What is driving extended, feedback inducing outflows around AGNs?

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Thursday, 29th July, 2010
What drives the growth of black holes?
Durham

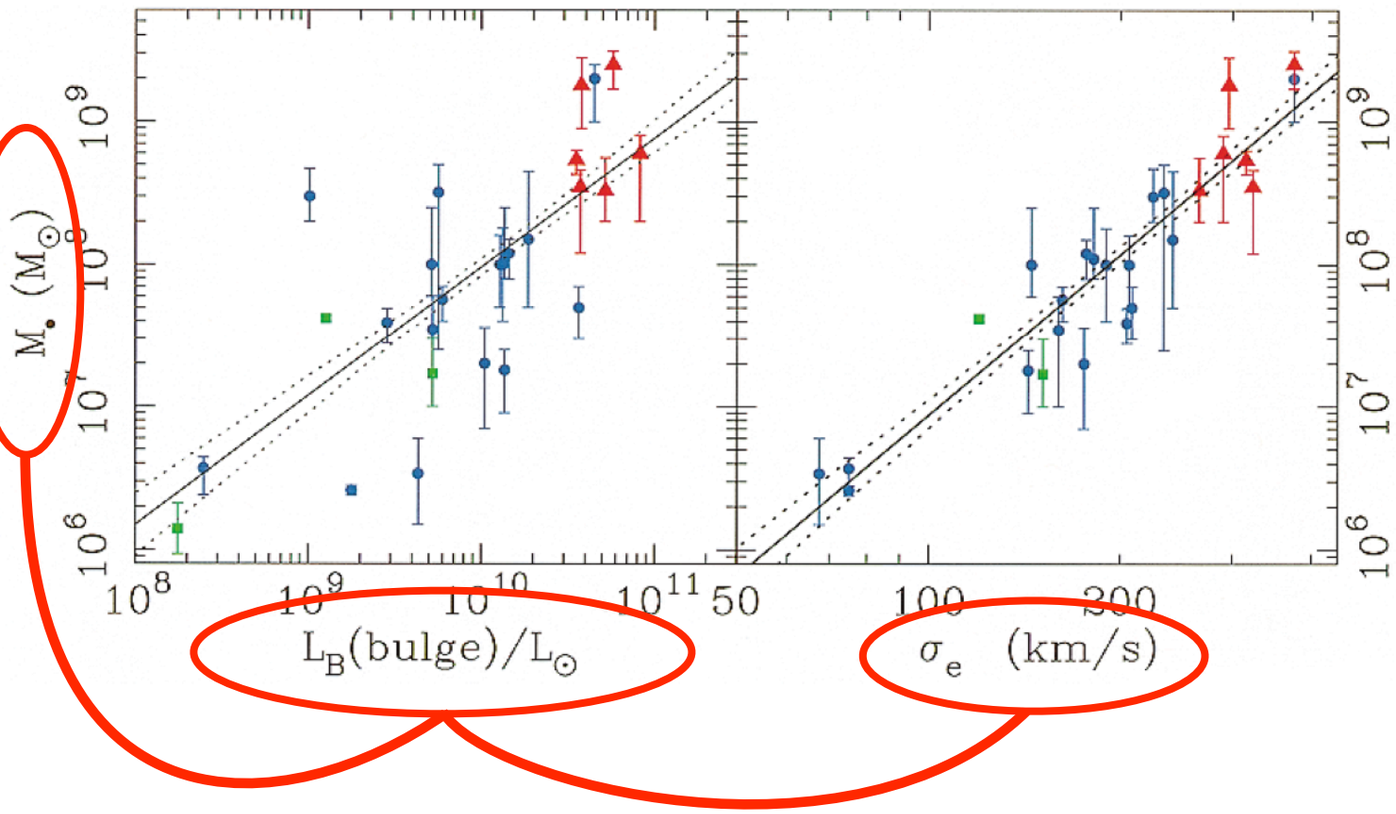
Poster 1.10: Paul Westerby

Why do we "need" AGN feedback?

$M_{BH} \sim 0.1\% M_{Bulge}$

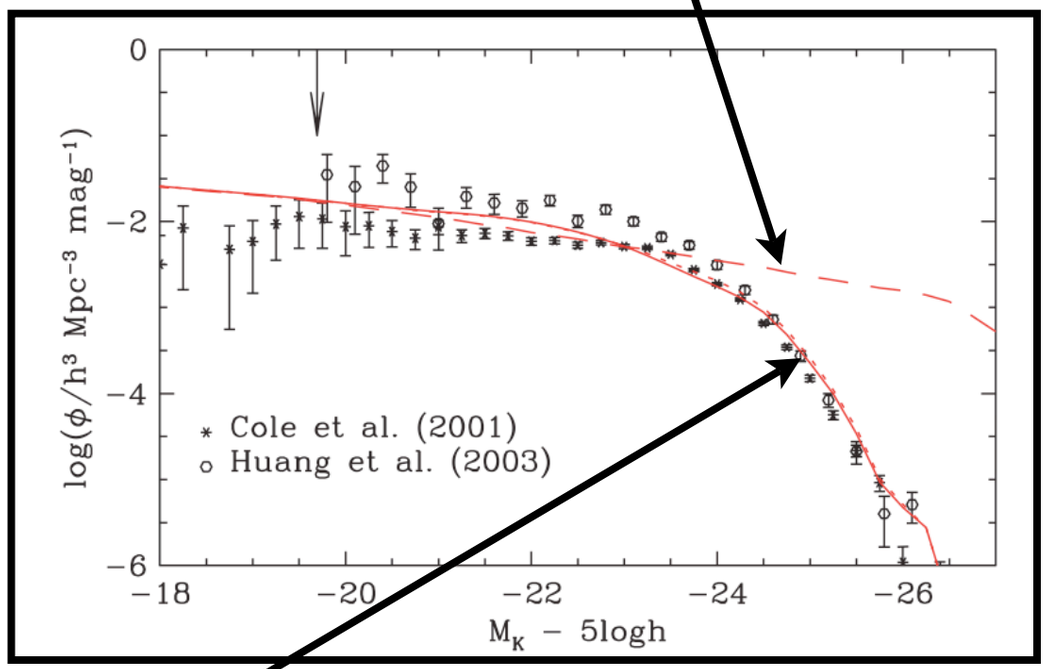
$R_{BH} \sim 0\% R_{Bulge}$(!)

Gebhardt+, '00



AGN Feedback

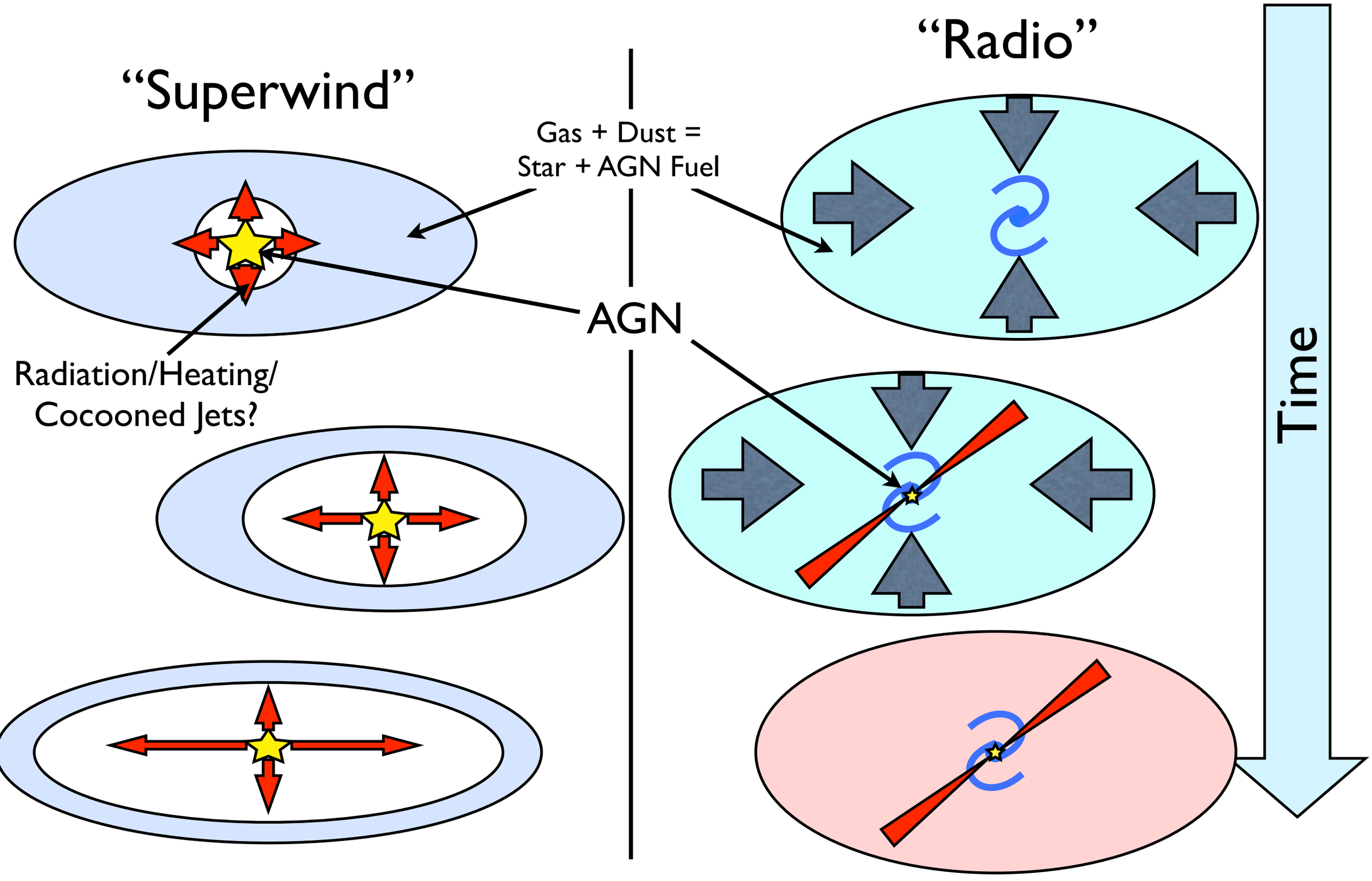
without AGN feedback



with AGN feedback

Bower+ '06

Stopping star formation:
Two modes



Radio Mode Feedback

$M_{\rm BH}^{0.6}$. Multiplying this by the fraction of time for which the AGN is active, the energy output scales as $M_{\rm BH}^{2.2}$. This is comparable to (or greater than) that required to counterbalance the gas cooling.

Many aspects of this calculation are uncertain; in particular, if

Best et al, '05:

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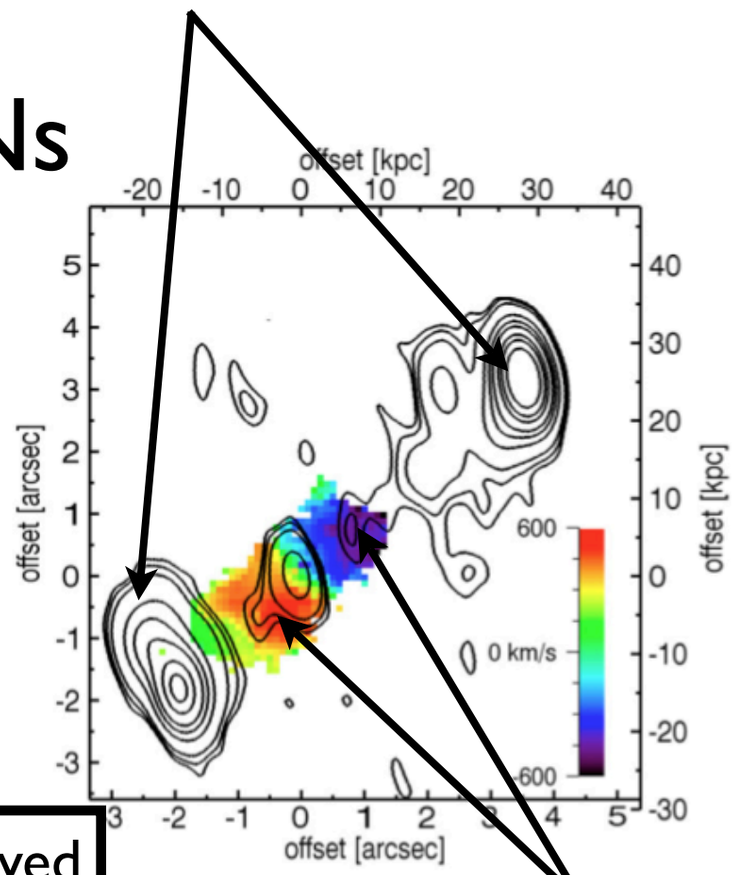
also:

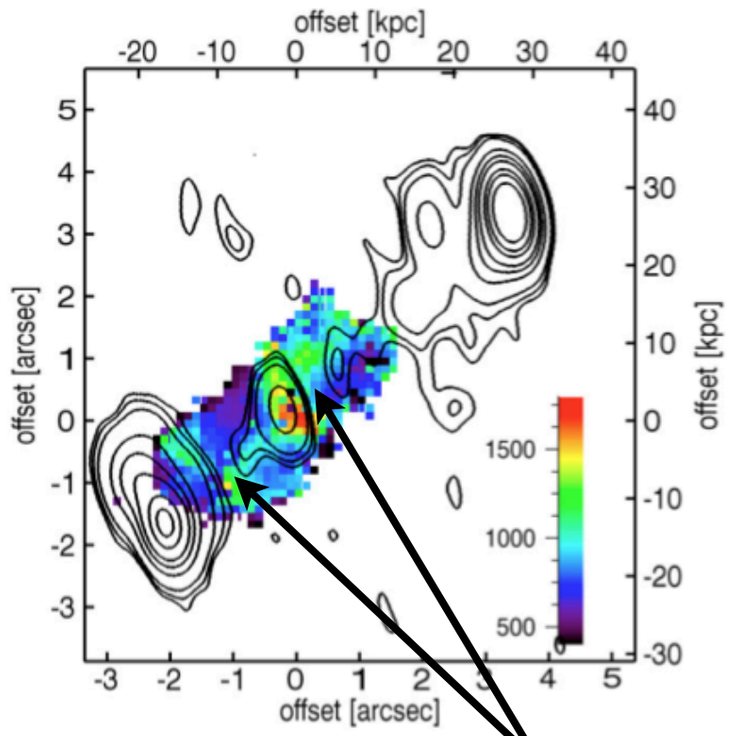
z~2 AGNs

Radio Contours



High Velocity Gas

from Nesvadba et al, '08

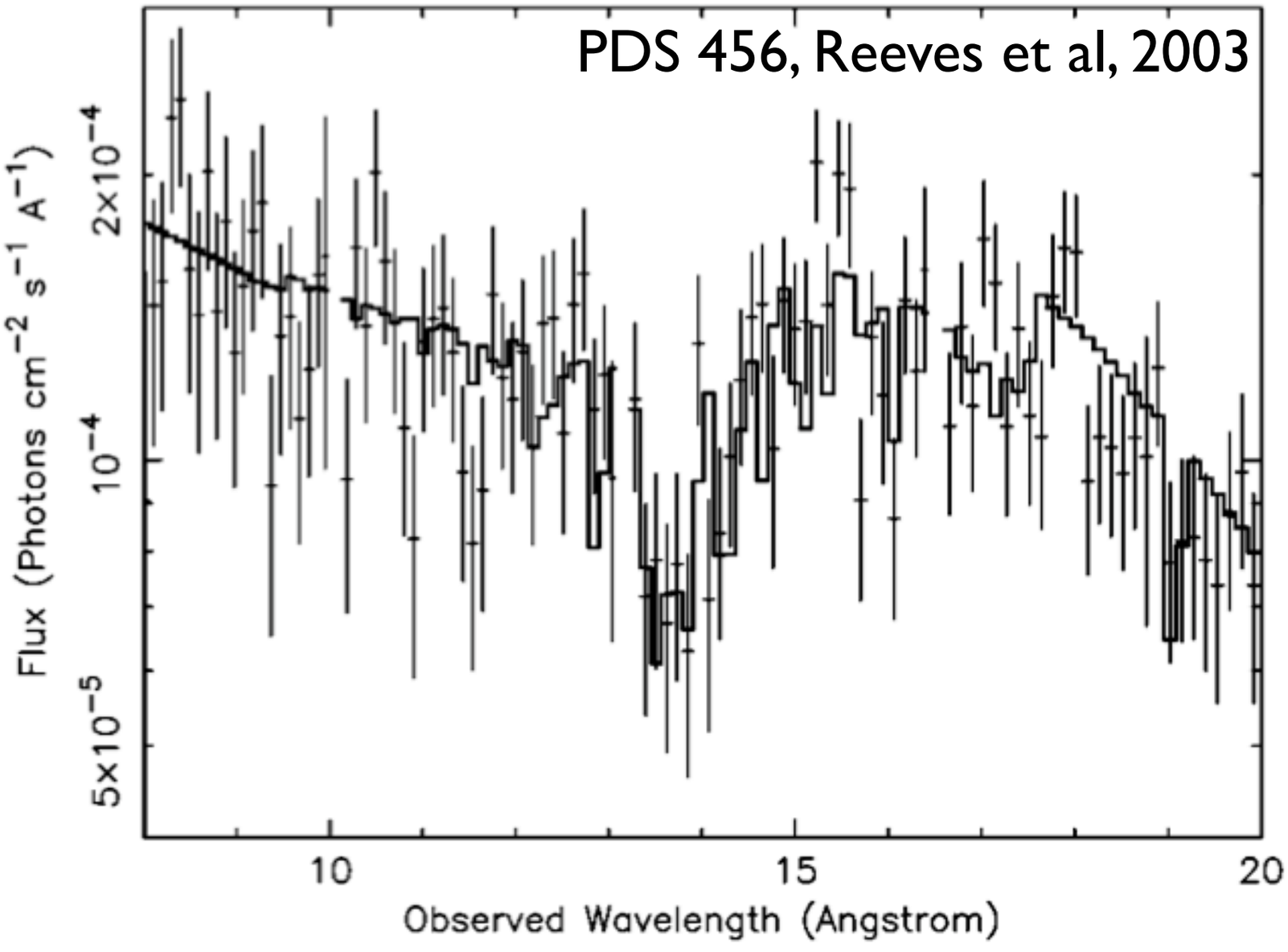


Turbulent Gas

Gas kinematics derived from [OIII]5007 emission lines.

BUT...

AGNs can produce other types of outflows:



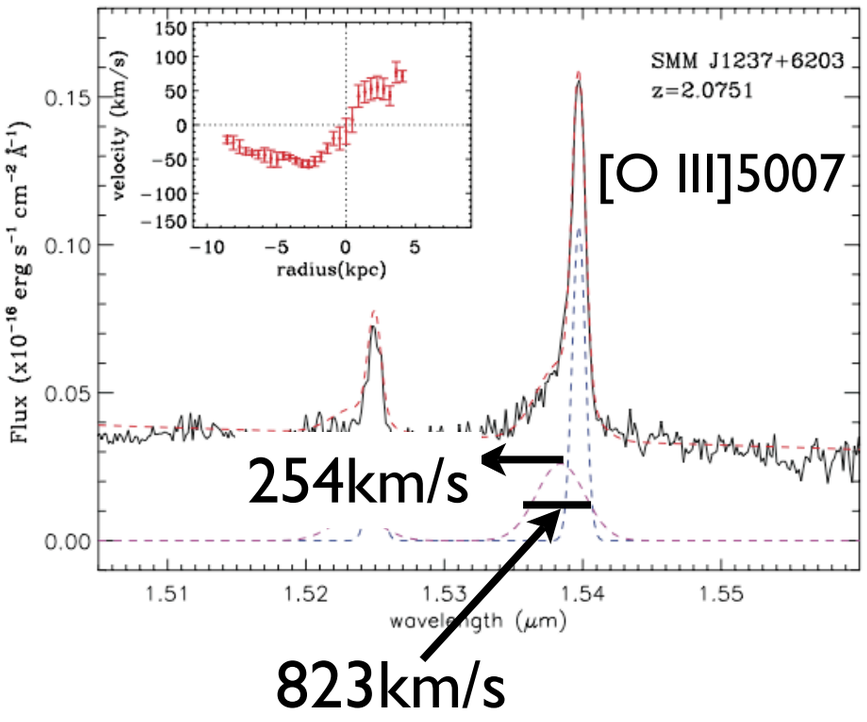
Outflows seen in U.V. absorption lines, but extended only over small scales
Crenshaw et al. ‘99

Also talks by Gallagher, Reeves

Radio quiet AGNs can also have extended outflows:

- z~2 sub-mm AGN.
- 3-4 orders of magnitude fainter at radio luminosities.
- Unlikely to be driven by jets.
- Possible quasar mode feedback

Alexander et al '10



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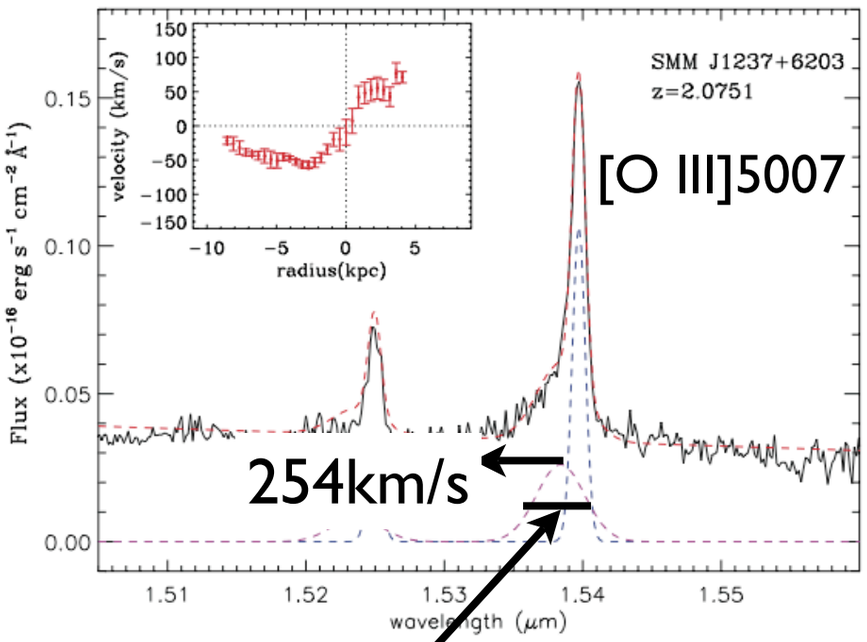
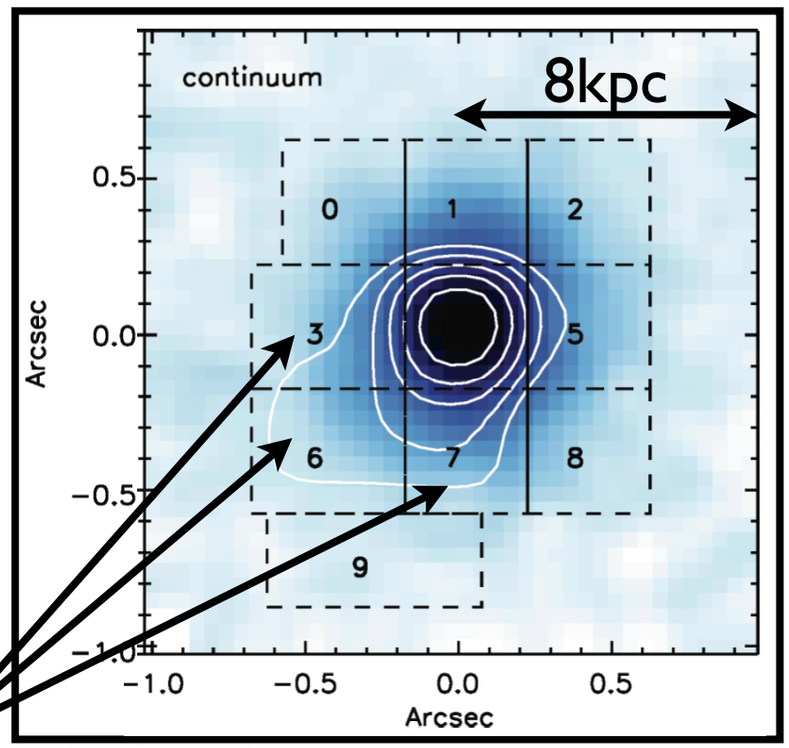
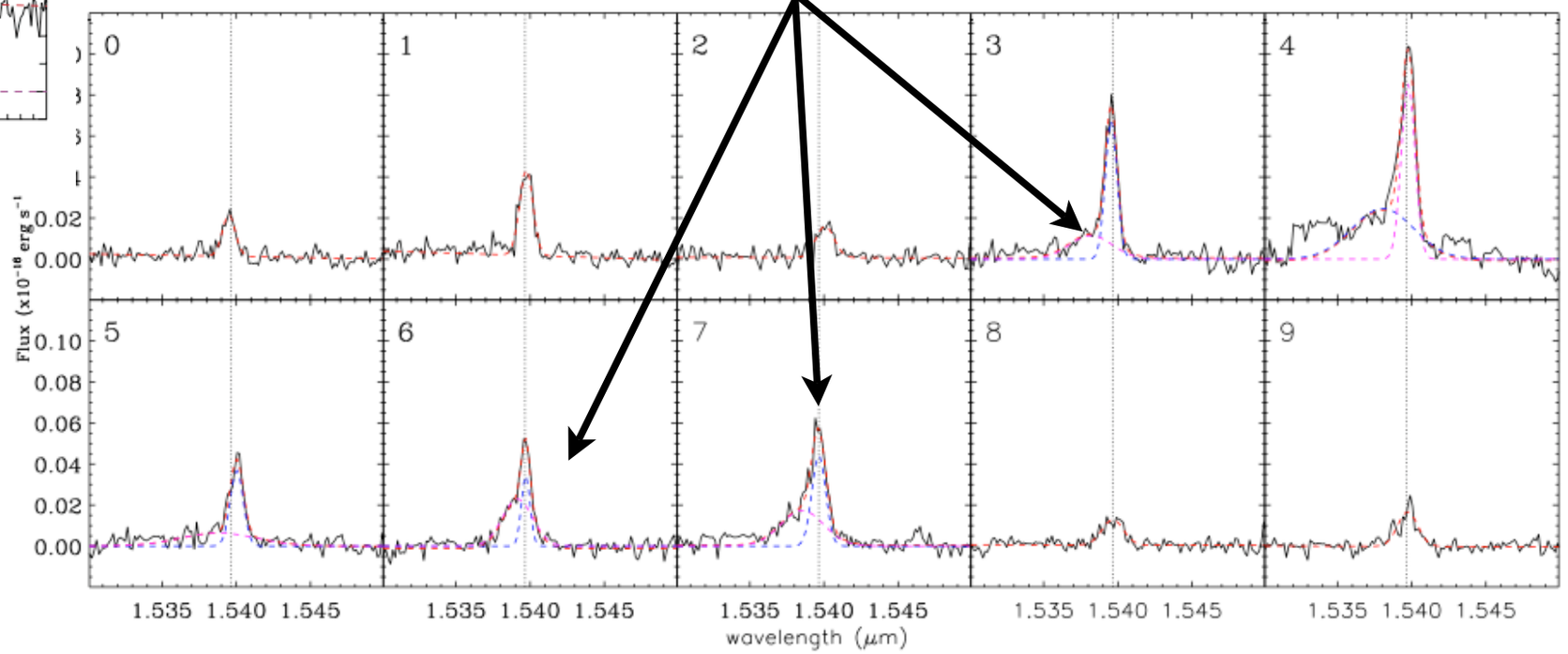




Turbulent, high velocity gas extended over kpc scales.

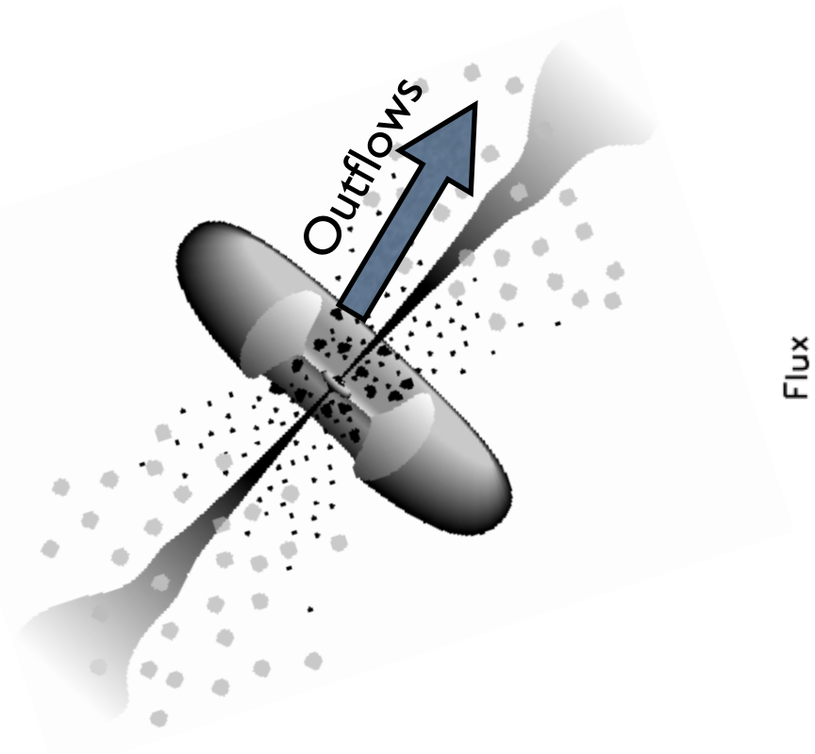


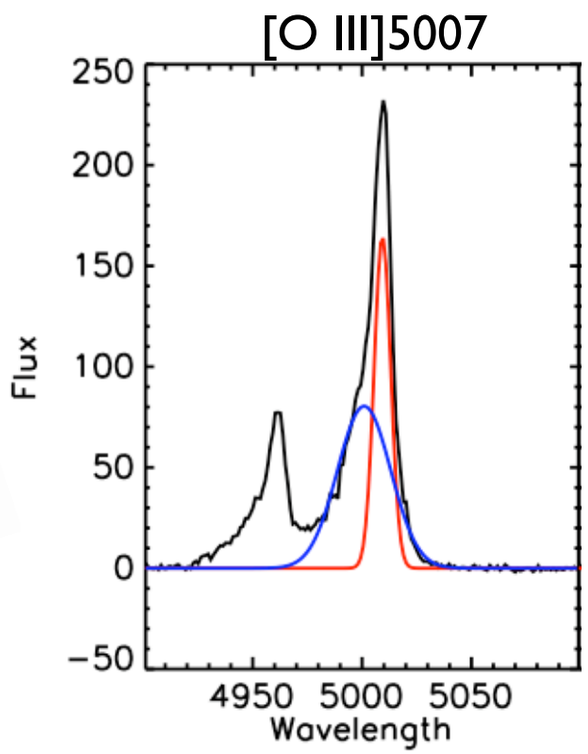
...but how common are such systems?

Search the SDSS DR7 for prospective kpc-scale outflows

- Explore the [O III] profiles of 'local' Type 1 AGNs.

- 24,627 AGNs at z<0.4 ([N II] coverage)
- Type 1 AGNs: 10,554 (1096 NLS1s)
- Type 2 AGNs: 13,713





Also see Whittle '92, Greene+ '05
(select AGNs) (Type 2s)

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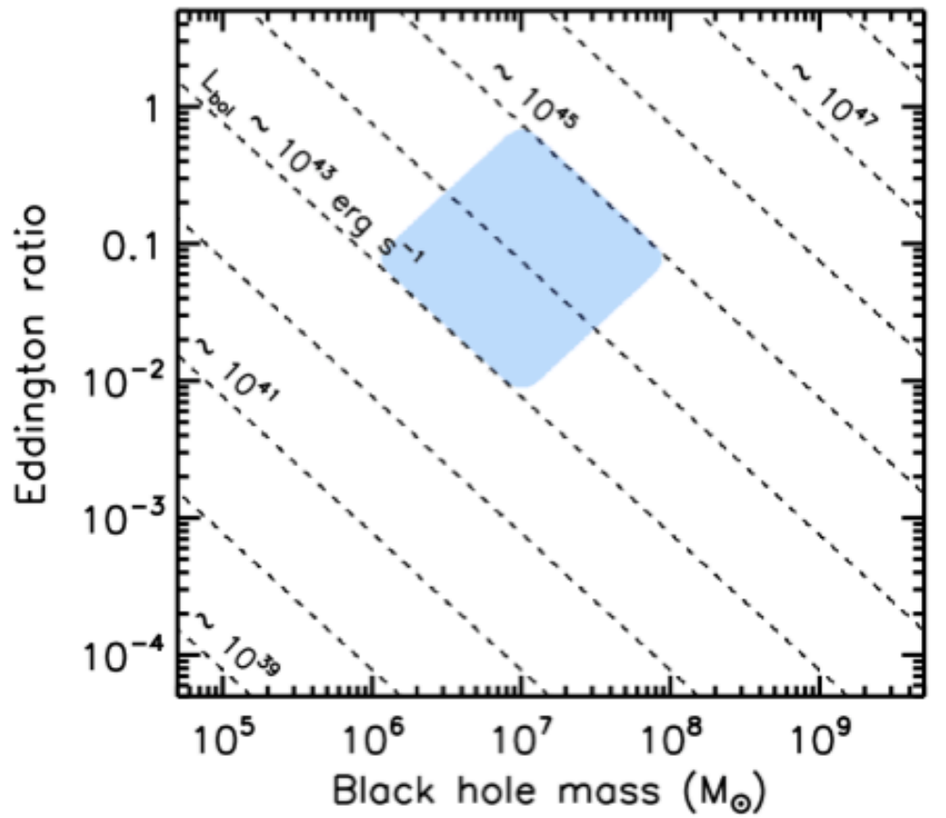

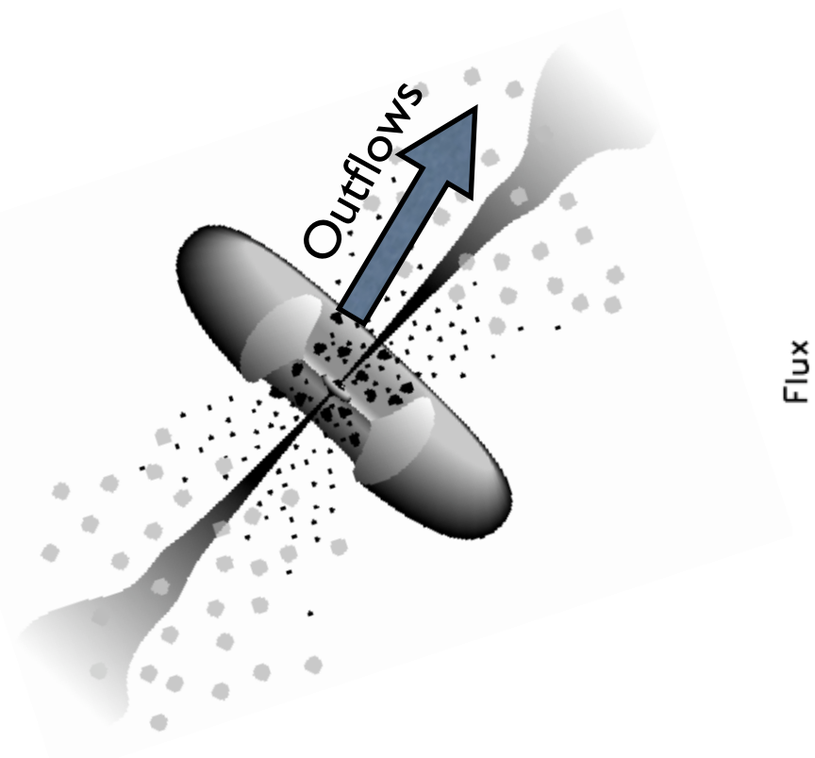

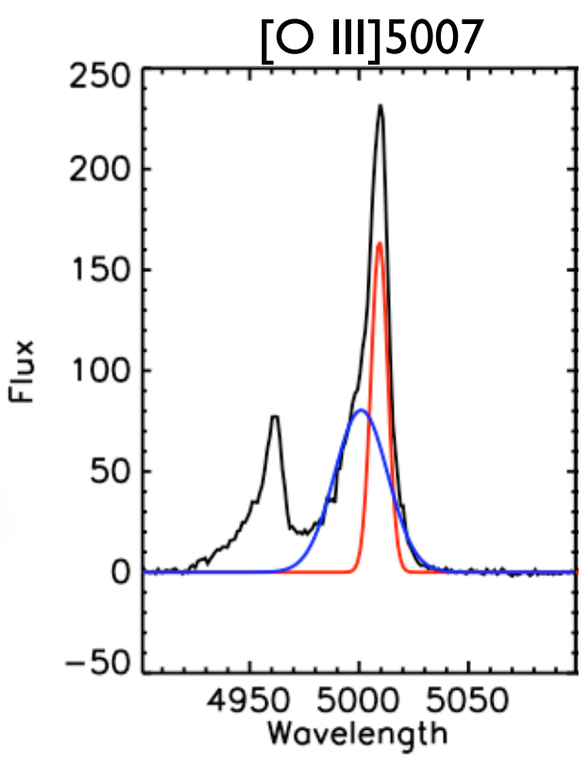

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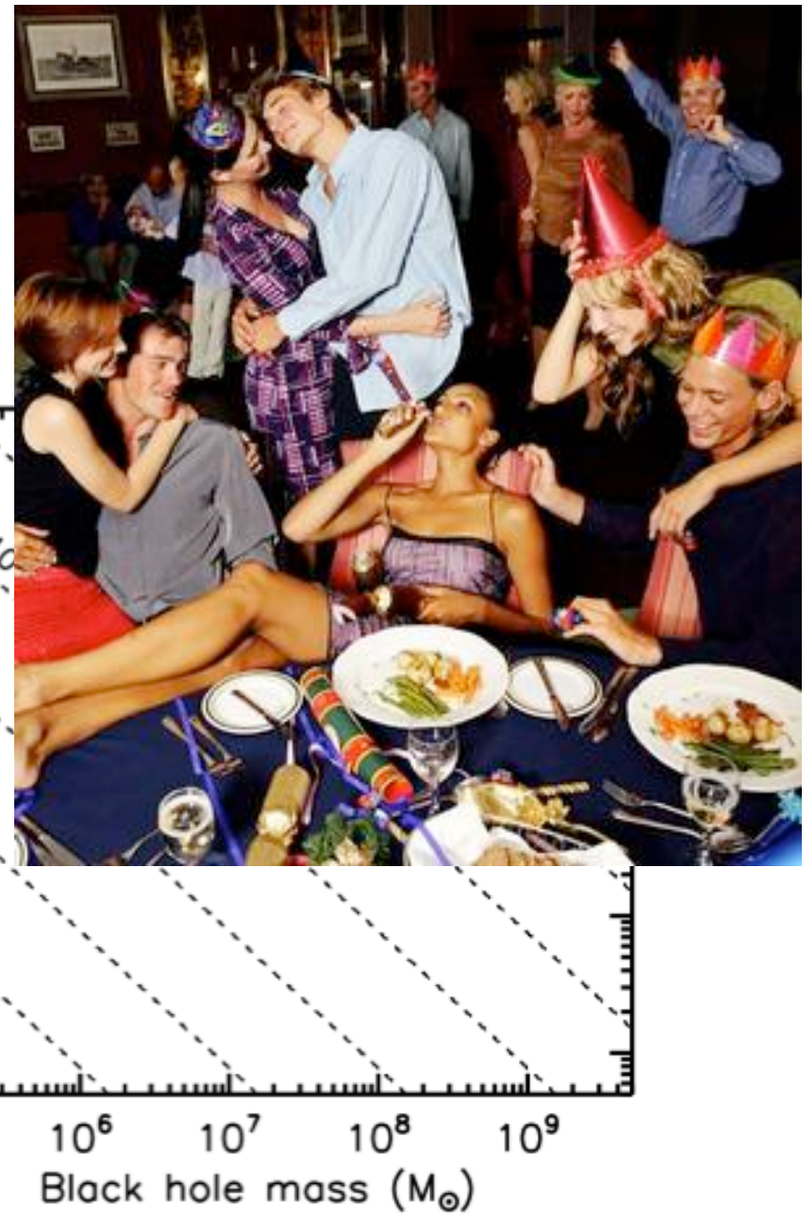

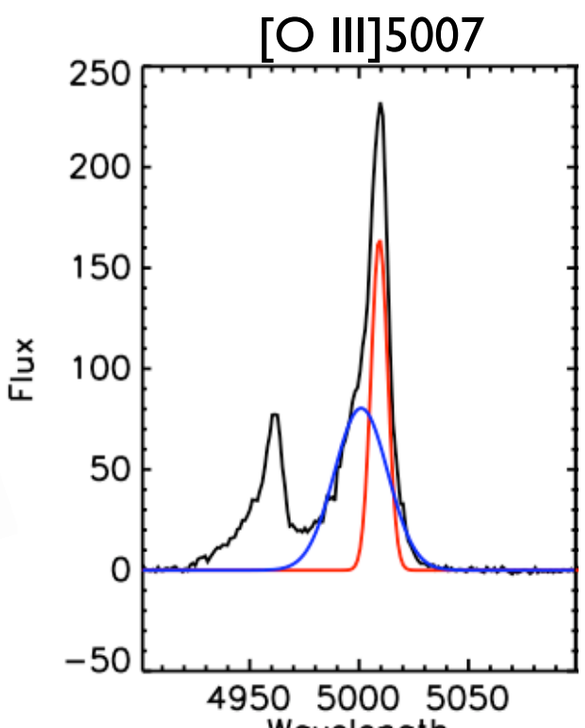

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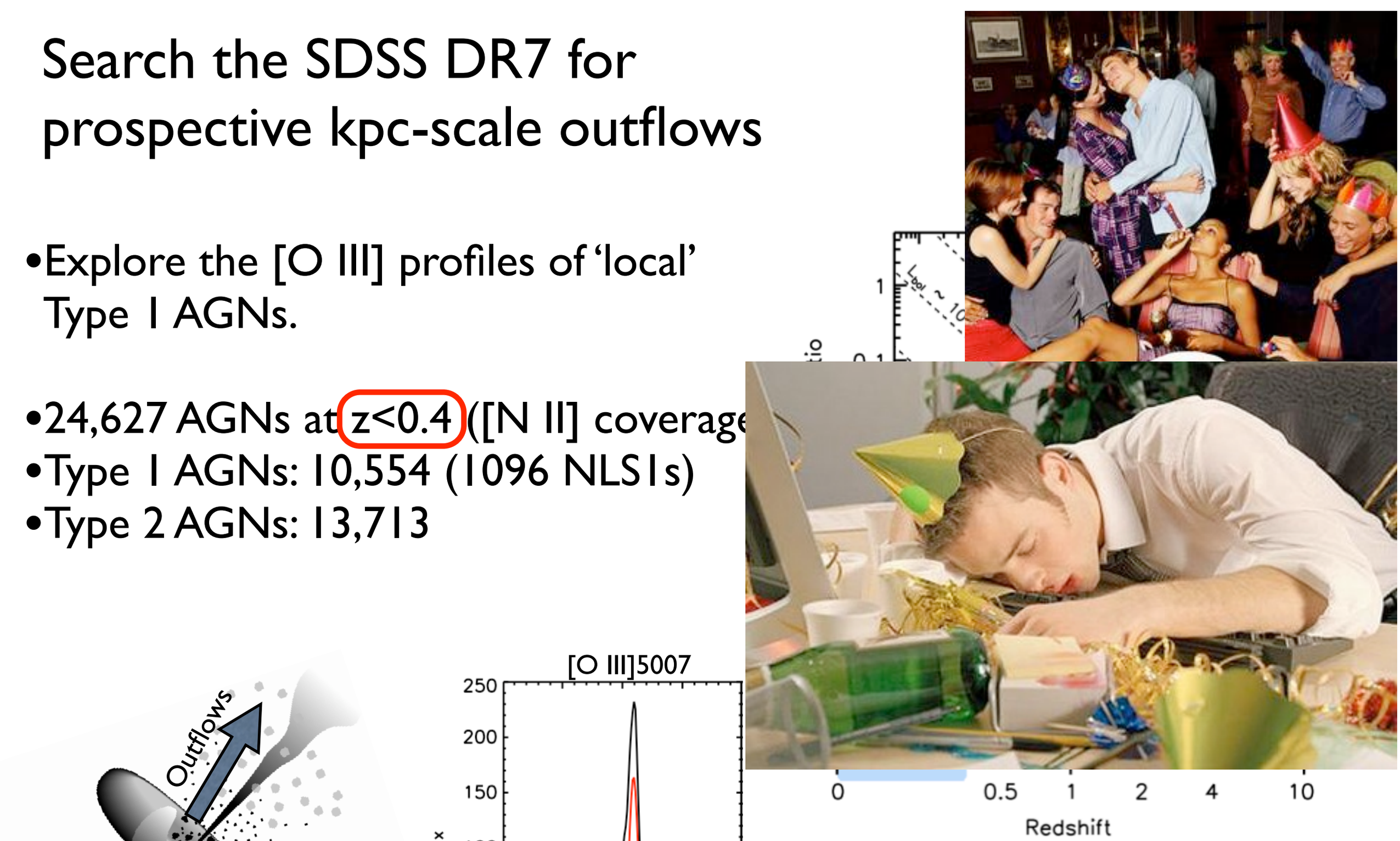

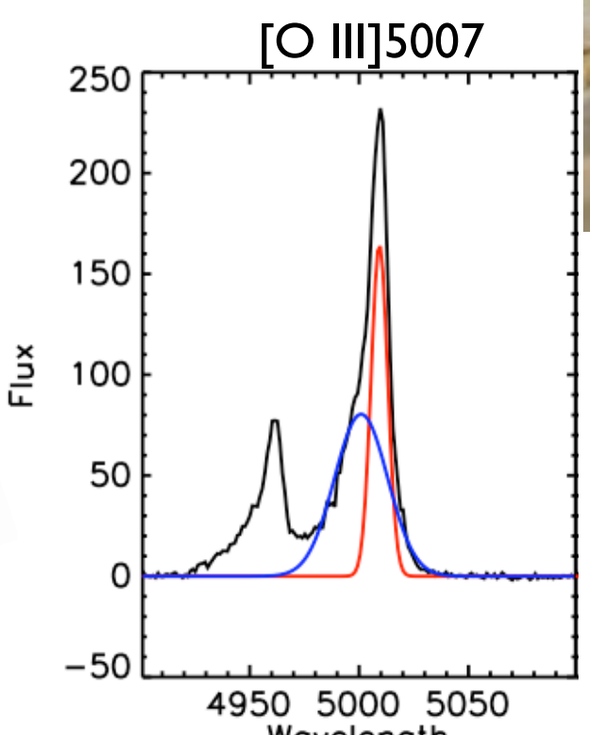

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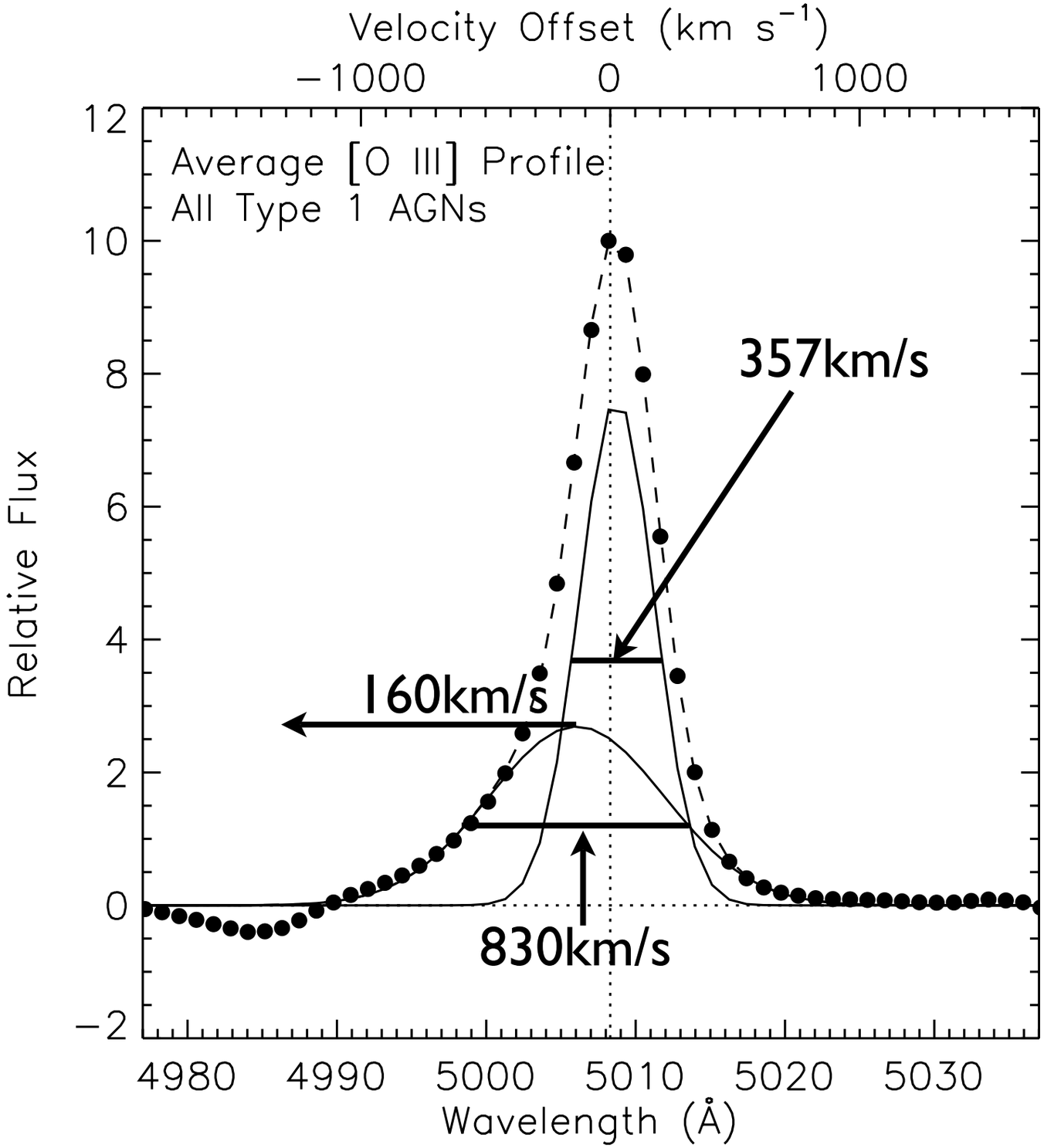
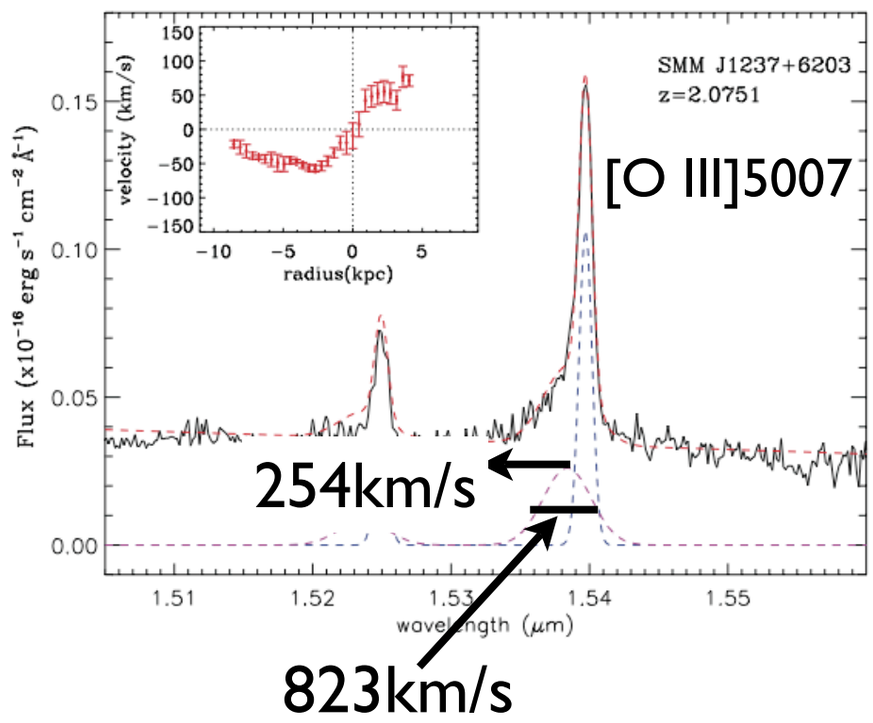
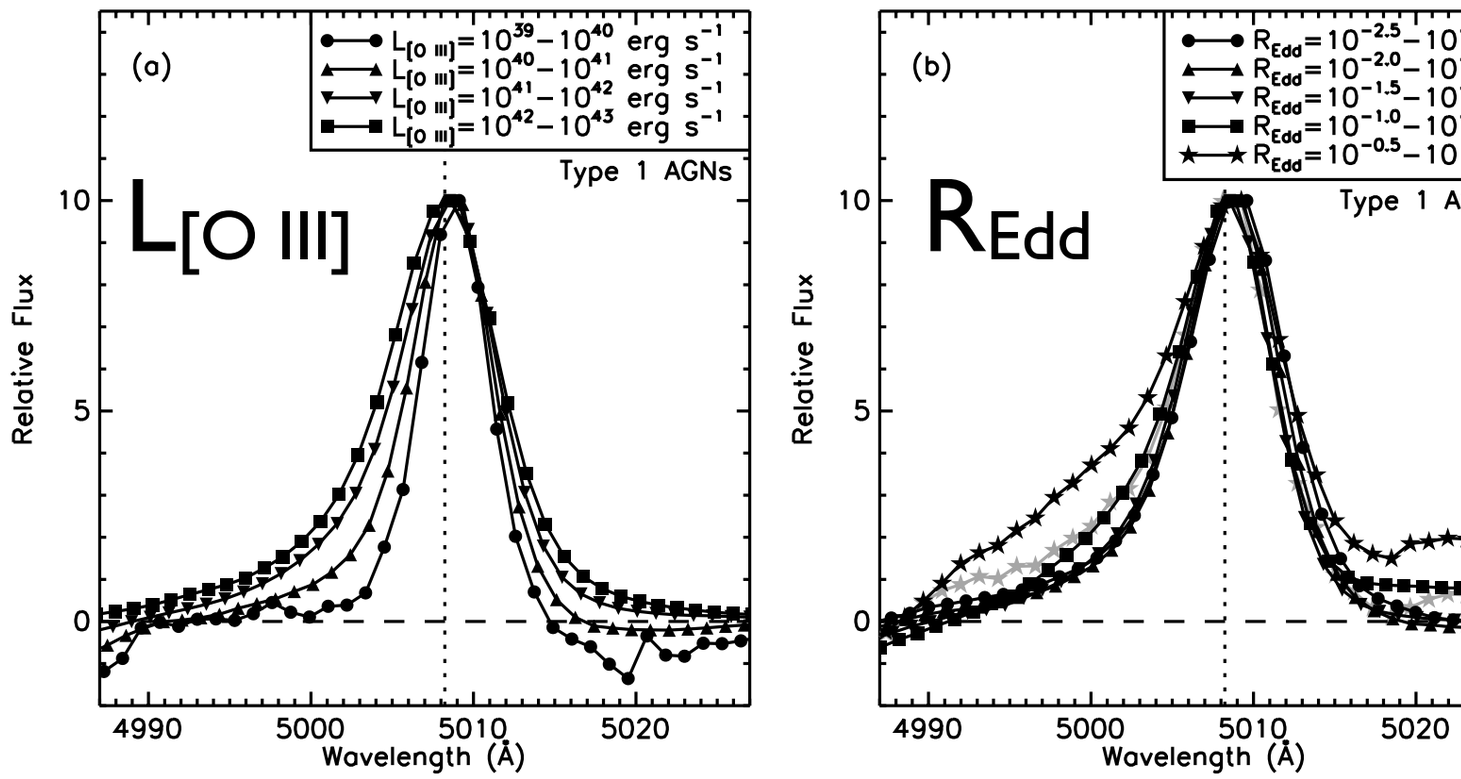
(select AGNs) (Type 2s)

Start simply: Stack the entire Type 1 sample





Split sample: Bin & stack according to $L_{[O\ III]}$, R_{Edd}, R_{Rad}, L_{Rad}.



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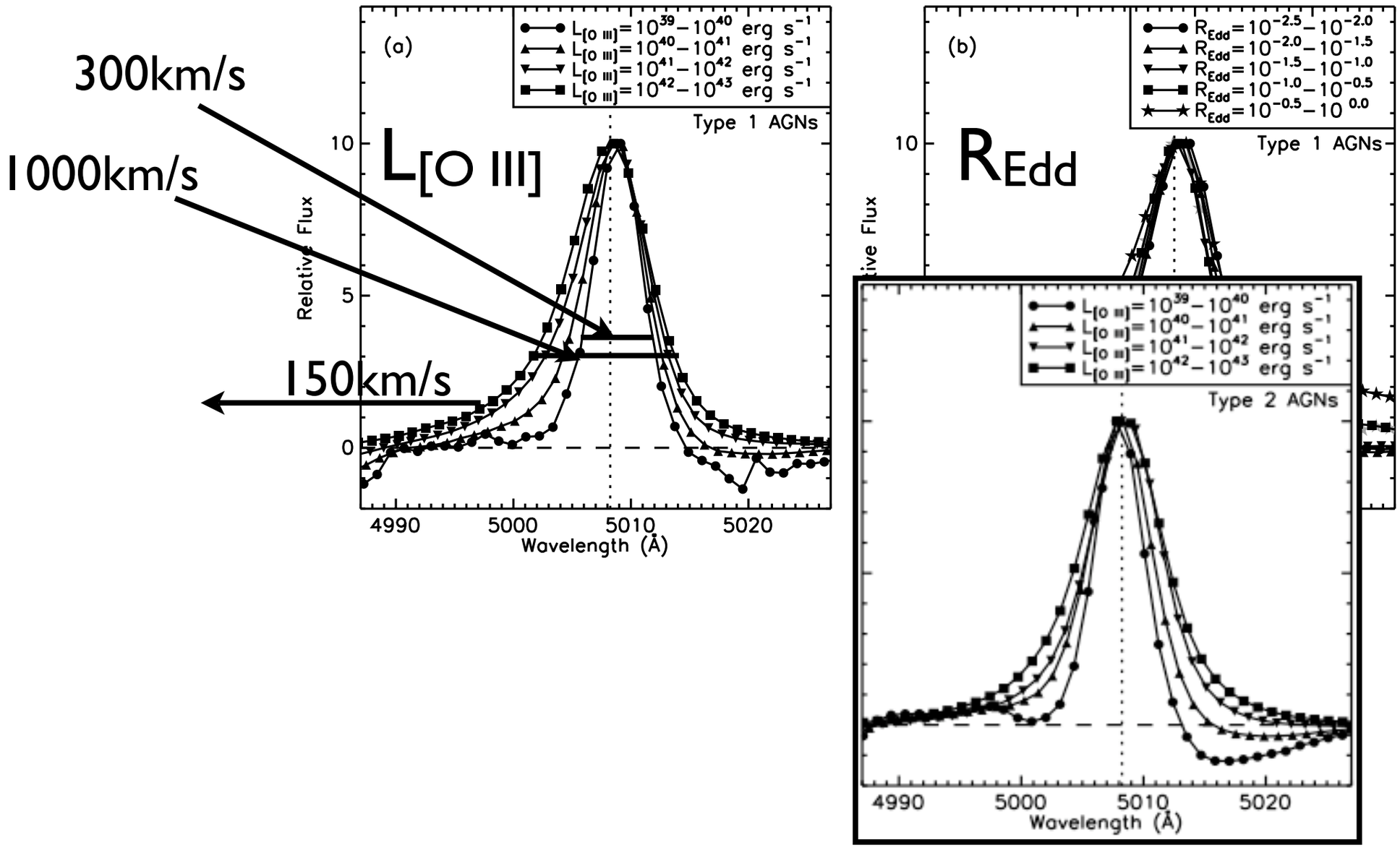

Type 2s

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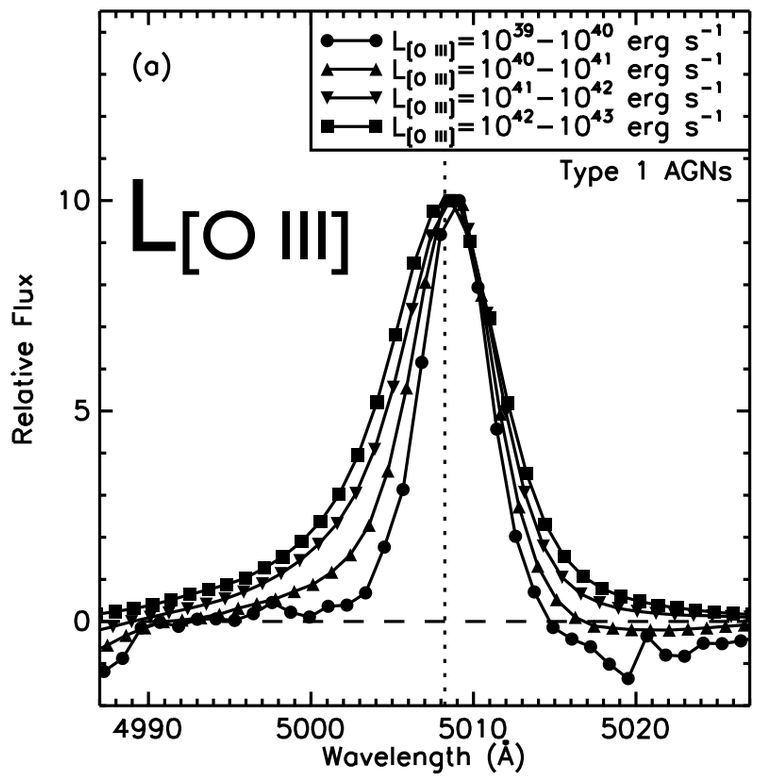
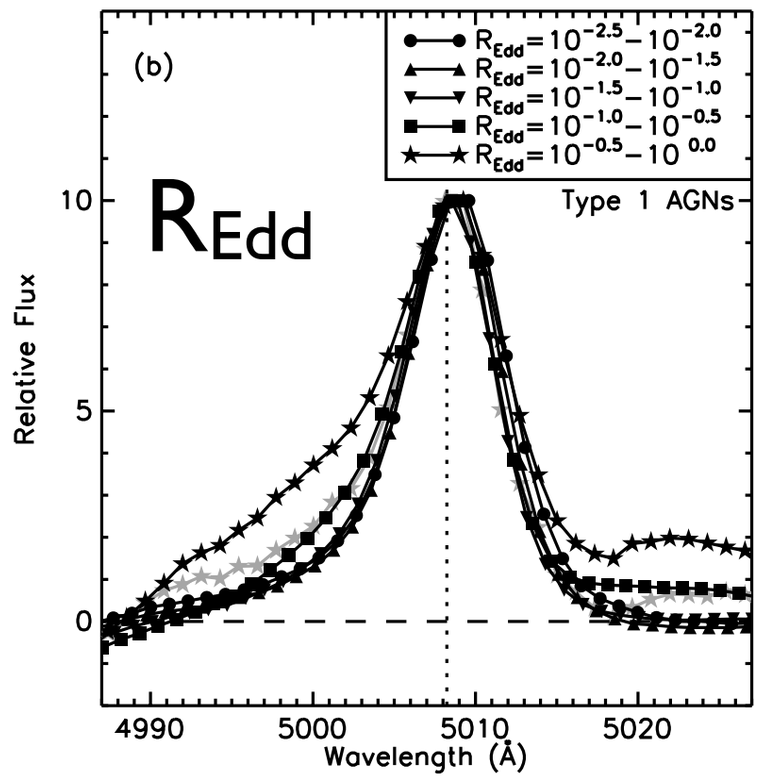
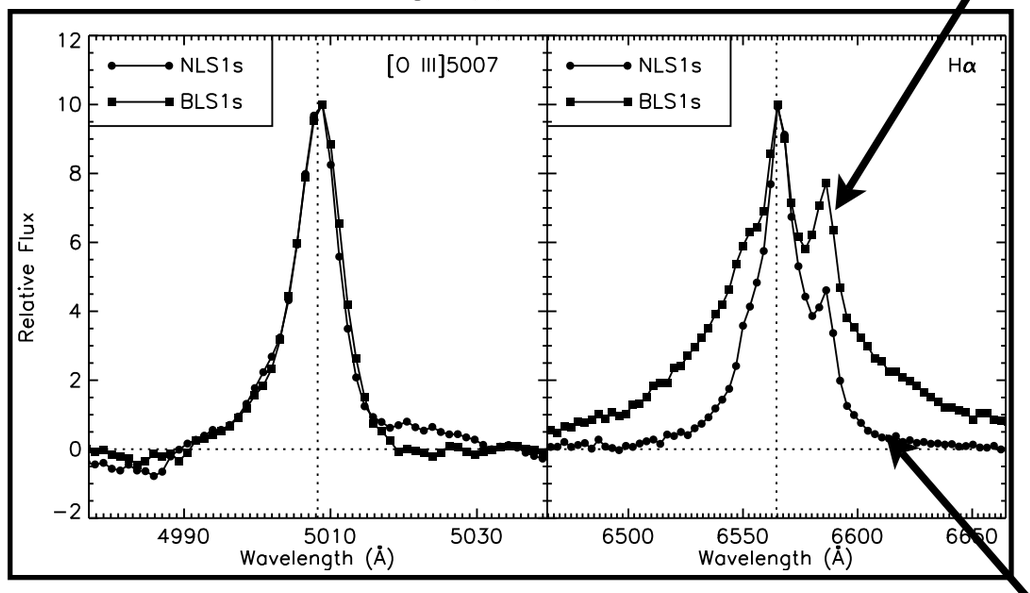


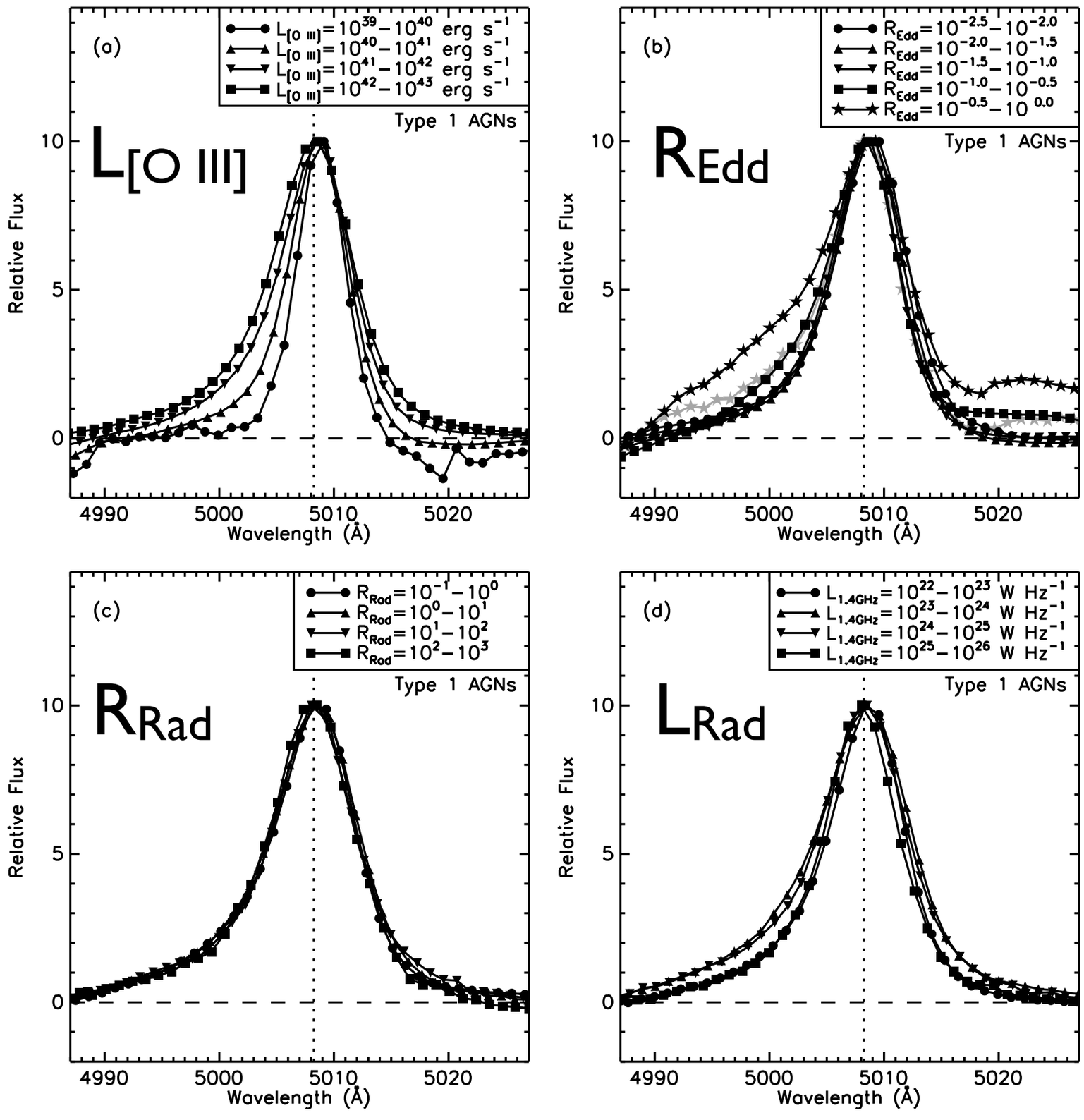


BLS1s



NLS1s

Split sample: Bin & stack according to $L_{[O\ III]}$, R_{Edd}, R_{Rad}, L_{Rad}.



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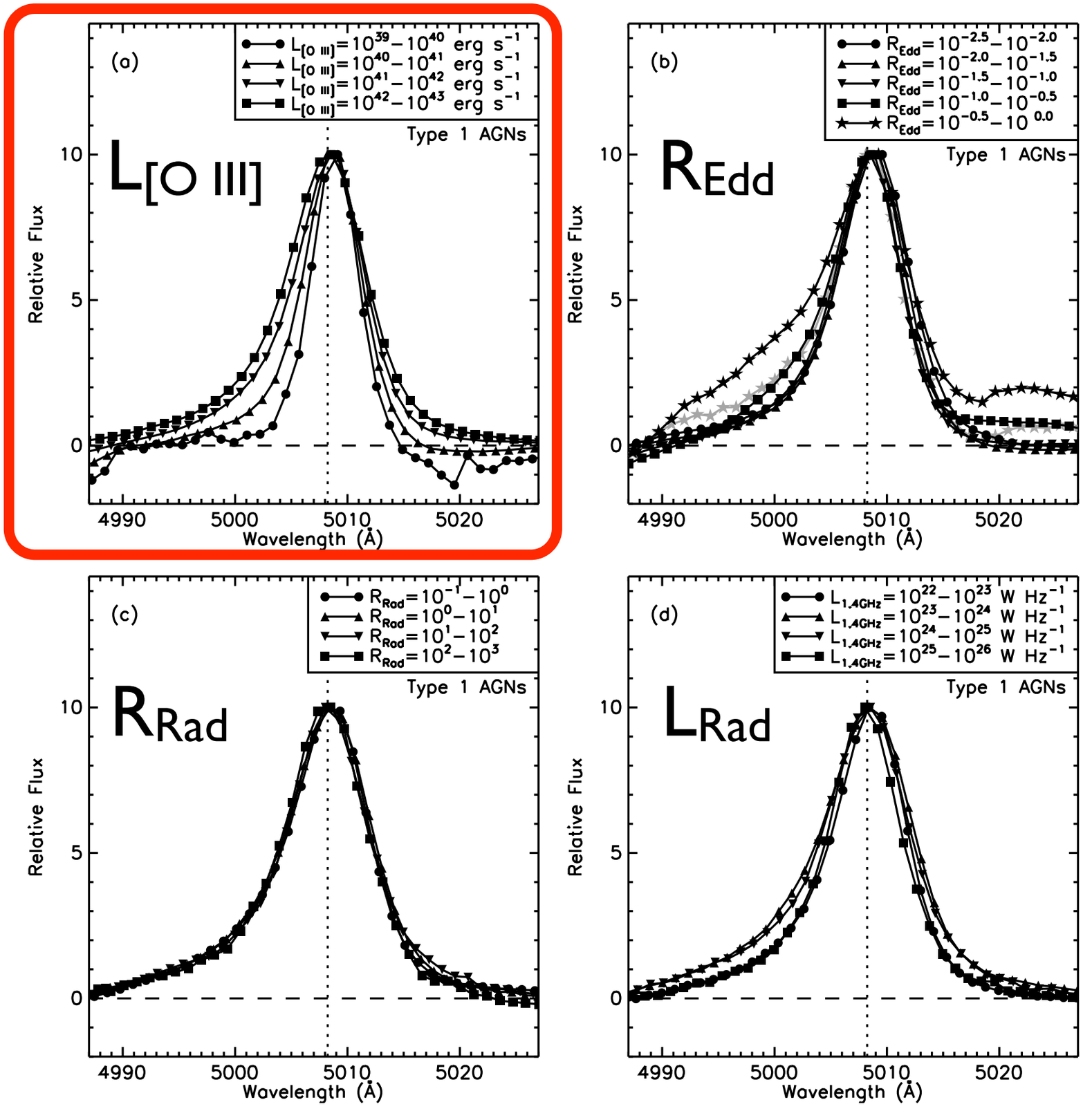
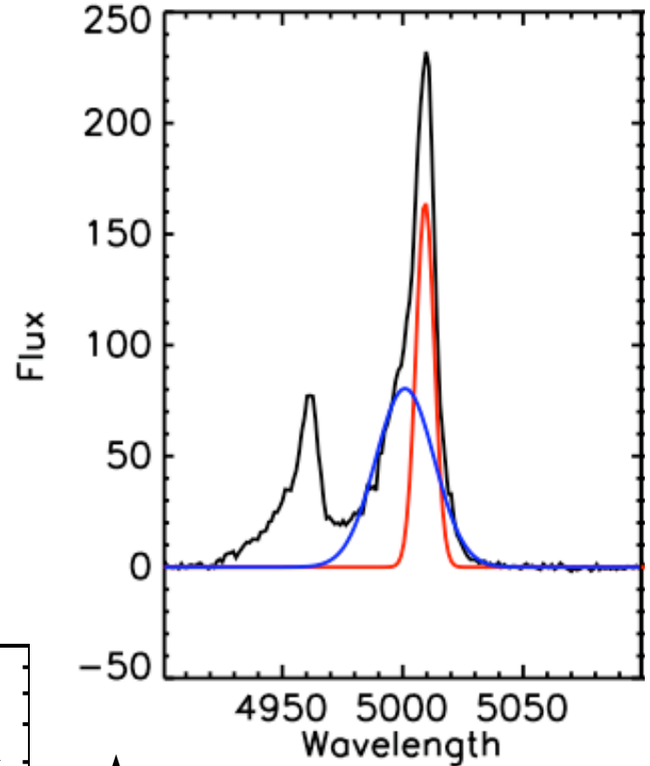
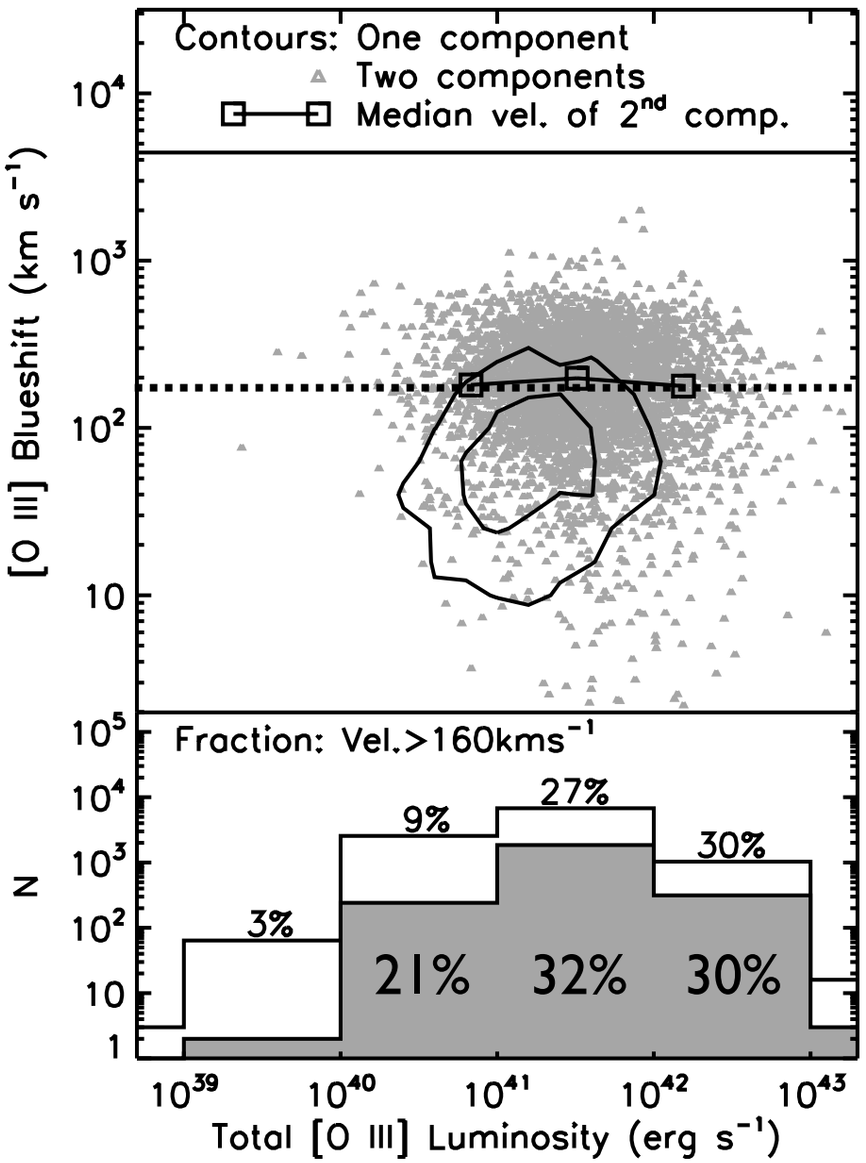
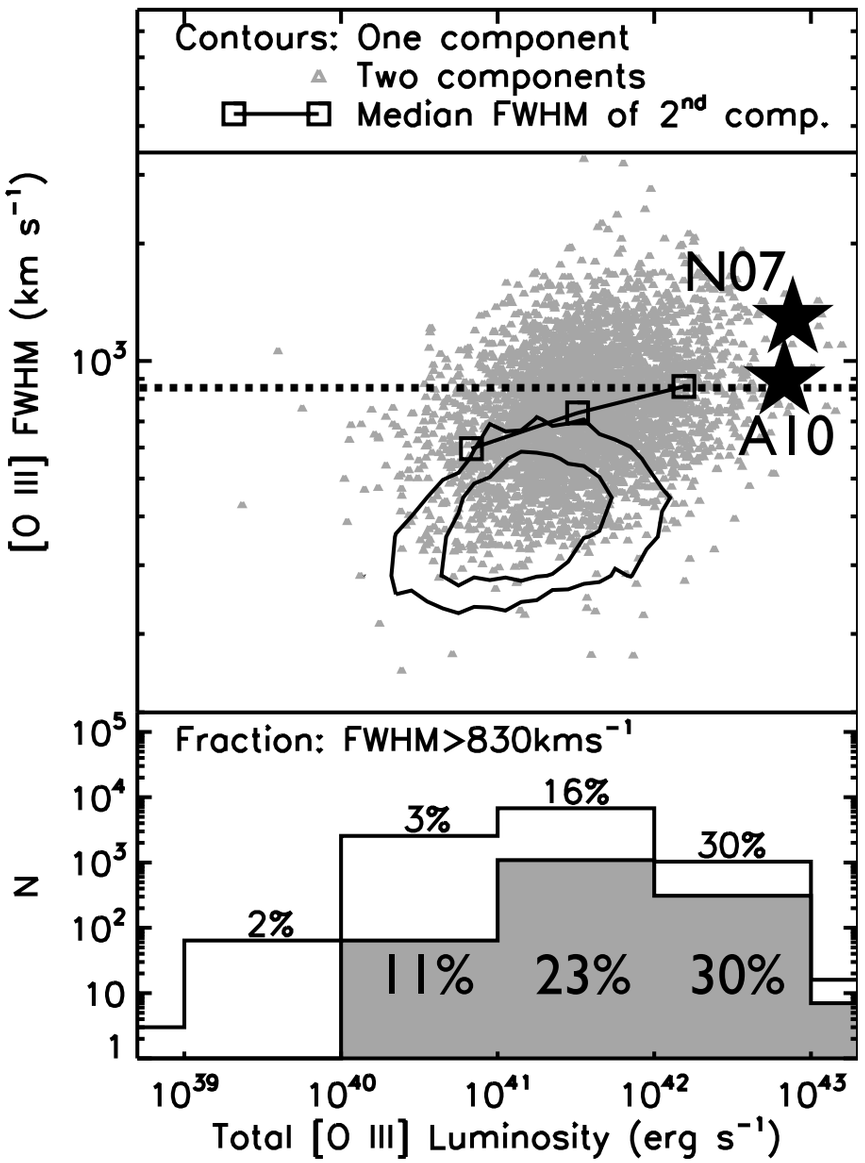


The proportions of AGNs with outflow signatures.

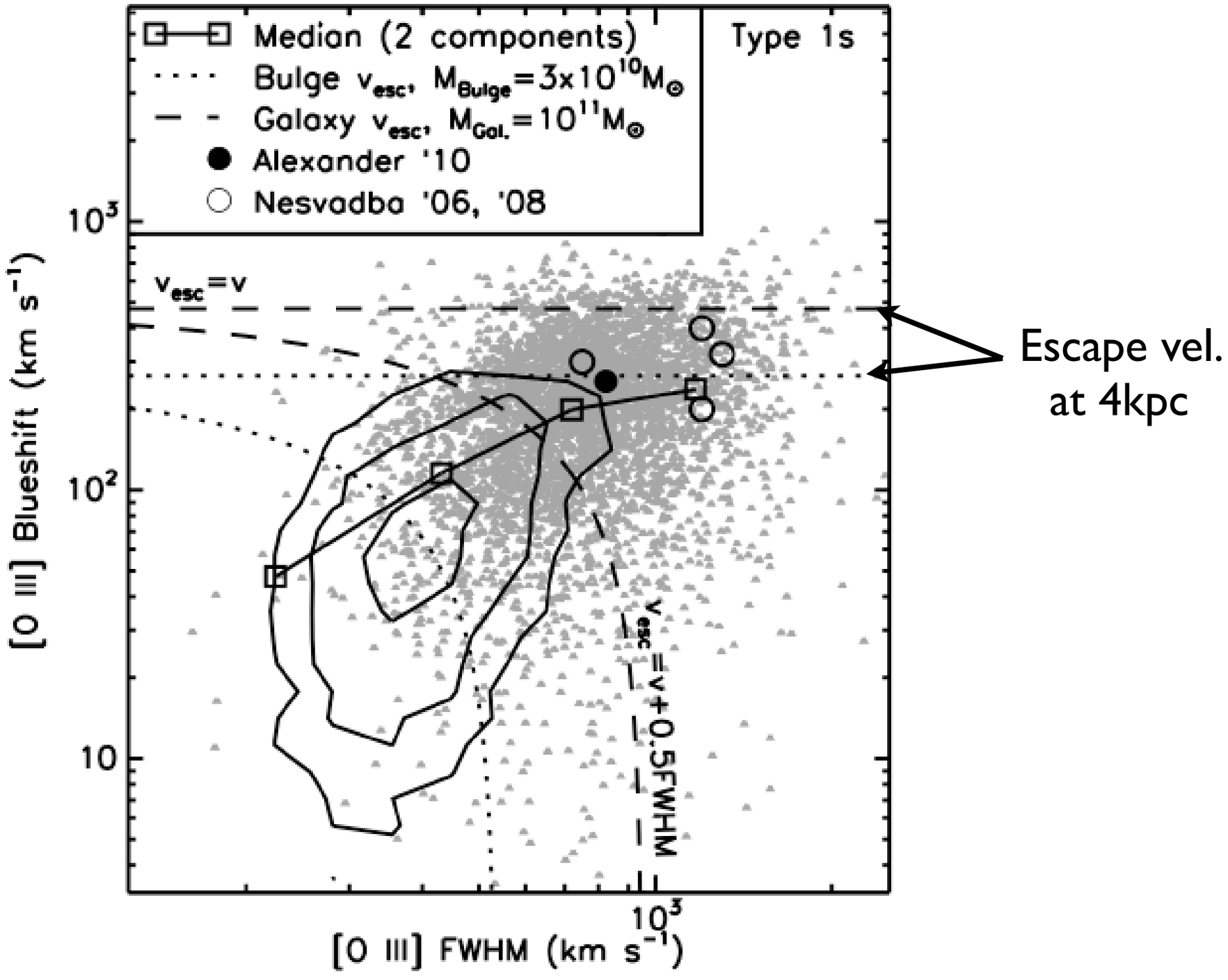






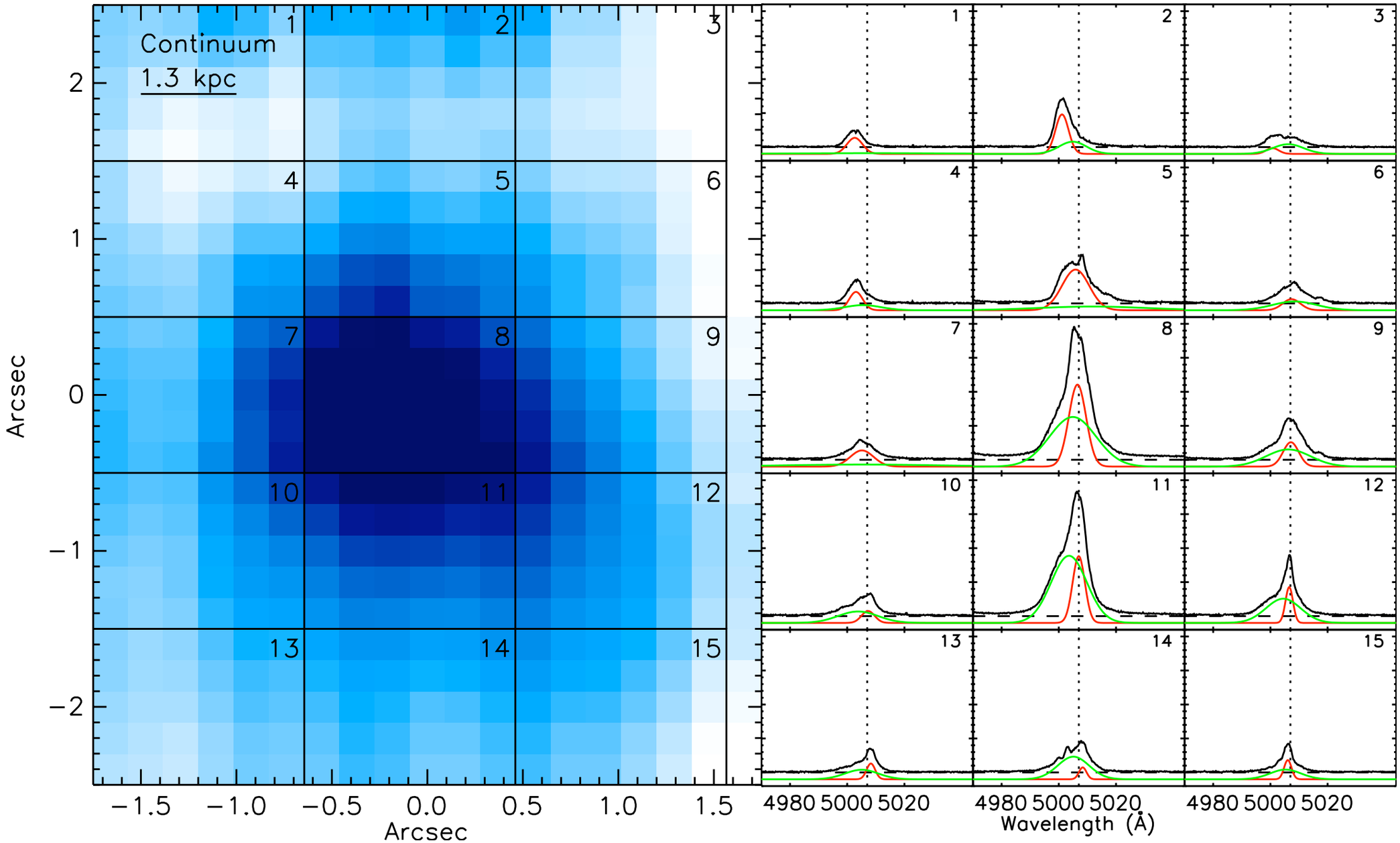
★ N06
★ N08

Where do the outflows go?



Escape vel. at 4kpc

But...
are these ‘outflows’ really extended?



Conclusions...at least at z<0.4...

- AGN luminosity appears to be the most important factor in producing broad, blueshifted [O III] components.
- Radio luminosity or loudness has no clear influence on the profile of [O III].
- No difference in average profile [O III] between NLS1s and BLS1s.
- ~30% of local, luminous AGNs show evidence of possible feedback inducing outflows...
- ...but, not clear that these can escape potential of galaxy.
- Early evidence suggests that they are extended over kpc scales.