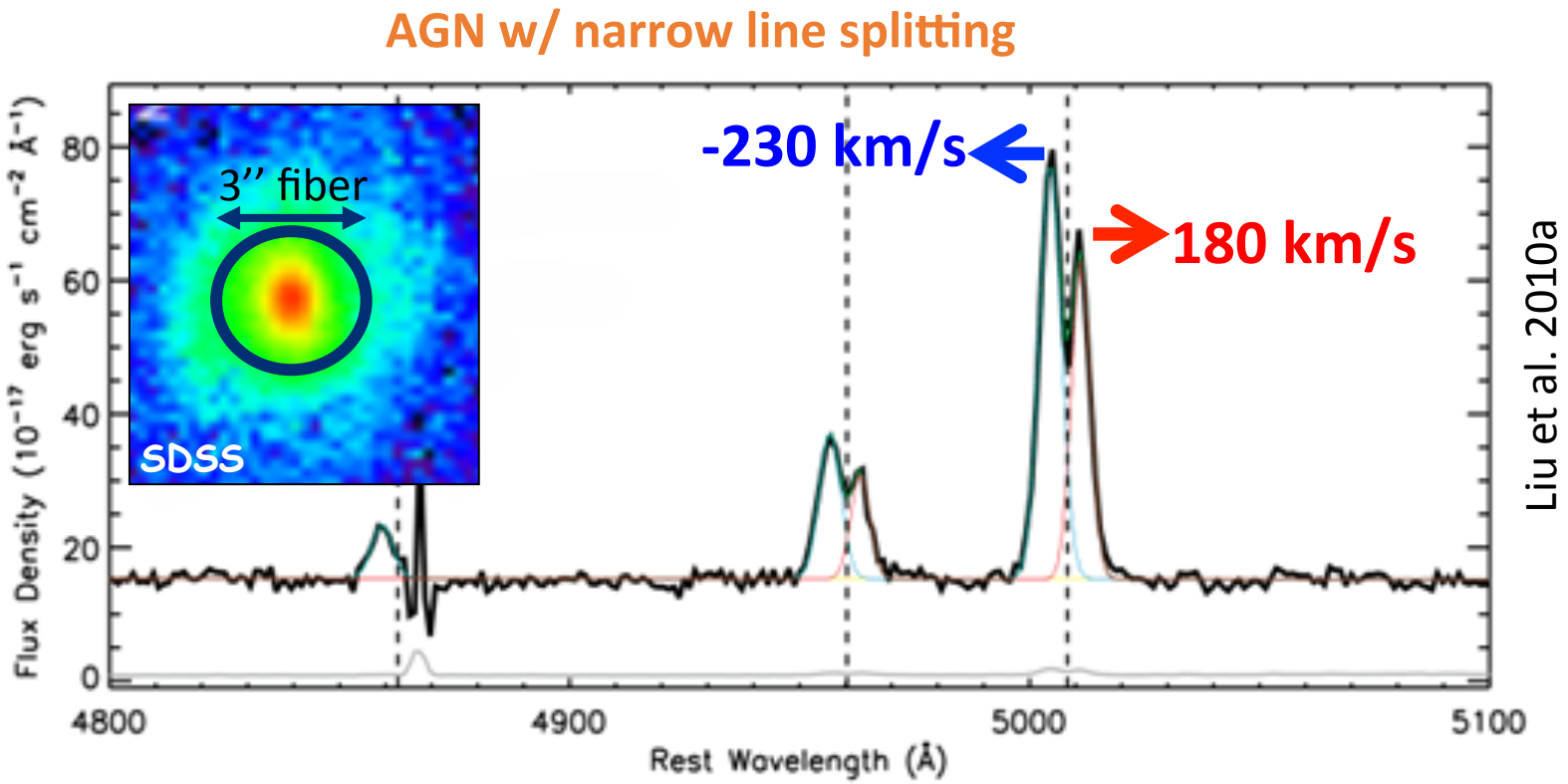


Fischer et al. (2011)

Bicone outflow

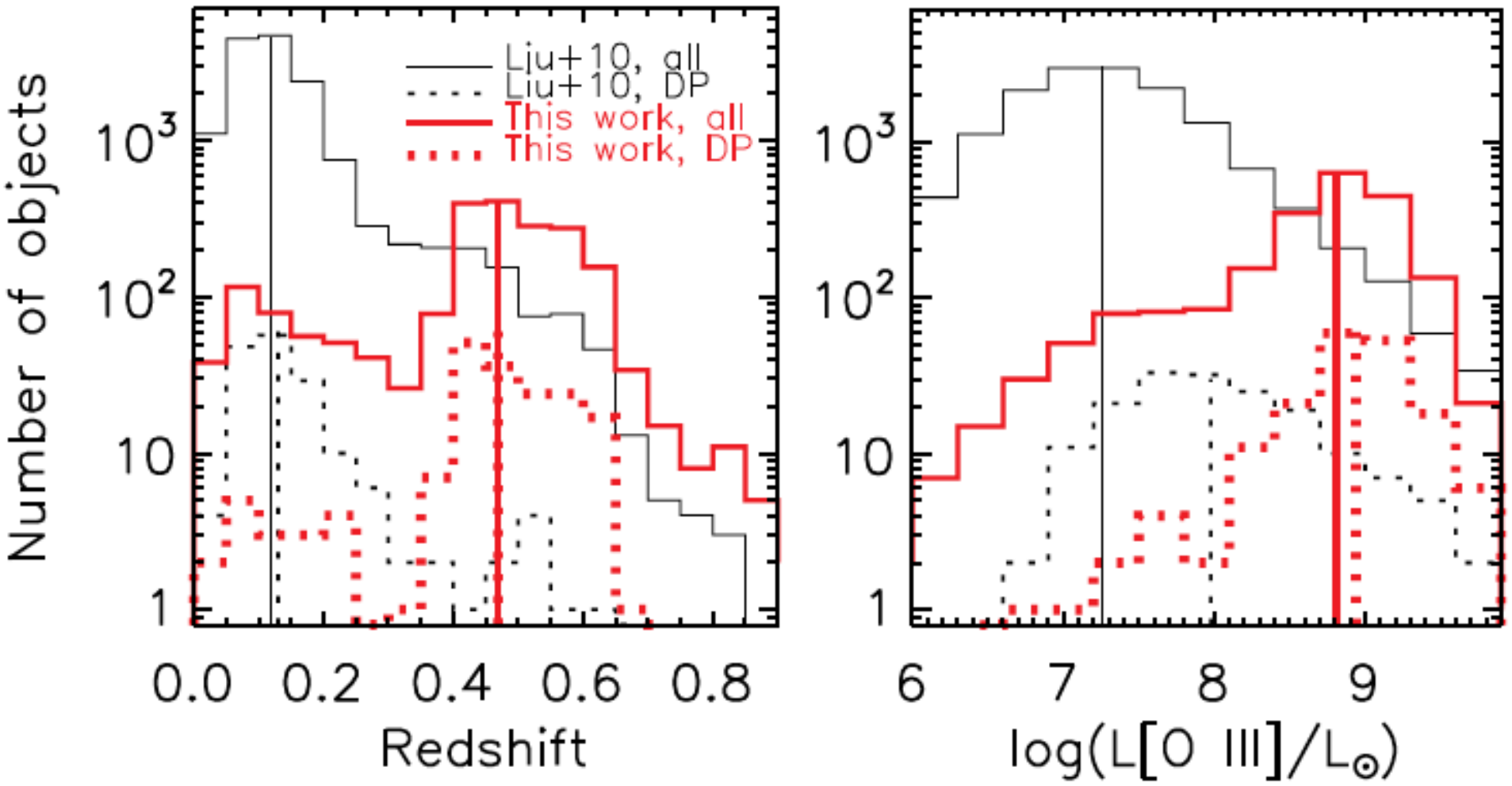


Double peak [O III] in integrated spec of 1% z~0.1 AGN



(e.g., Sargent et al. 1972, Heckman et al. 1981, Comerford et al. 2009, Wang et al. 2009, Smith et al. 2010, etc.)

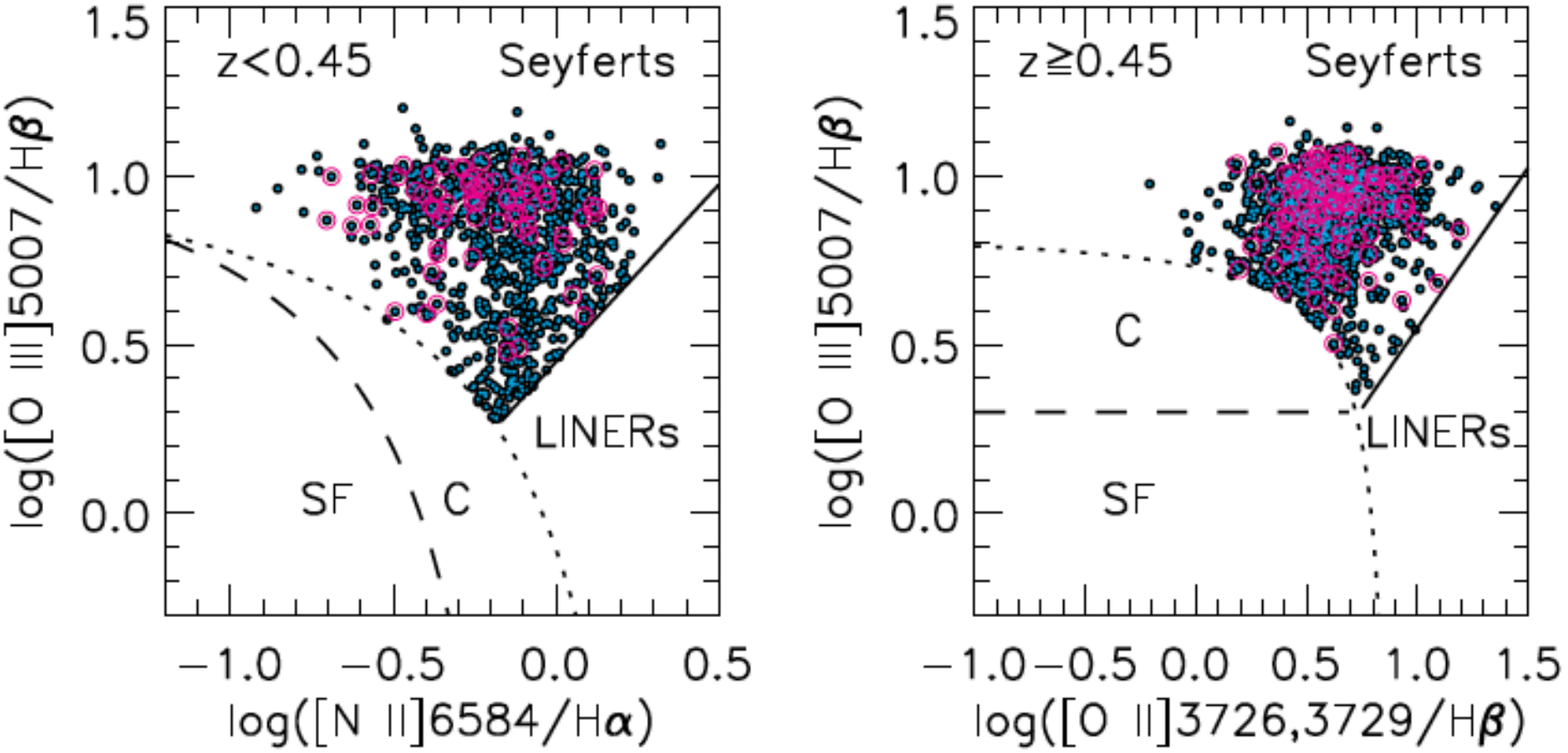
Probing more luminous AGN w/ BOSS



Liu et al. (2010): z~0.1 sample from SDSS

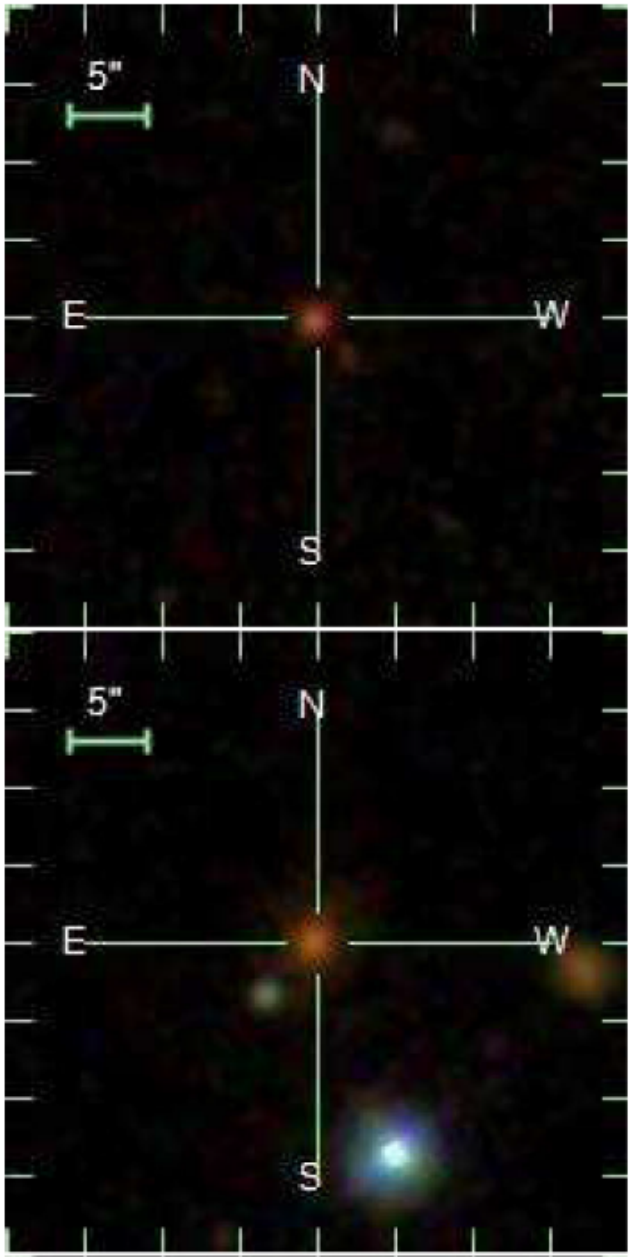
Lyu & Liu (2016): z~0.5 sample from BOSS

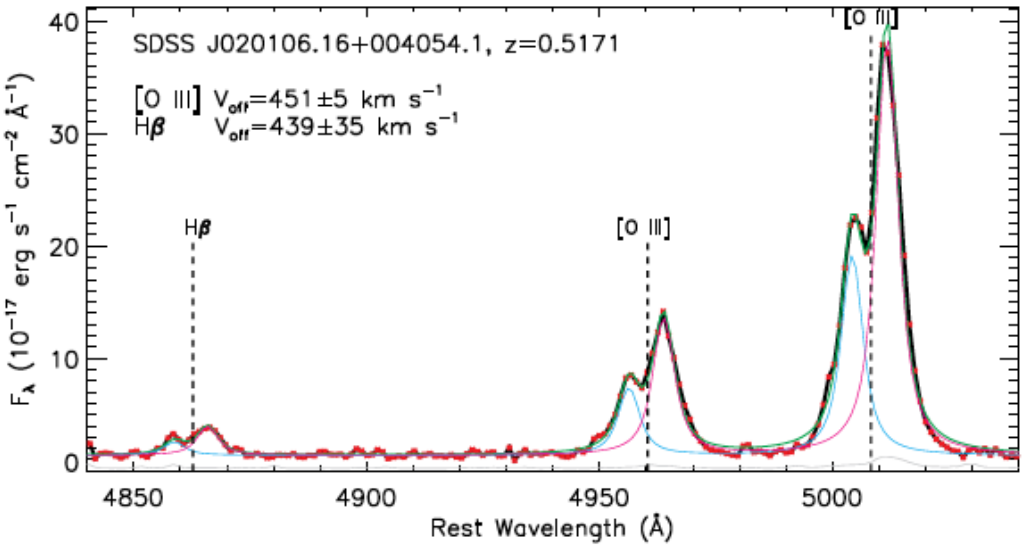
Probing more luminous AGN w/ BOSS

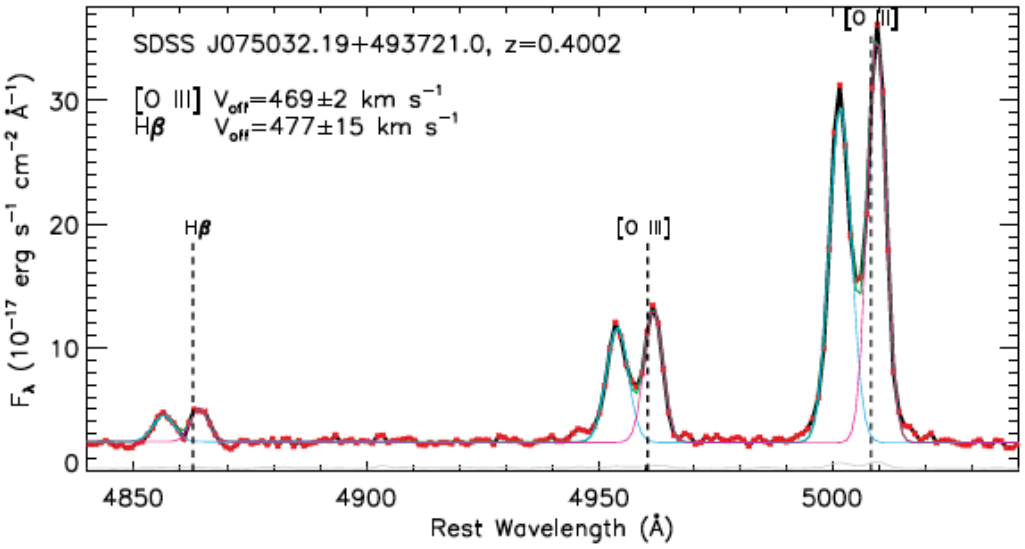


Type II AGN/quasars selected using [O III] and diagnostic emission-line ratios

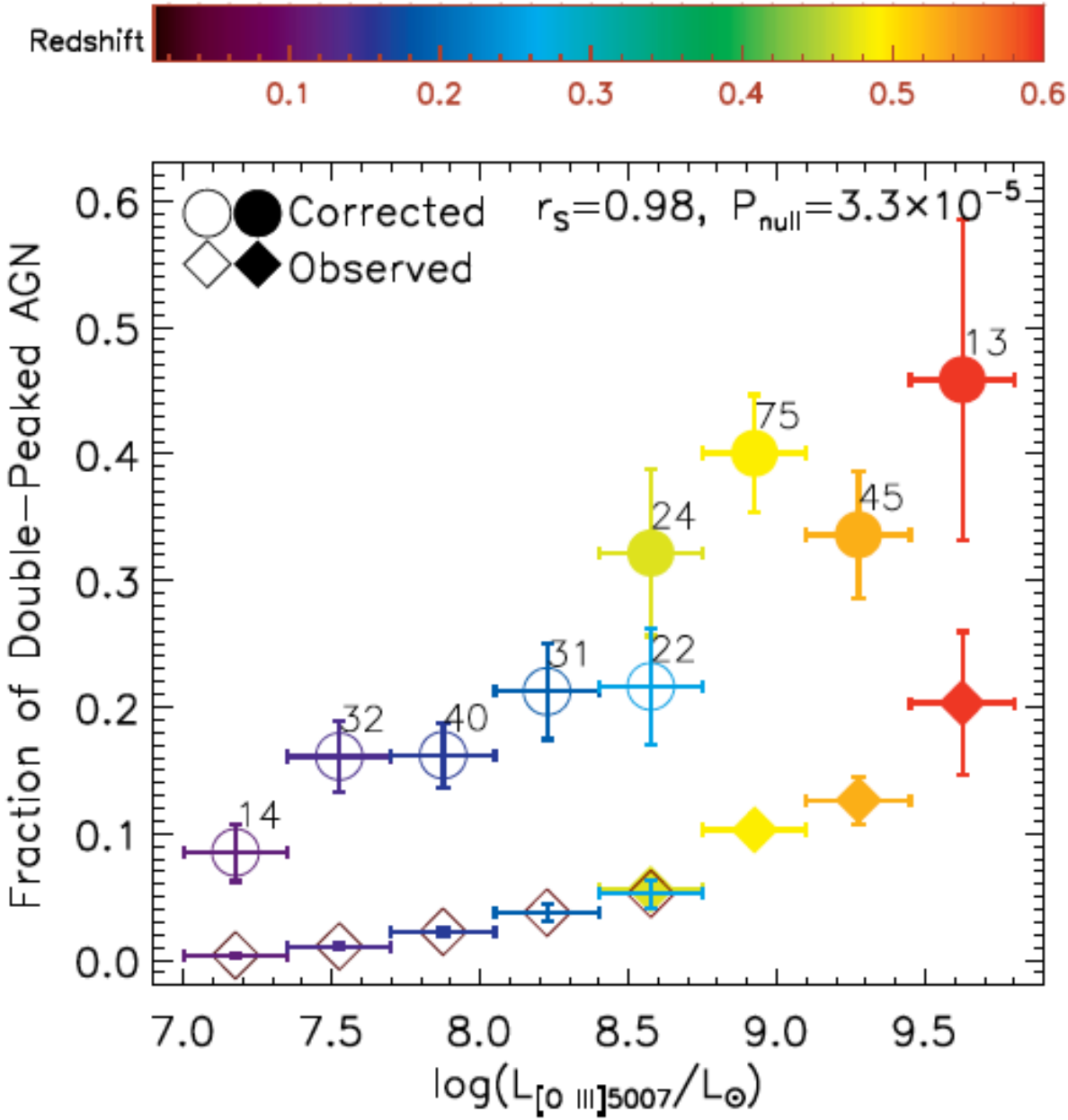
More frequent velocity splitting, larger offset?



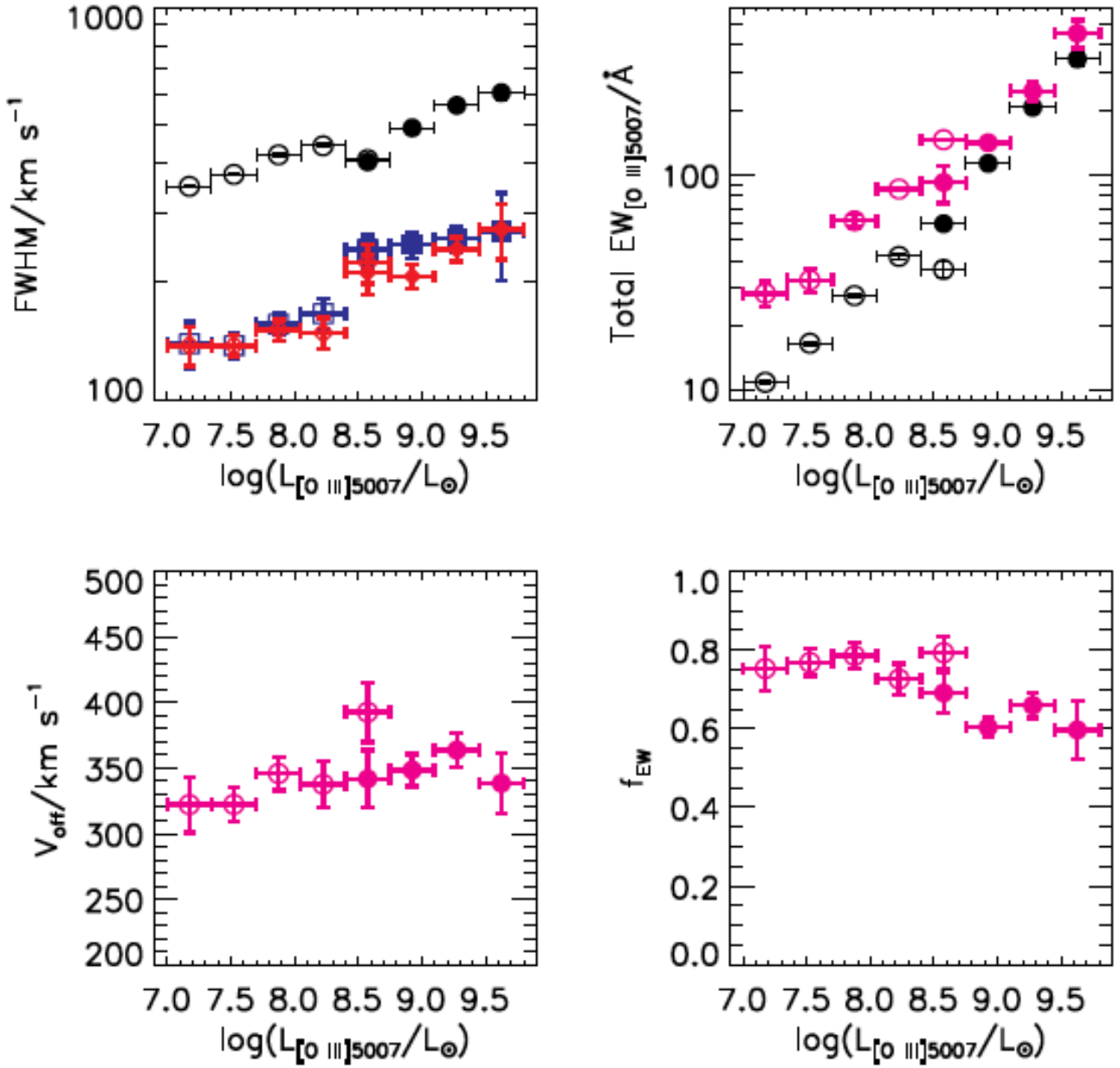




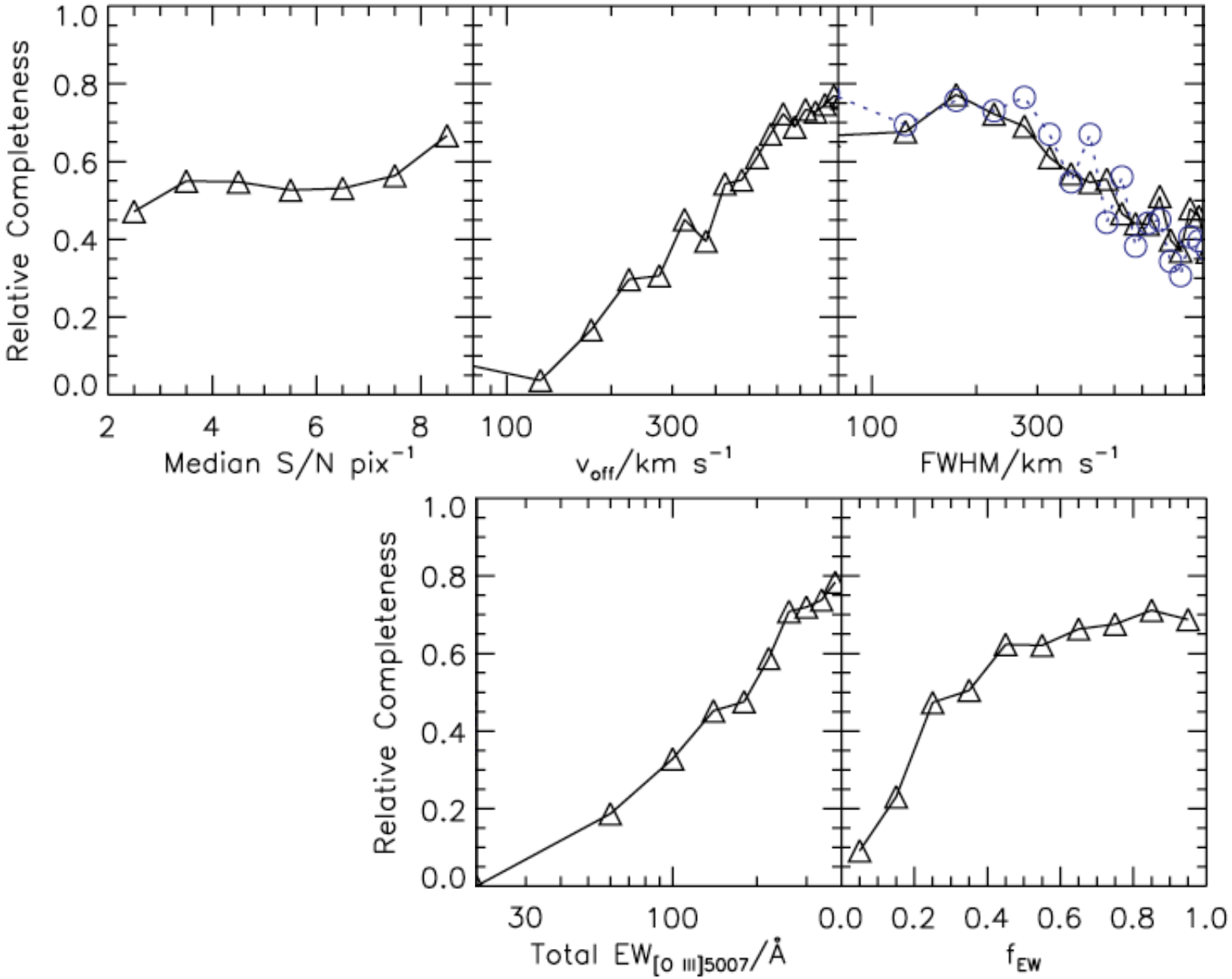
More double-peaked NLs in more luminous AGN



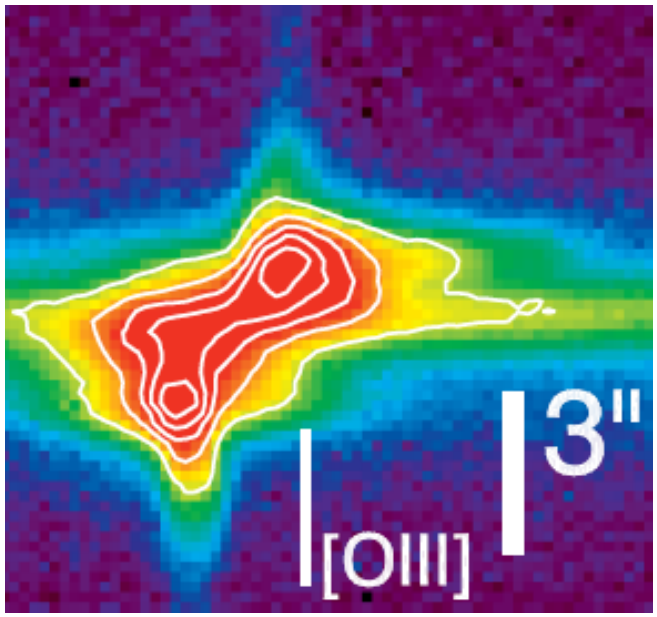
Correcting for selection bias and incompleteness

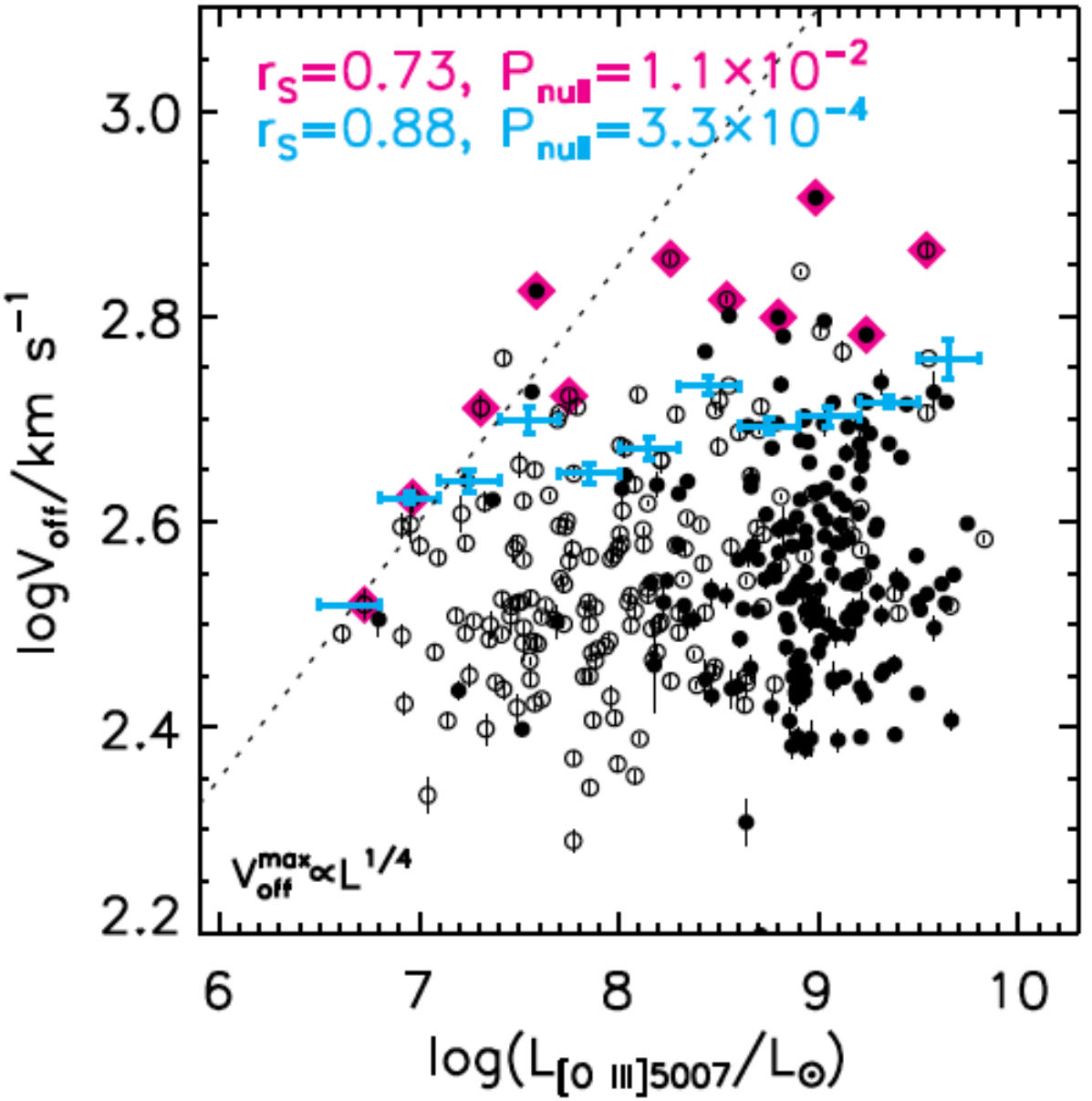


Correcting for selection bias and incompleteness



Larger velocity splitting in more luminous AGN (?)





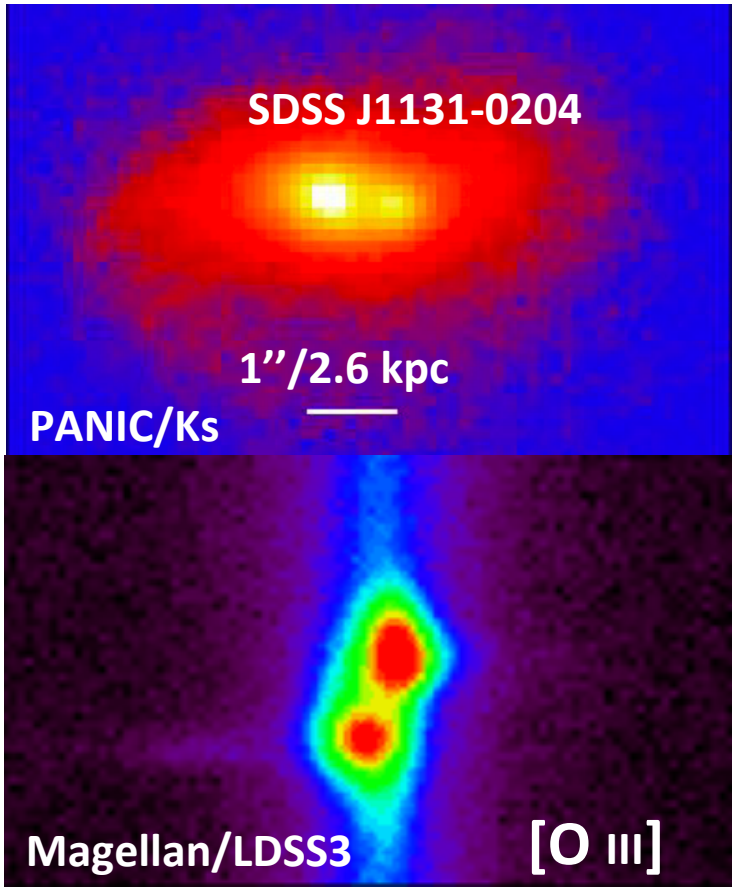
Implications and caveats

- **Statistical evidence for more NLR outflows in more powerful AGN**
- **Disk rotation, dual AGN?**
- **[O III] vs. AGN luminosity**
- **Selection bias**
- **Type 1 AGN?**
- **Link between BLR and NLR outflows?**

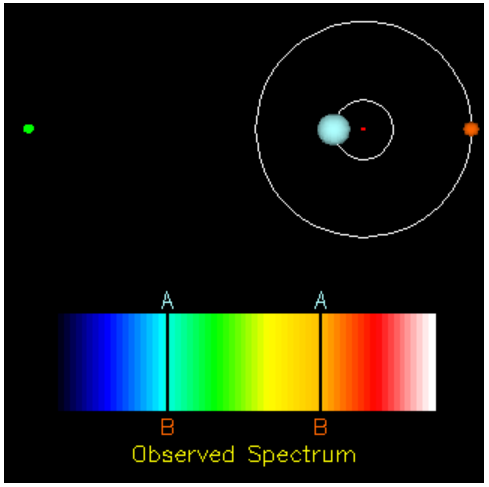
Details at: Lyu & Liu 2016, MNRAS, 463, 24

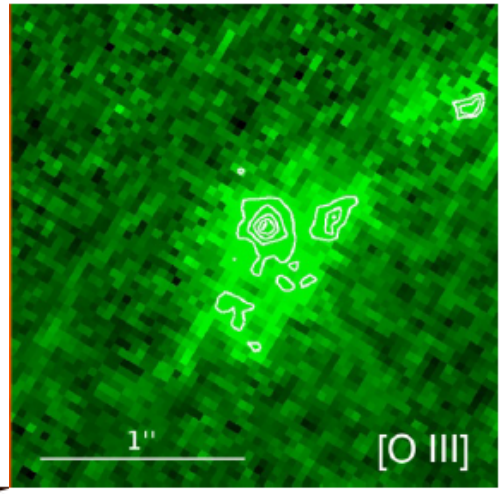
Mixed origins of double-peaked narrow lines

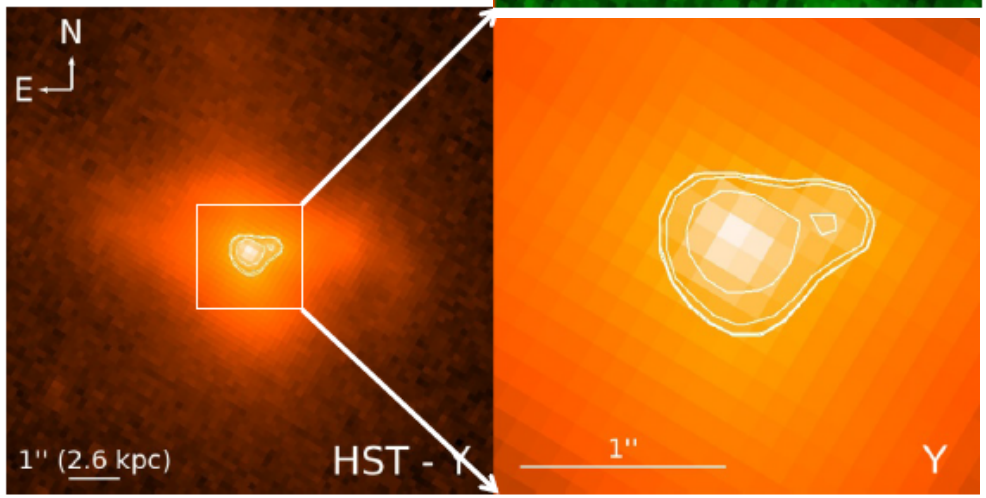
Dual AGN



Liu et al. 2010b







HST/WFC3 (Liu et al. in prep)