M_{BH} estimation
— for type 2 Qsos

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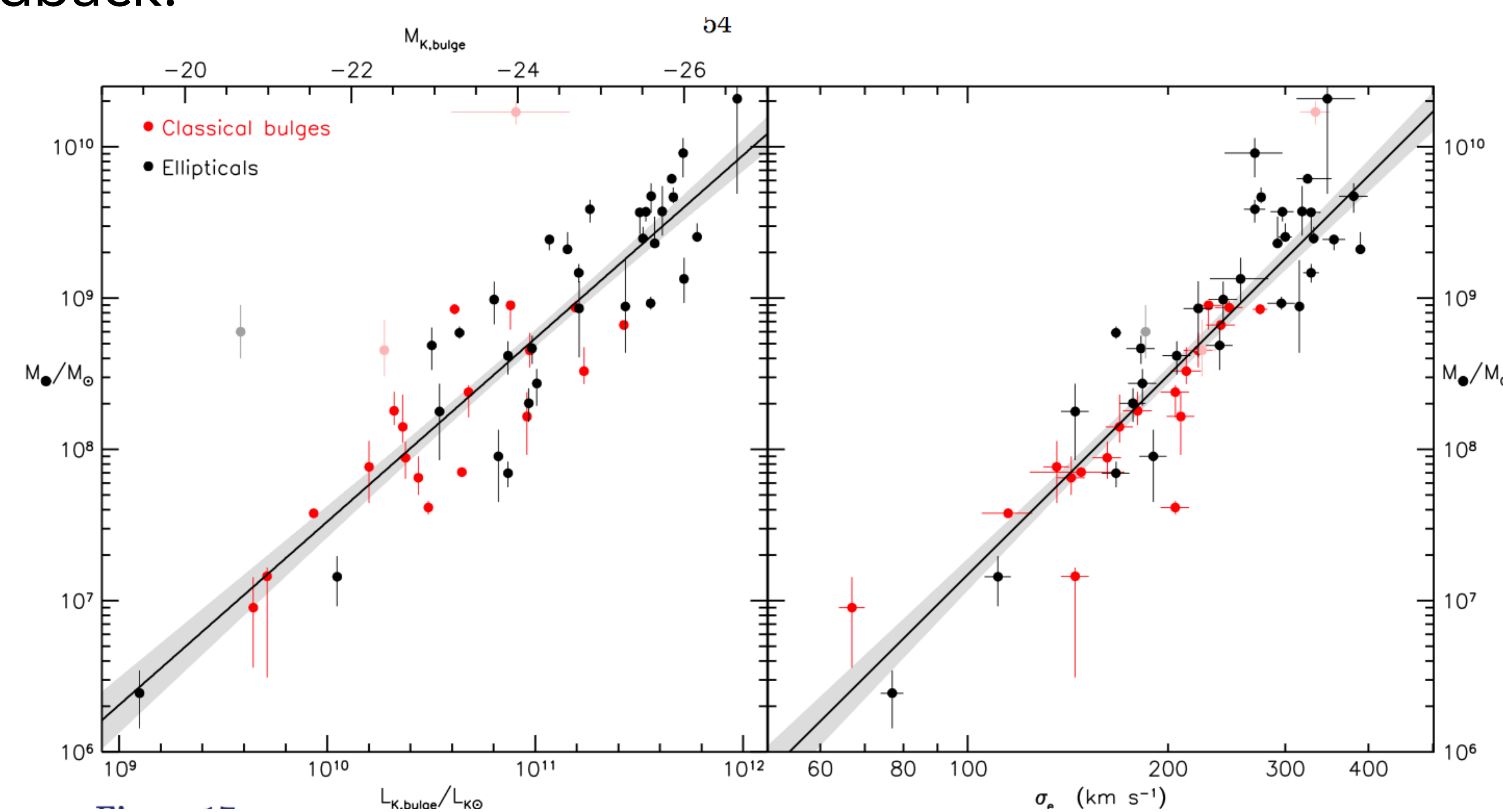
I, Why we interested in M_{BH}

Inportance of M_{BH} investigation

- There almost exist a BH in each center of AGNs/galaxies
- Co-evolution exists between BHs and host galaxies
- In the LCDM universe: BHs grow along with galaxies through accretion and mergers (both minor and major) and influence the galaxy through feedback.

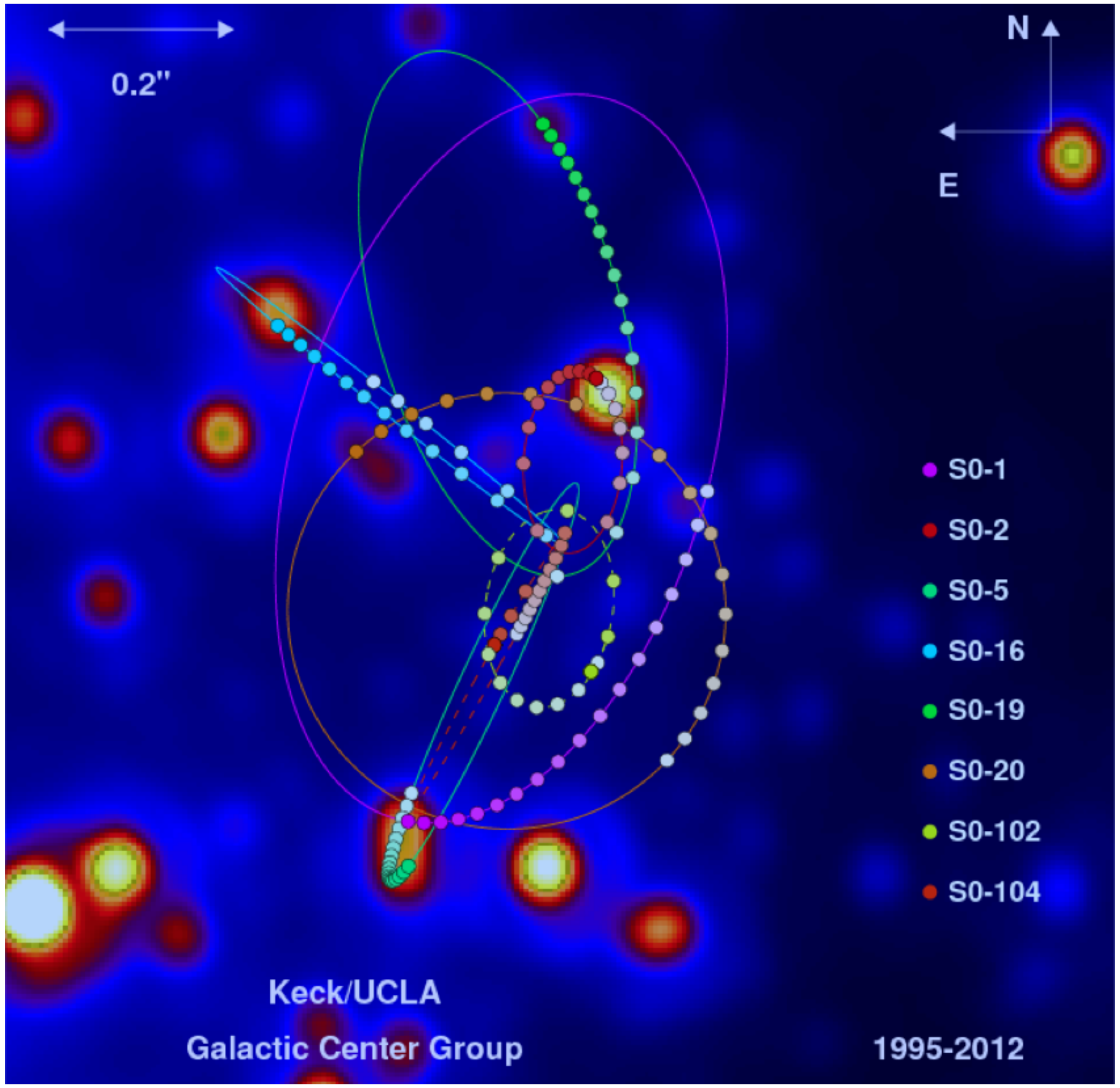


Kormendy & Ho 2014

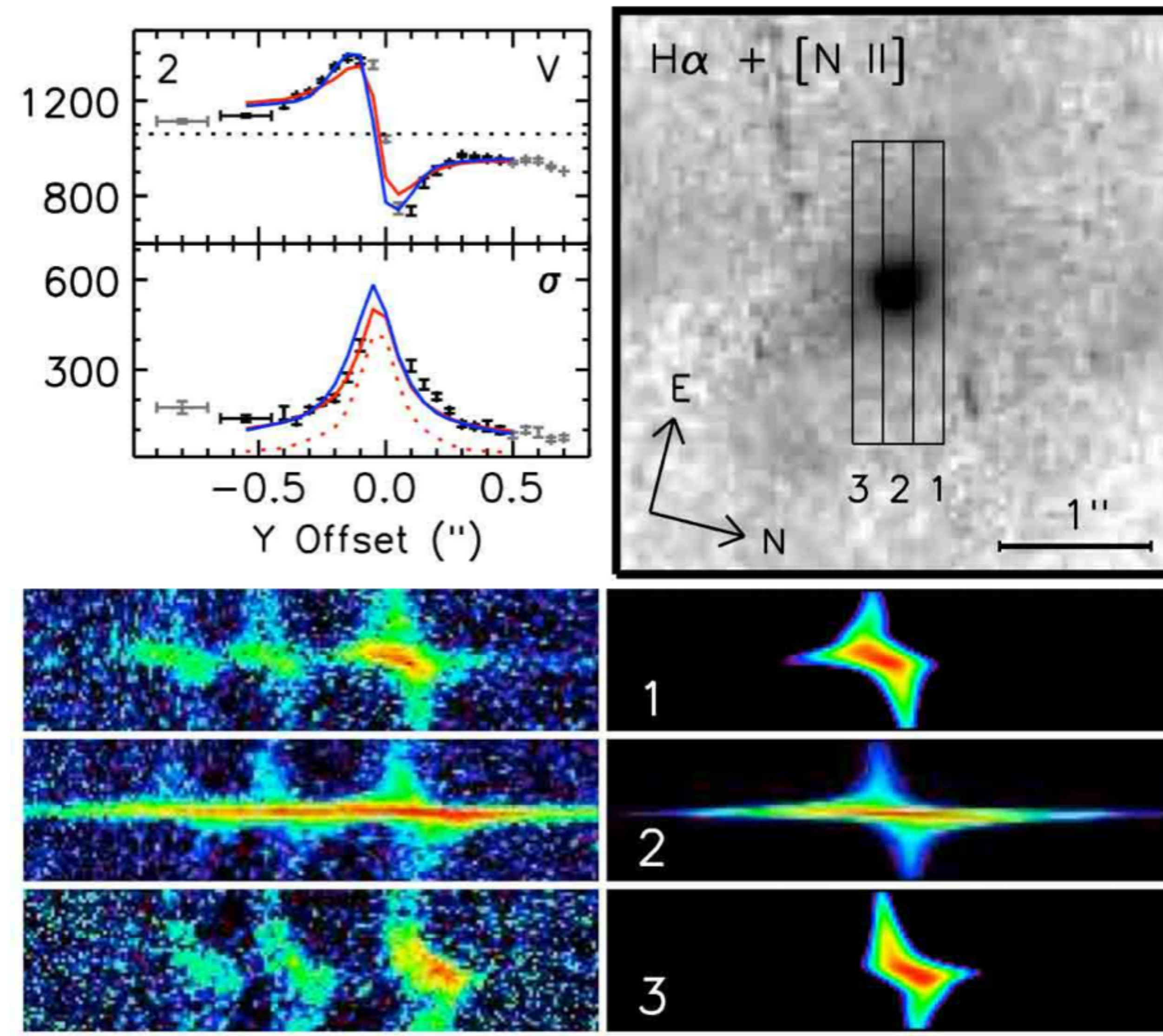
Methods of M_{BH} estimation I

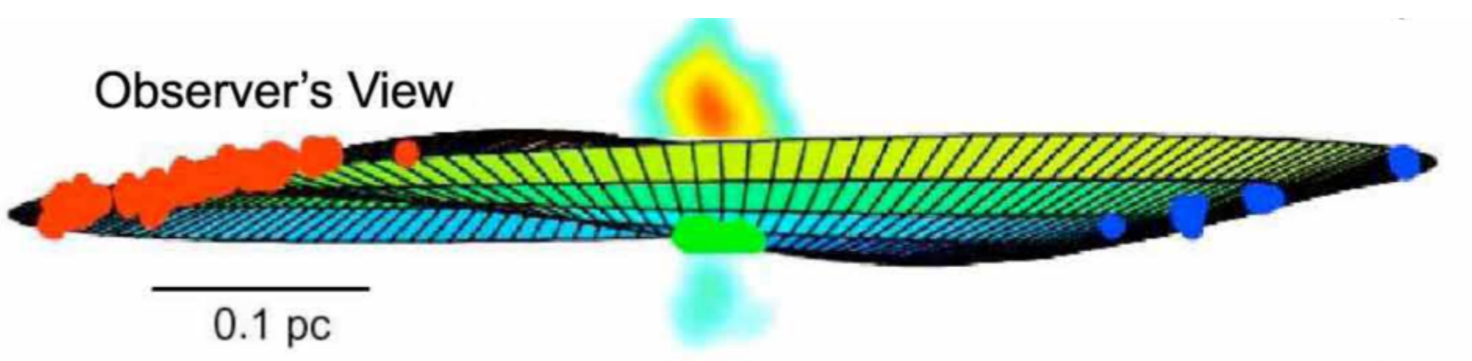
— Dynamics

•stellar dynamics



•ionized gas dynamics

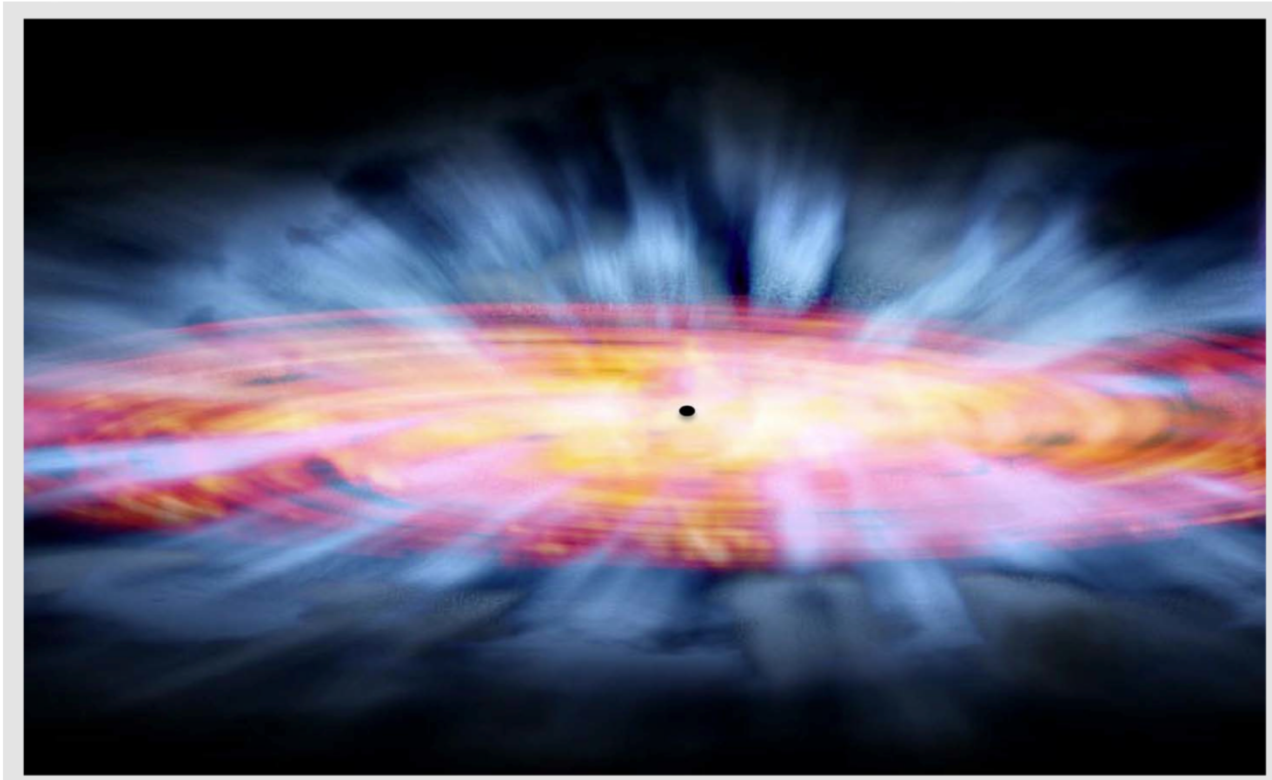




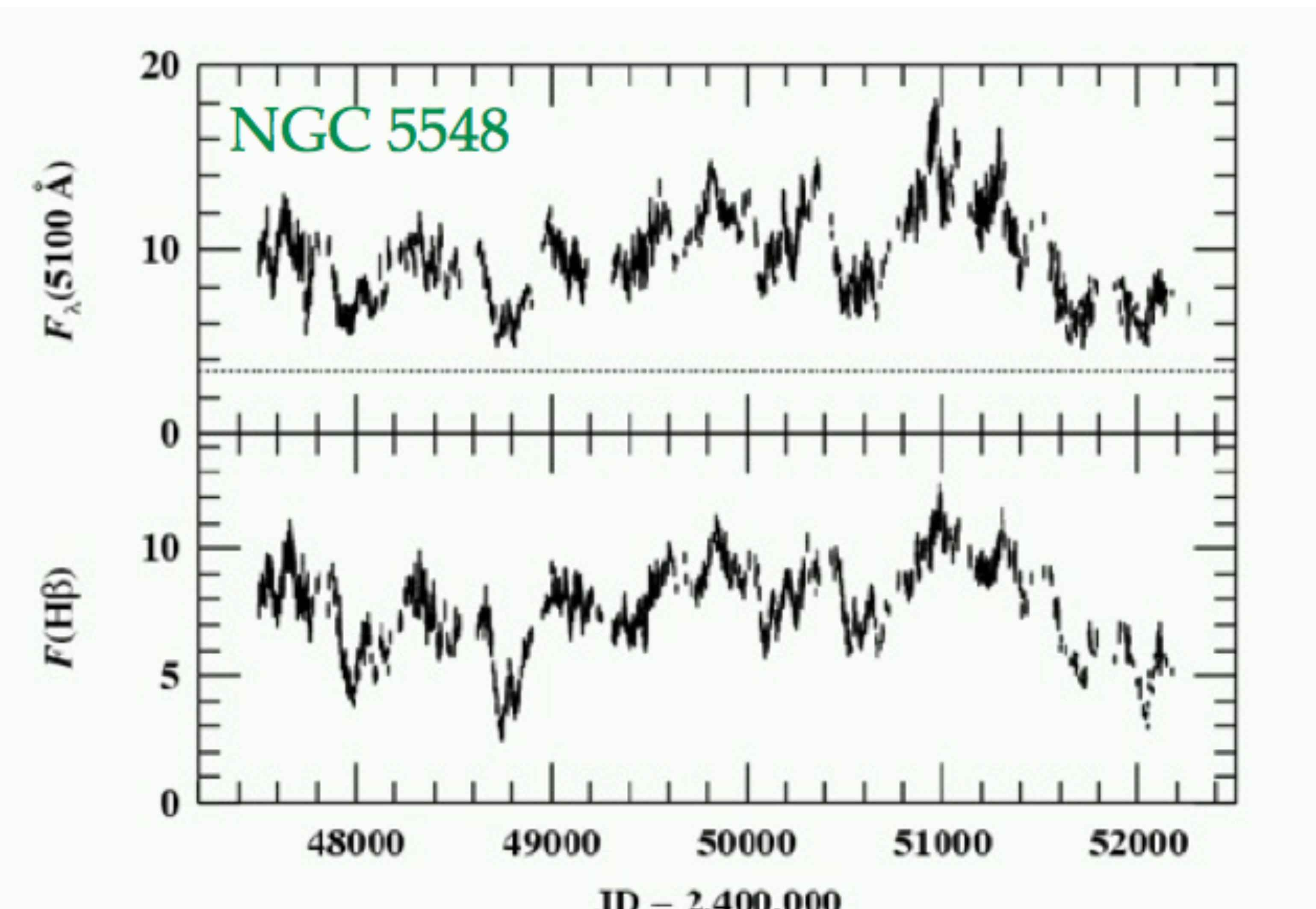
•maser dynamics

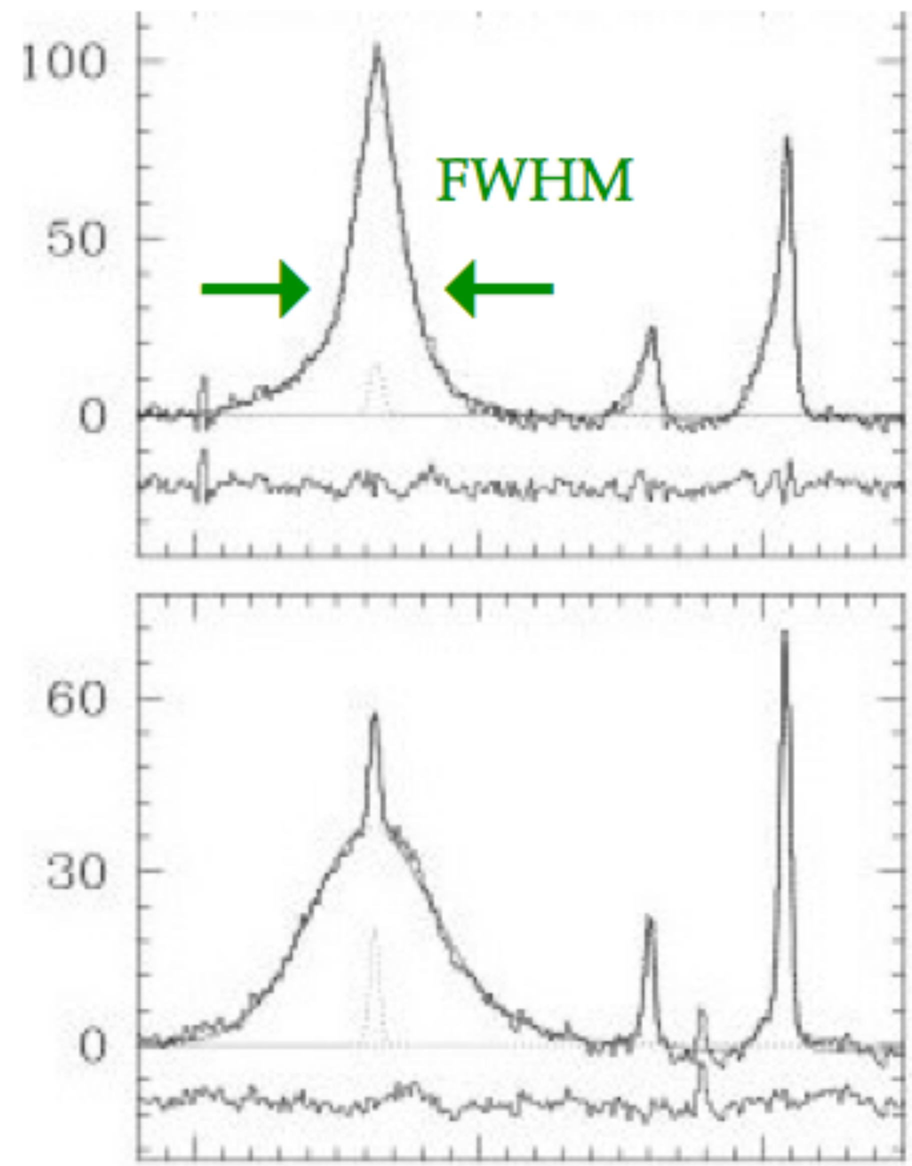
Methods of M_{BH} estimation II

— Reverberation mapping



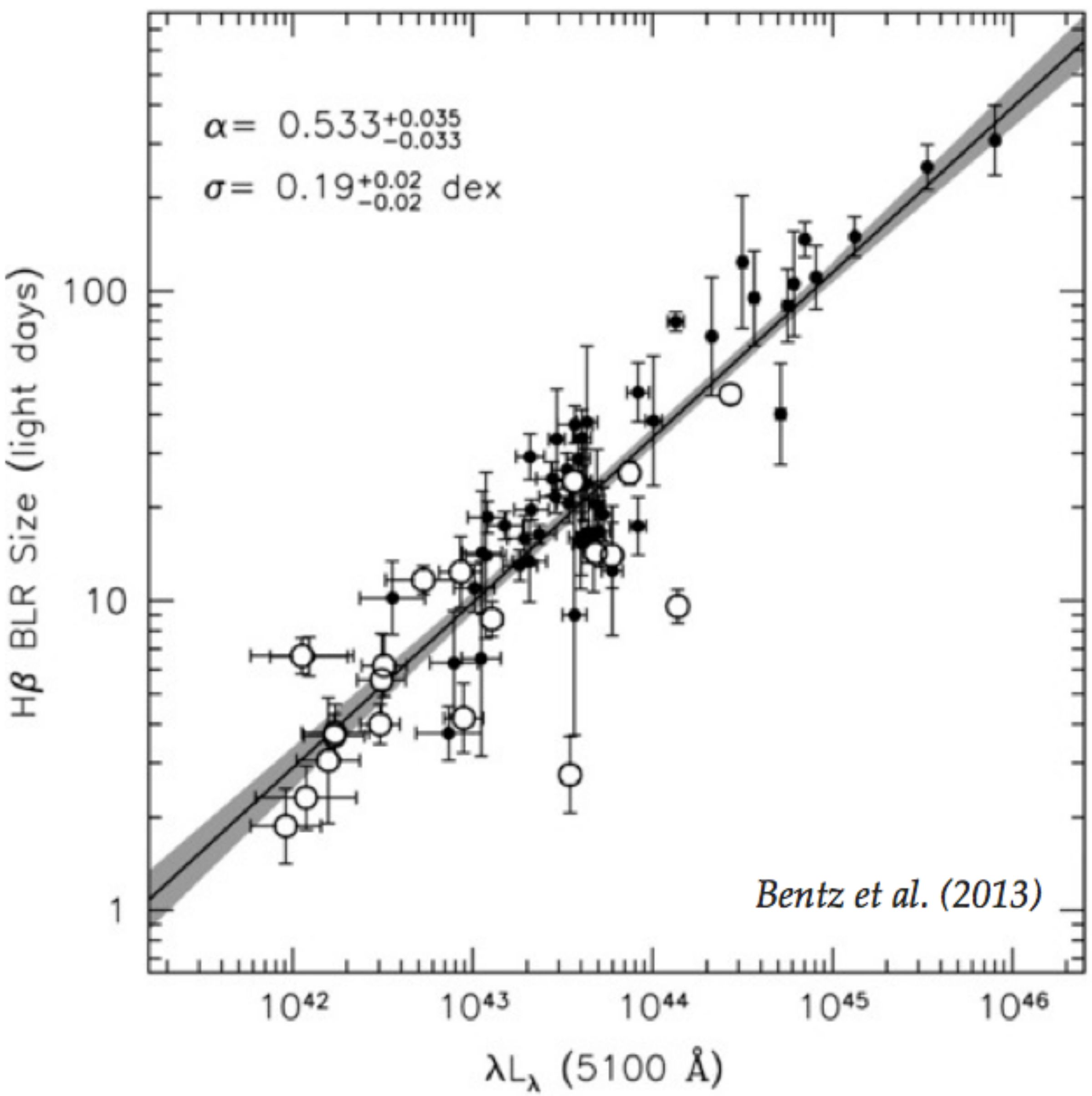
$$M_{\mathrm{virial}} = f\,RV^2/G$$

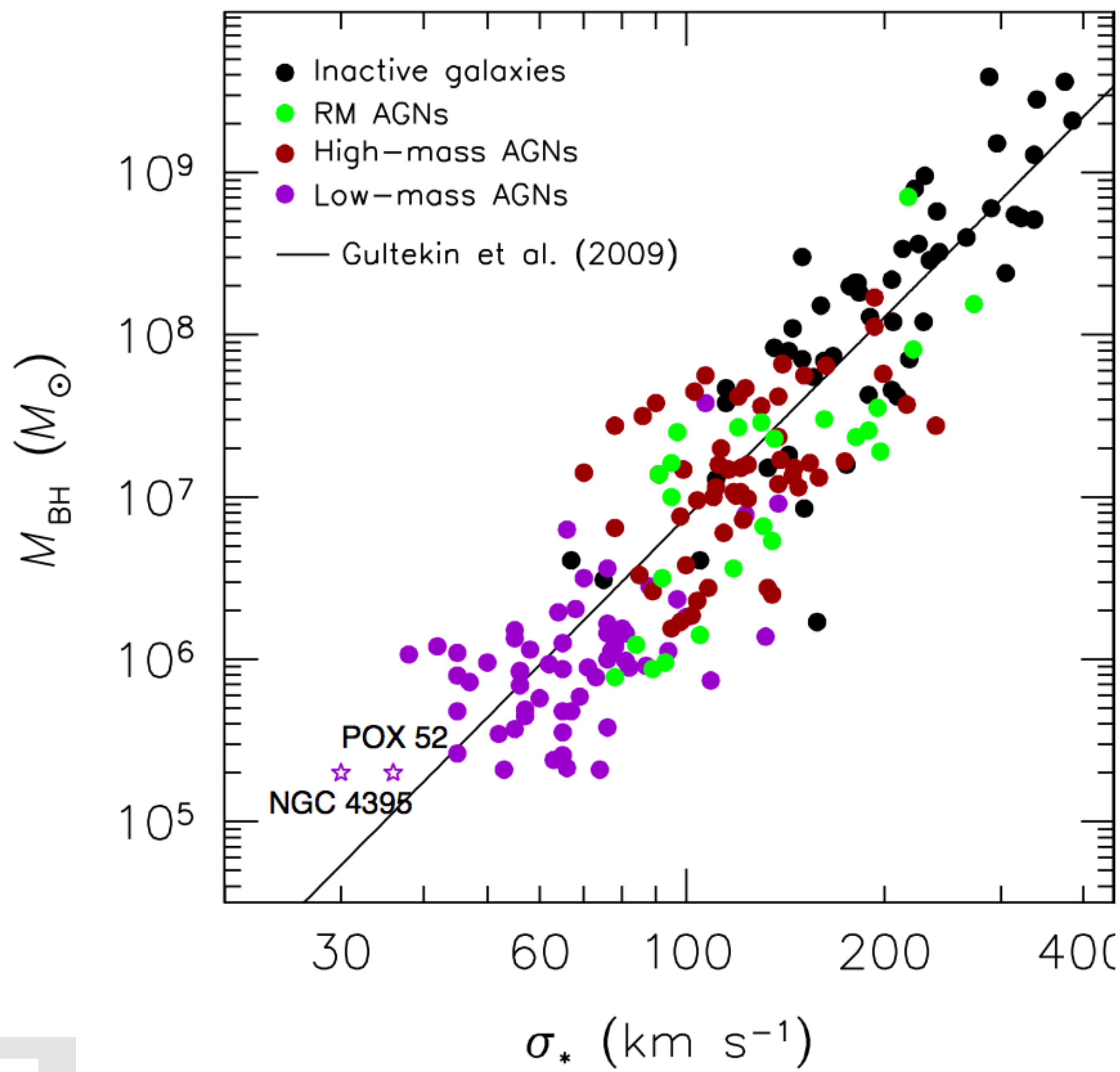




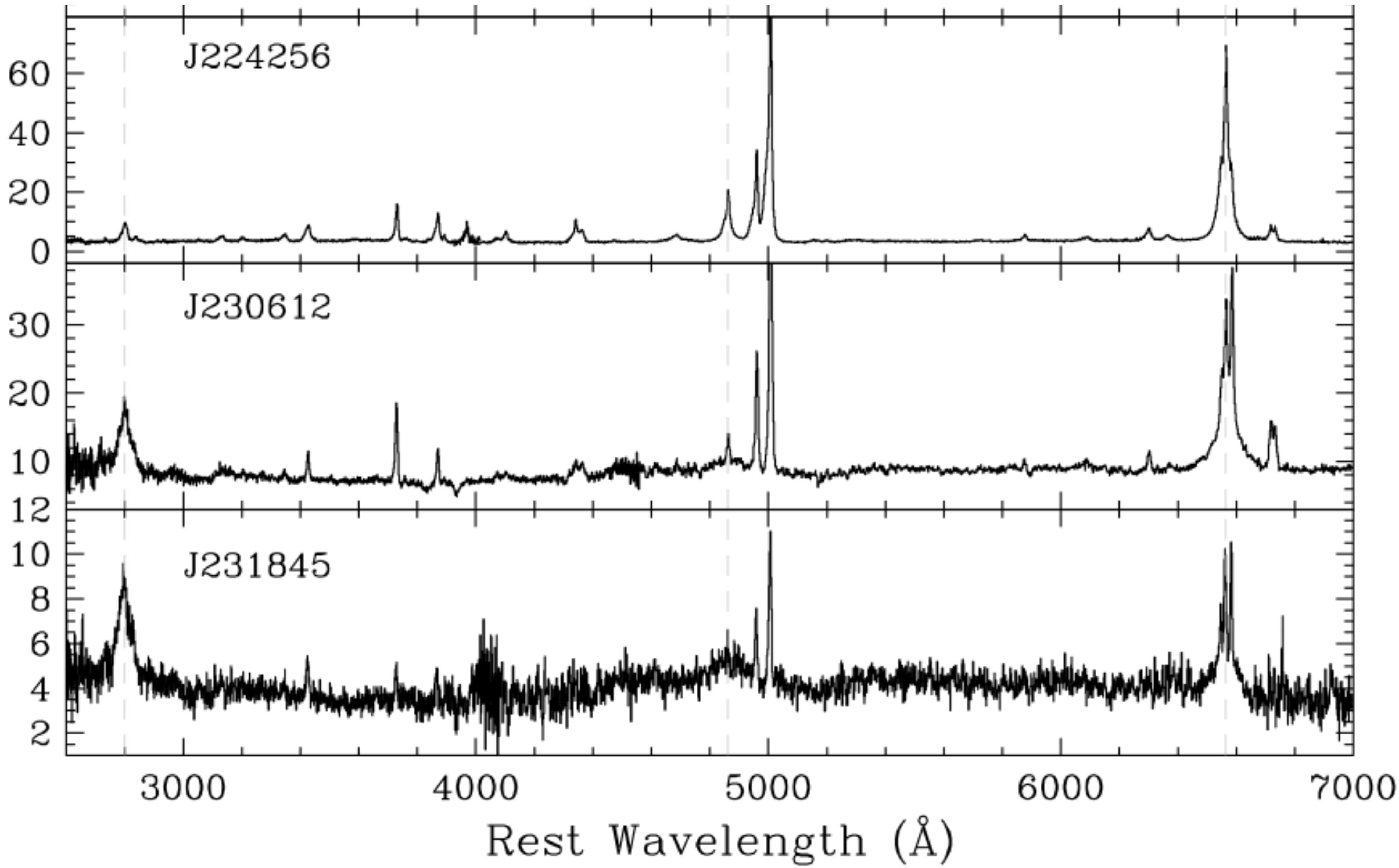
Peterson et al. (2002)

M_{BH} esitmation with empirical relationships

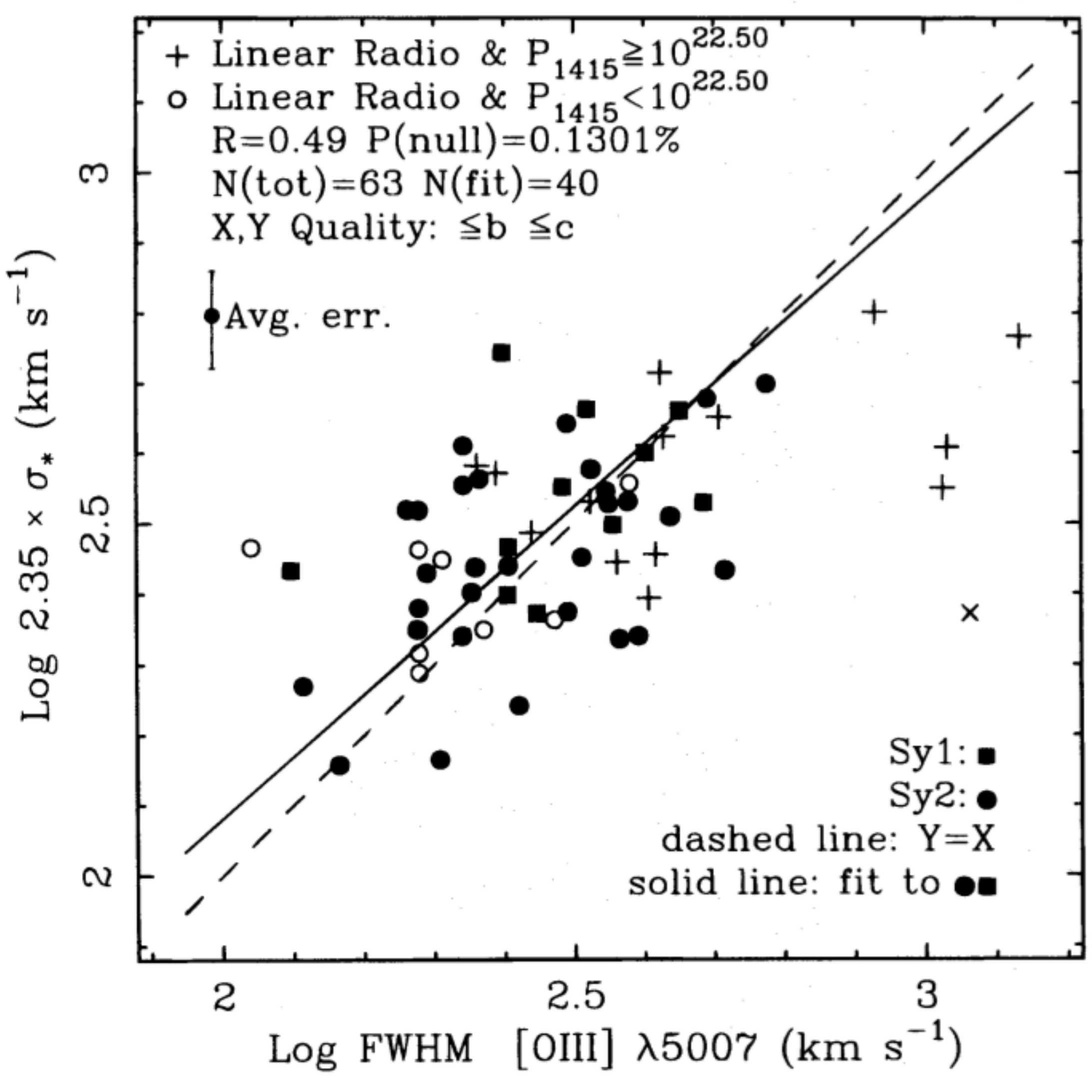




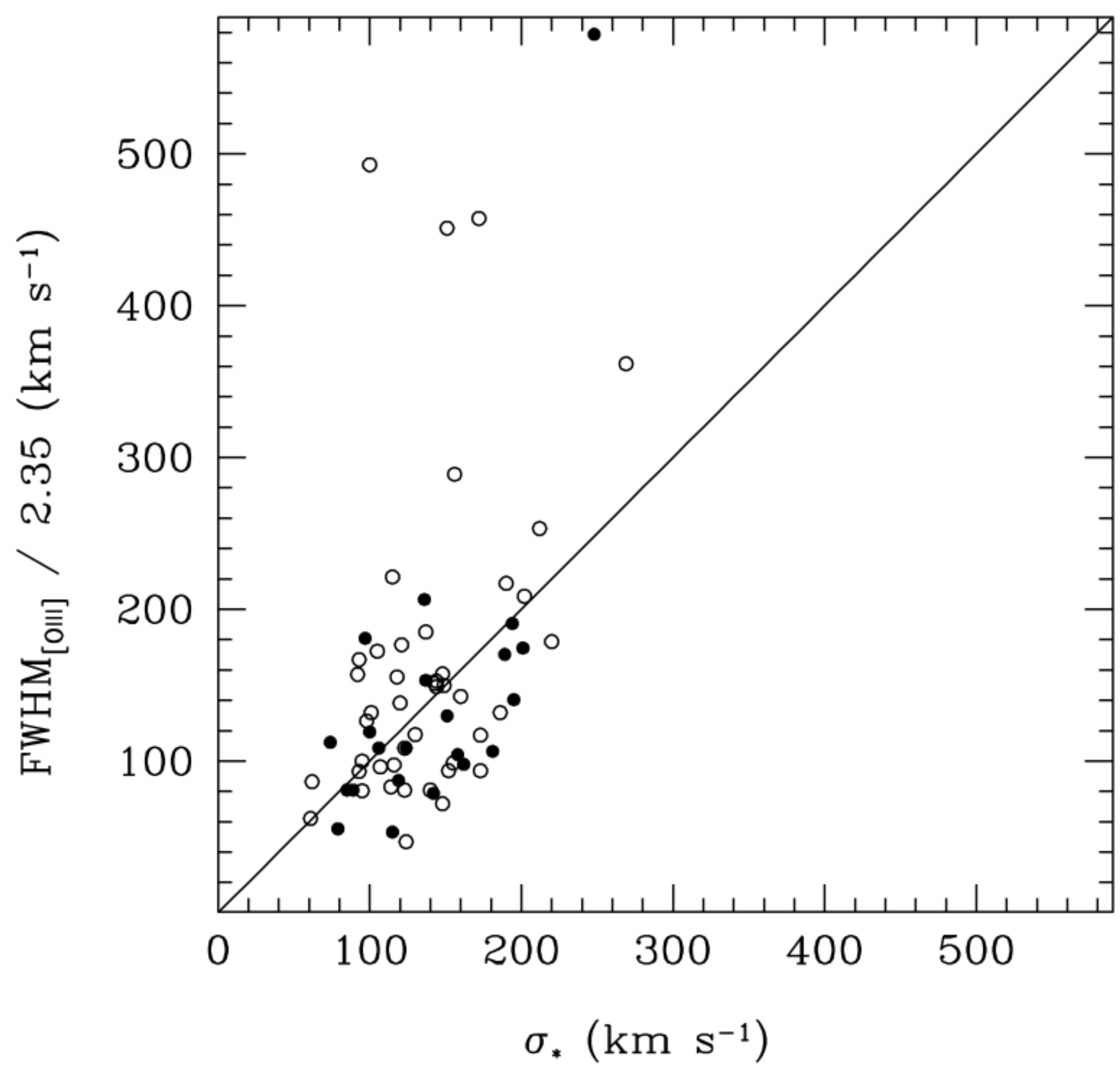
$$\frac{M_{\mathrm{BH}}}{10^{6}\ M_{\odot}} = 4.35\left[\frac{\nu L_{\nu}(5100\ \text{Å})}{10^{44}\ \mathrm{ergs\ s^{-1}}}\right]^{0.7}\left[\frac{\mathrm{FWHM(H}\beta)}{10^{3}\ \mathrm{km\ s^{-1}}}\right]^{2}$$


J224256
J230612
J231845
0
20
40
60
10
20
30
12
10
8
6
4
2
3000
4000
5000
6000
7000
Rest Wavelength (Å)

Relations between gas and stellar velocity dispersion

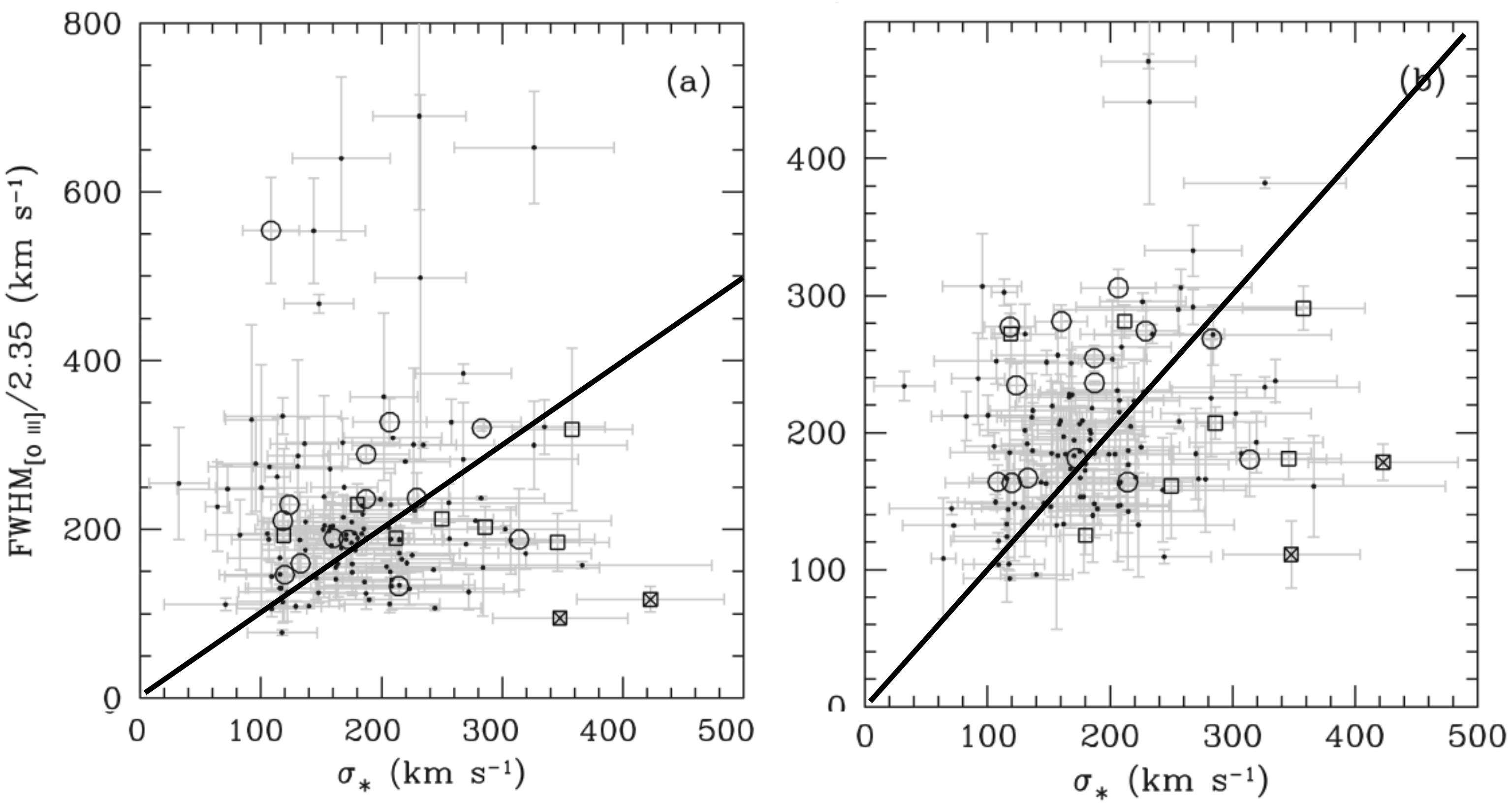


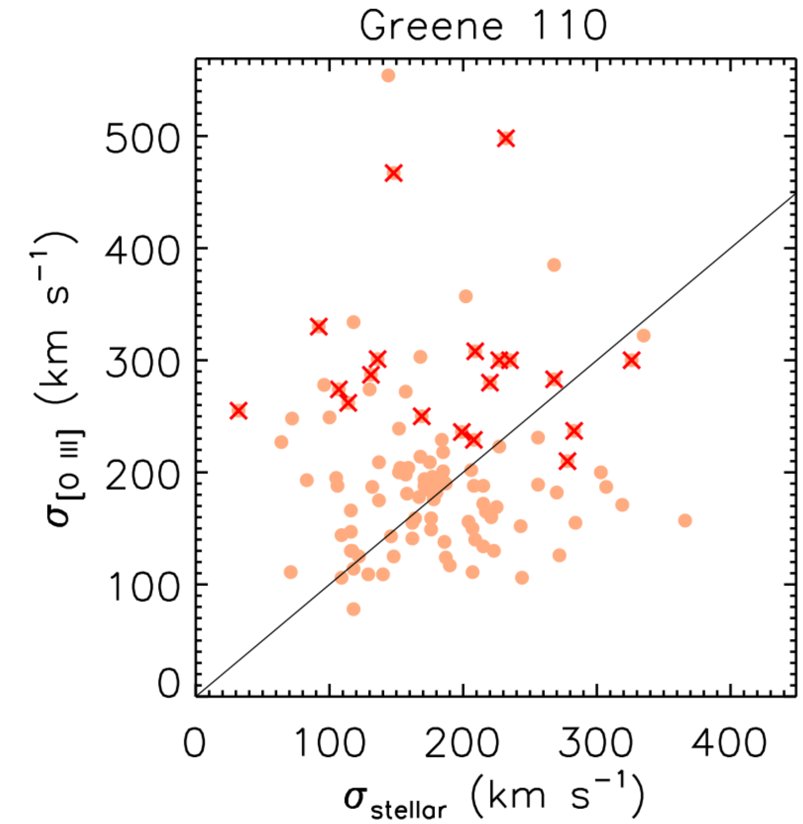
Nelson & Whittle 1996



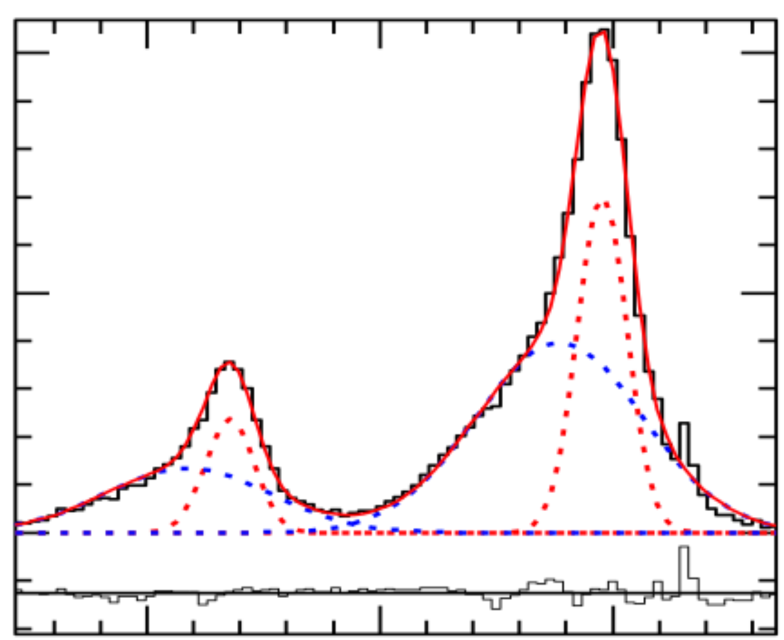
Greene & Ho 2005

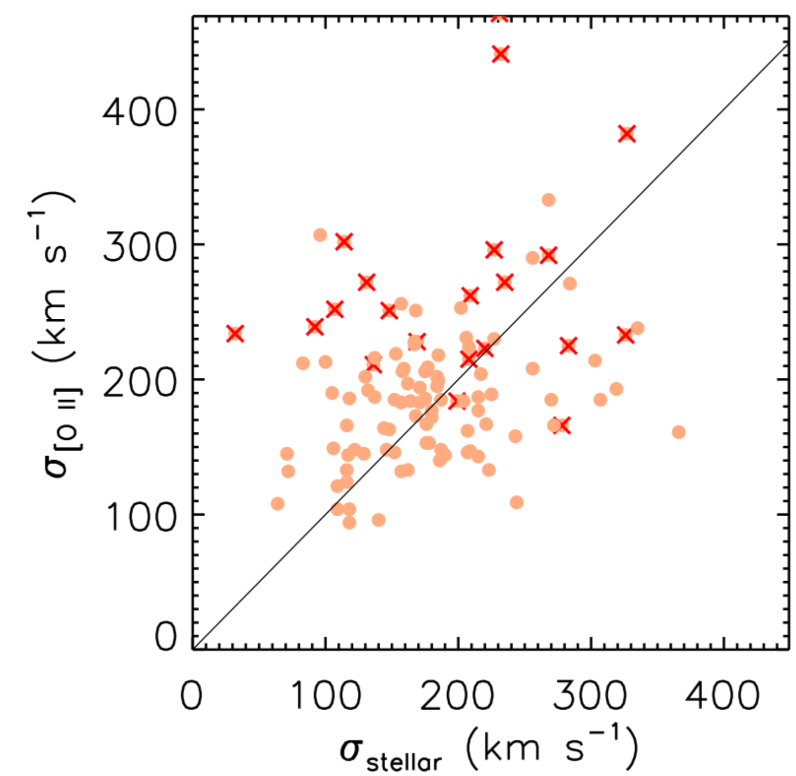
Similar comparison for type 2 Qsos





Greene et al. 2009





- Check the relation for ionized gas velocity disperson of [O II], [O III] and absorption lines in a large sample of type 2 Qsos after removing wing effects

- Check this relation for [S II] low ionization lines

II, Sample and data reduction

Sample selection

SPACE DENSITY OF OPTICALLY SELECTED TYPE 2 QUASARS (Reyes et al. 2008)

- luminosity cut, $L_{[OIII]} > 10^{8.3} L_{\star}$
- z， 0~0.83
- emission line diagnostic criteria of the form suggested by Kewley et al. (2001) to distinguish type 2 quasars from star-forming galaxies and narrow-line AGN

$$\log(\mathcal{R}) > \frac{0.61}{\log([\mathrm{N\,II}]6583/\mathrm{H}\alpha) - 0.47} + 1.19$$

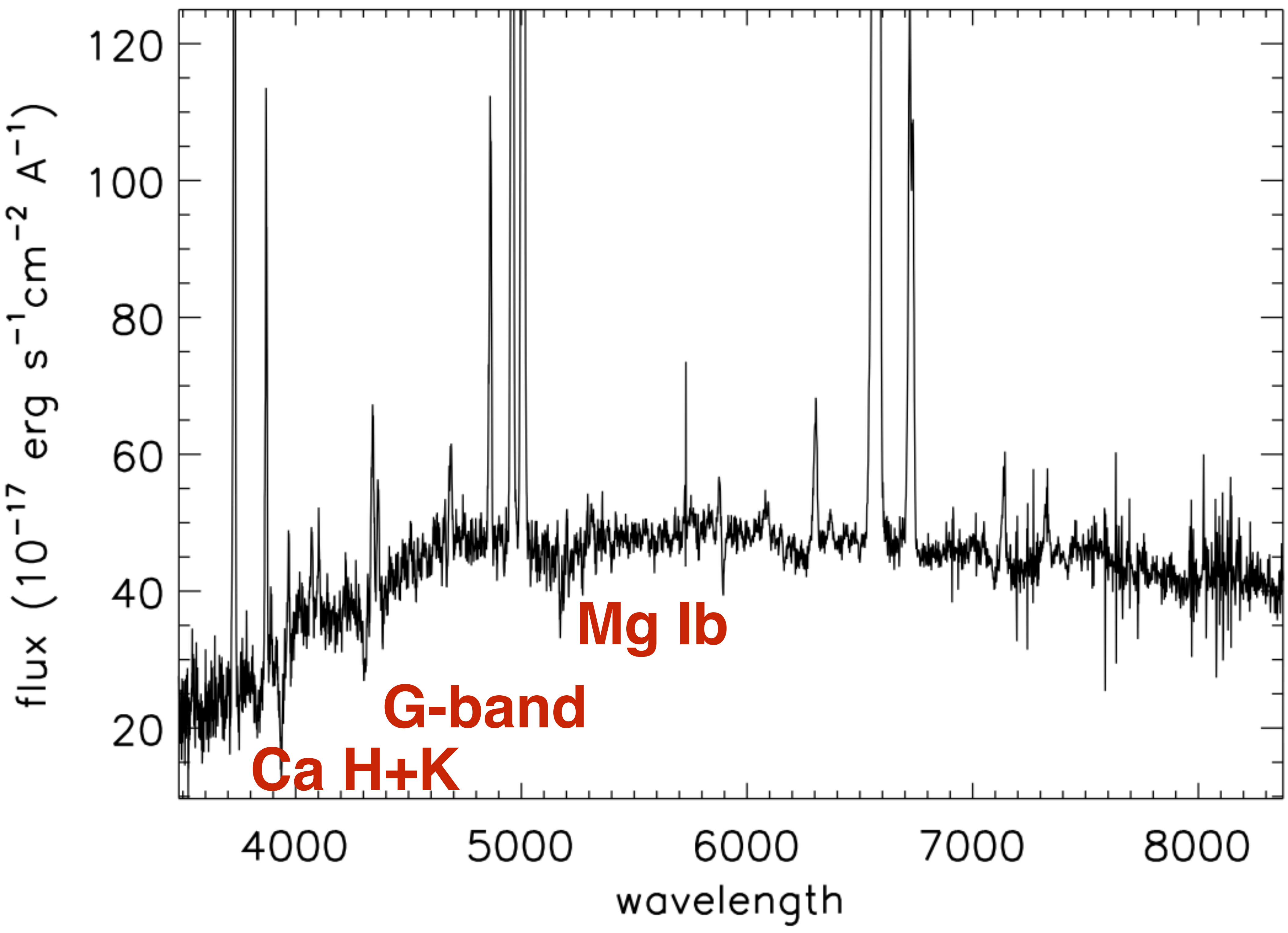
$$\mathcal{R} \equiv [\mathrm{O\,III}]5007/\mathrm{H}\beta$$

$$\log(\mathcal{R}) > \frac{0.72}{\log([\mathrm{S\,II}]/\mathrm{H}\alpha) - 0.32} + 1.30,$$

$\log(\mathcal{R}) > 0.3$, if $\mathrm{H}\beta$ is detected with $S/N > 3$ $\quad 0.36 \leqslant z < 0.83,$

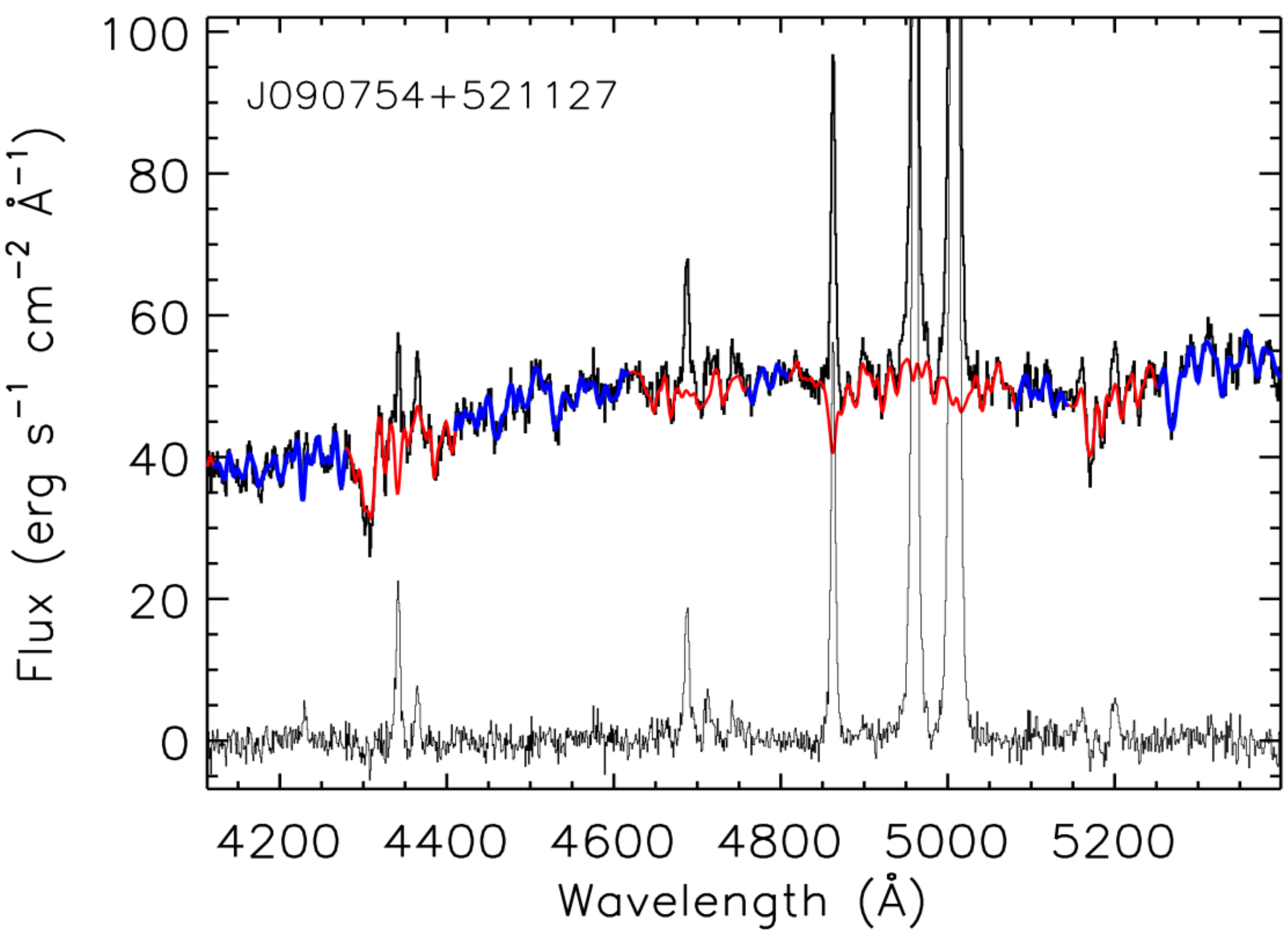
- 887， SDSS DR7

Spectra sample



σ measurements

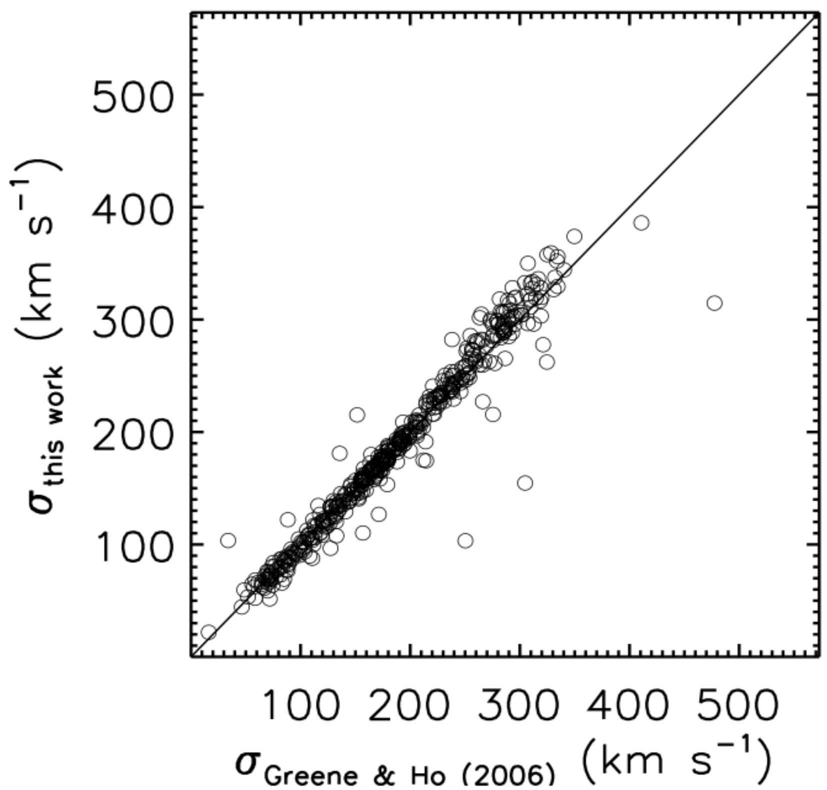
pPXF , CAPPELLARI & EMSELLEM, 1994



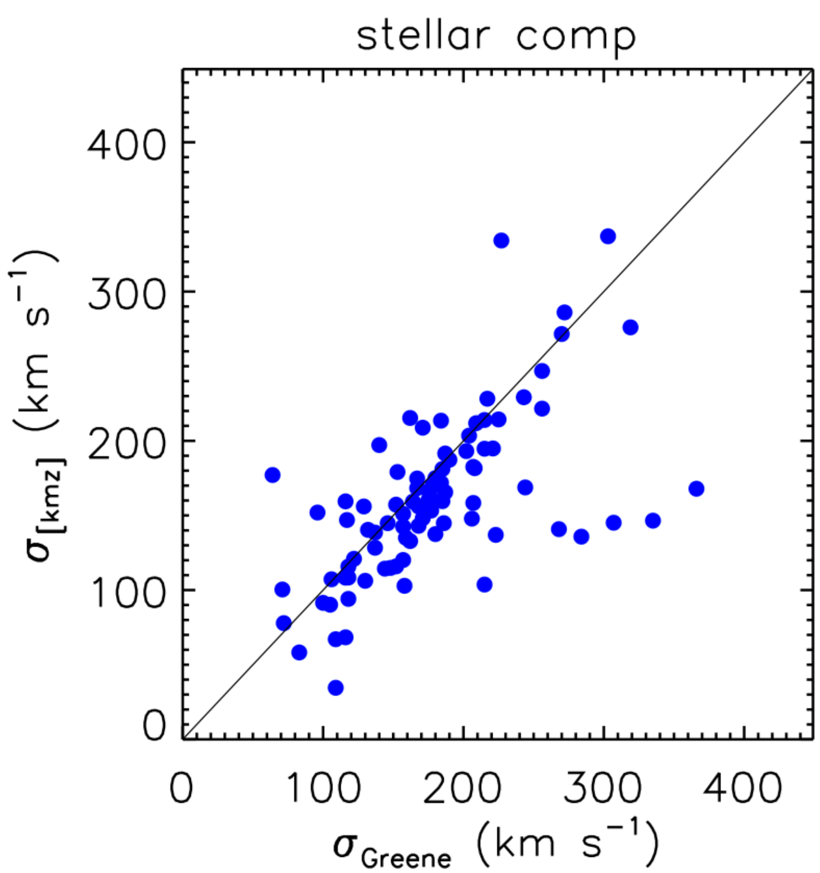
- galactic extinction
- redshift correction
- mask emision lines (800 km s^{-1})
- stellar measurements *(stellar library: Valdes et al. 2004)*

$$M_{mod}(x) = P(x)\ \{\sum_{j=1}^{N} w_j\ [T_j(x) \otimes G(x)]\} + C(x)$$

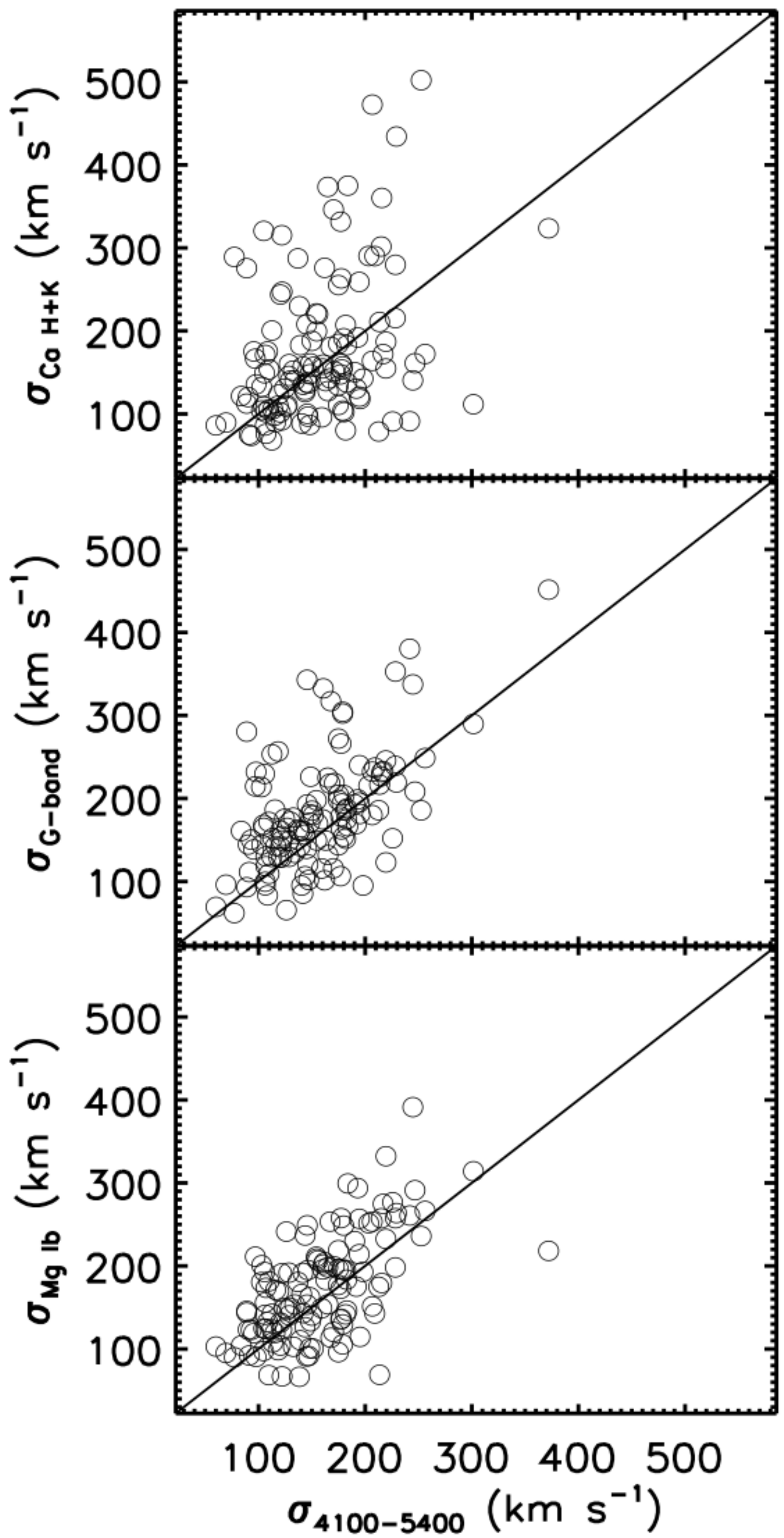
Data check



$\sigma_{\text{this work}}$ (km s^{-1})
$\sigma_{\text{Greene \& Ho (2006)}}$ (km s^{-1})

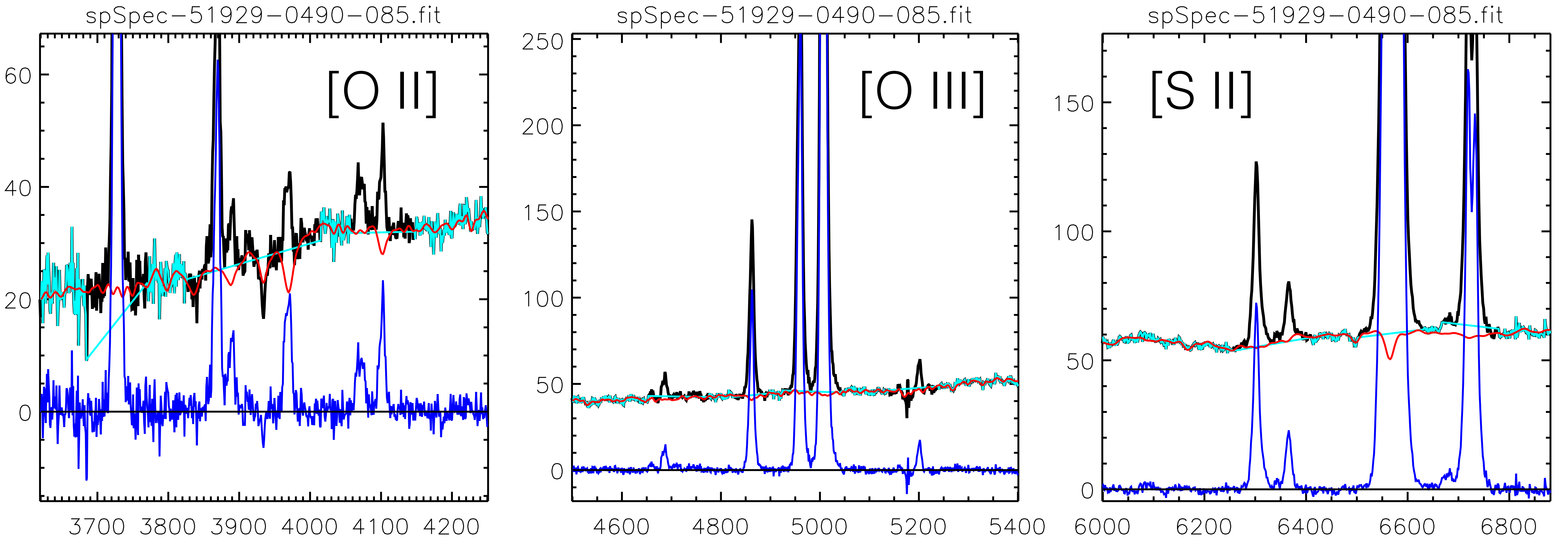


stellar comp
$\sigma_{[\text{kmz}]}$ (km s^{-1})
σ_{Greene} (km s^{-1})

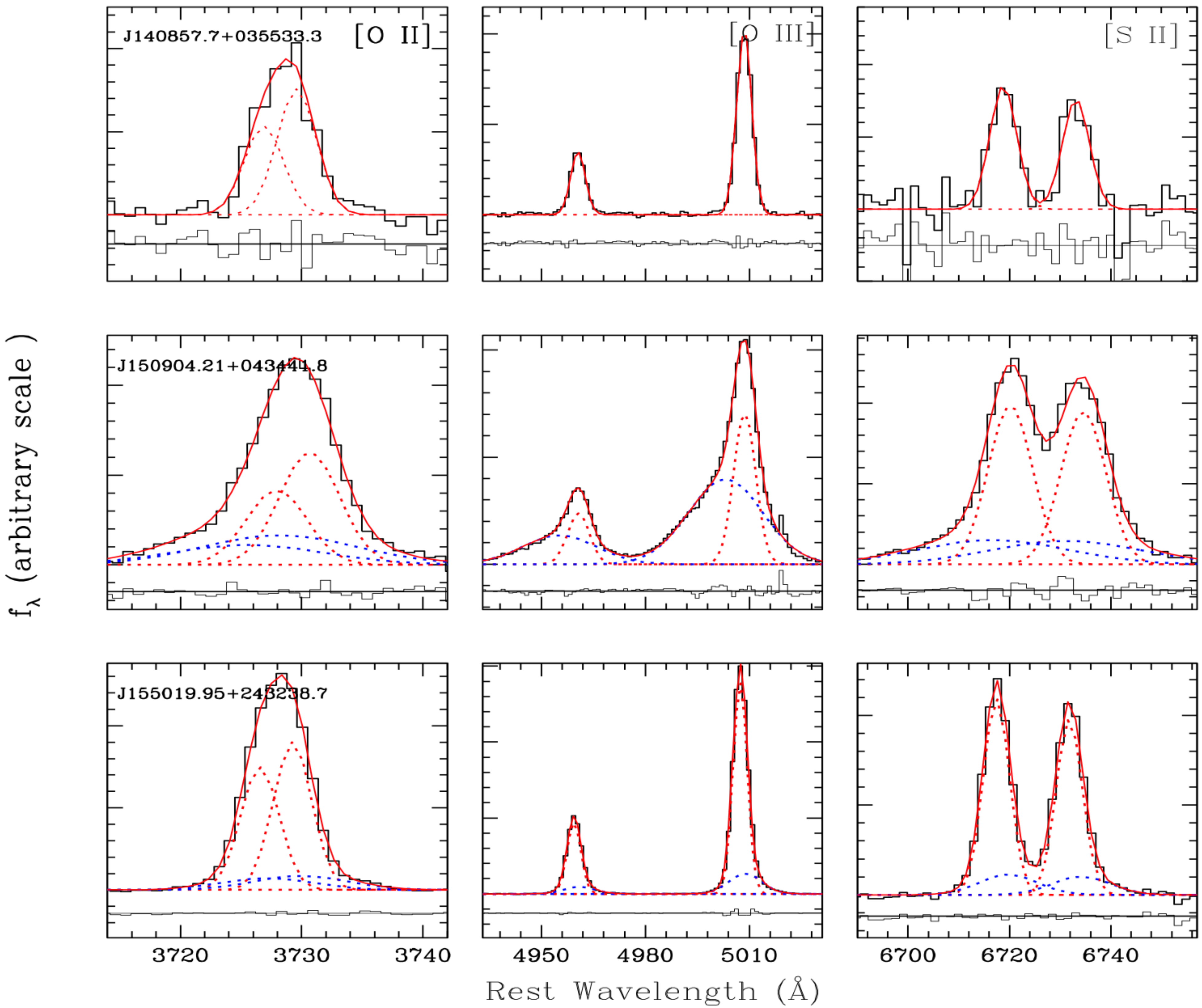


$\sigma_{\text{Ca H+K}}$ (km s^{-1})
$\sigma_{\text{G-band}}$ (km s^{-1})
$\sigma_{\text{Mg Ib}}$ (km s^{-1})
$\sigma_{4100-5400}$ (km s^{-1})

Emission line measurements

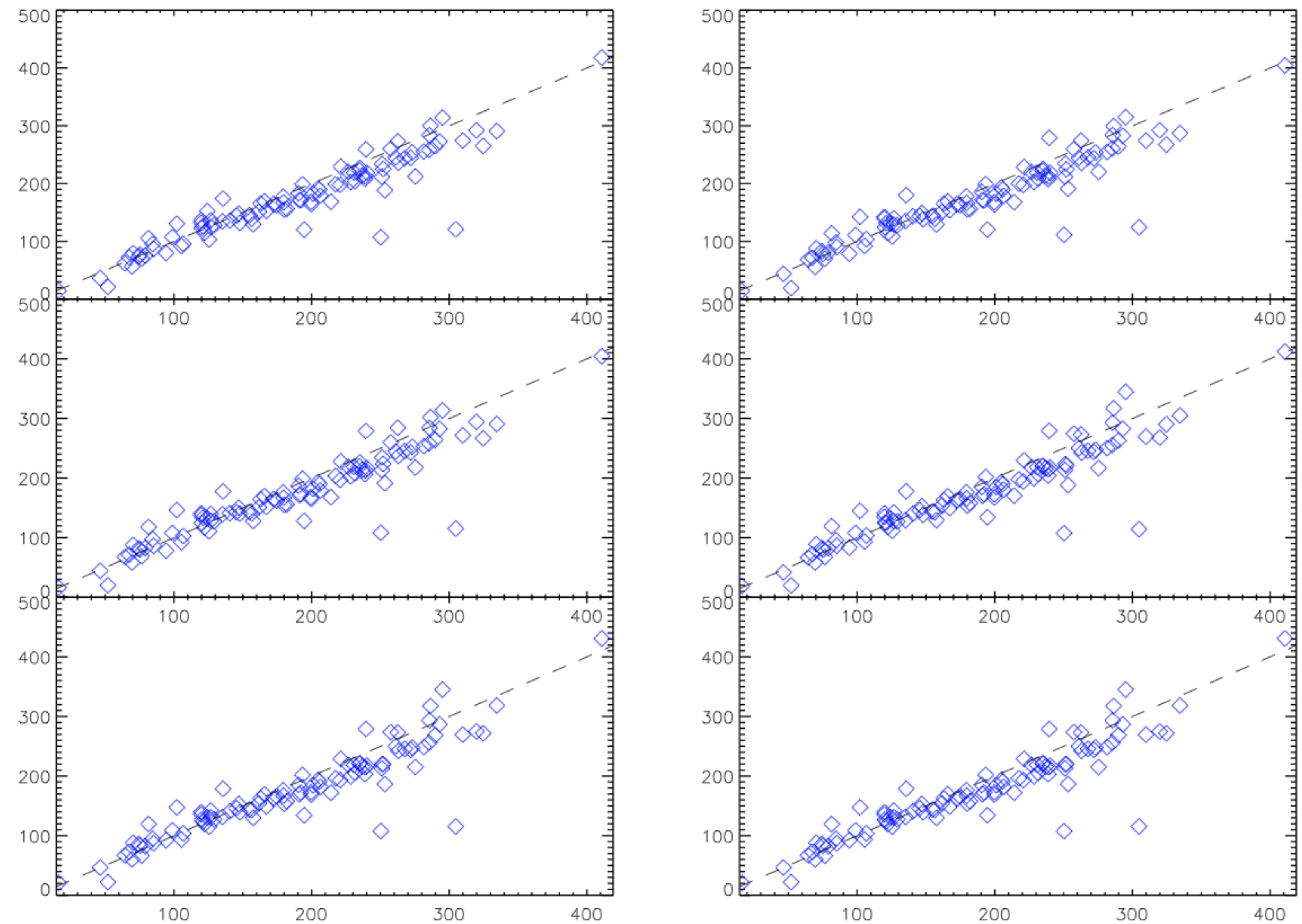


Emission line fitting



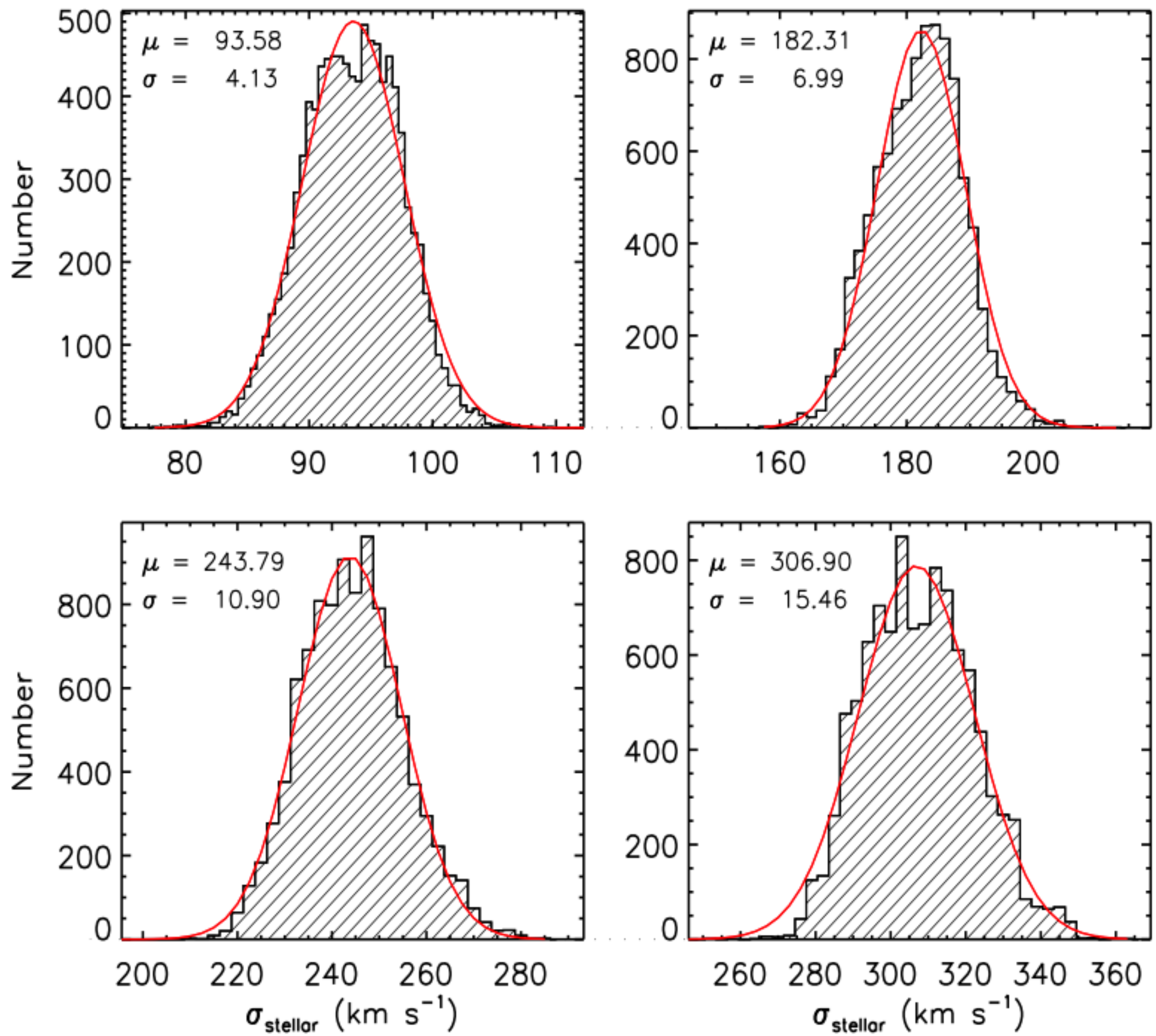
Measurement uncertainties

order of P(x),C(x)

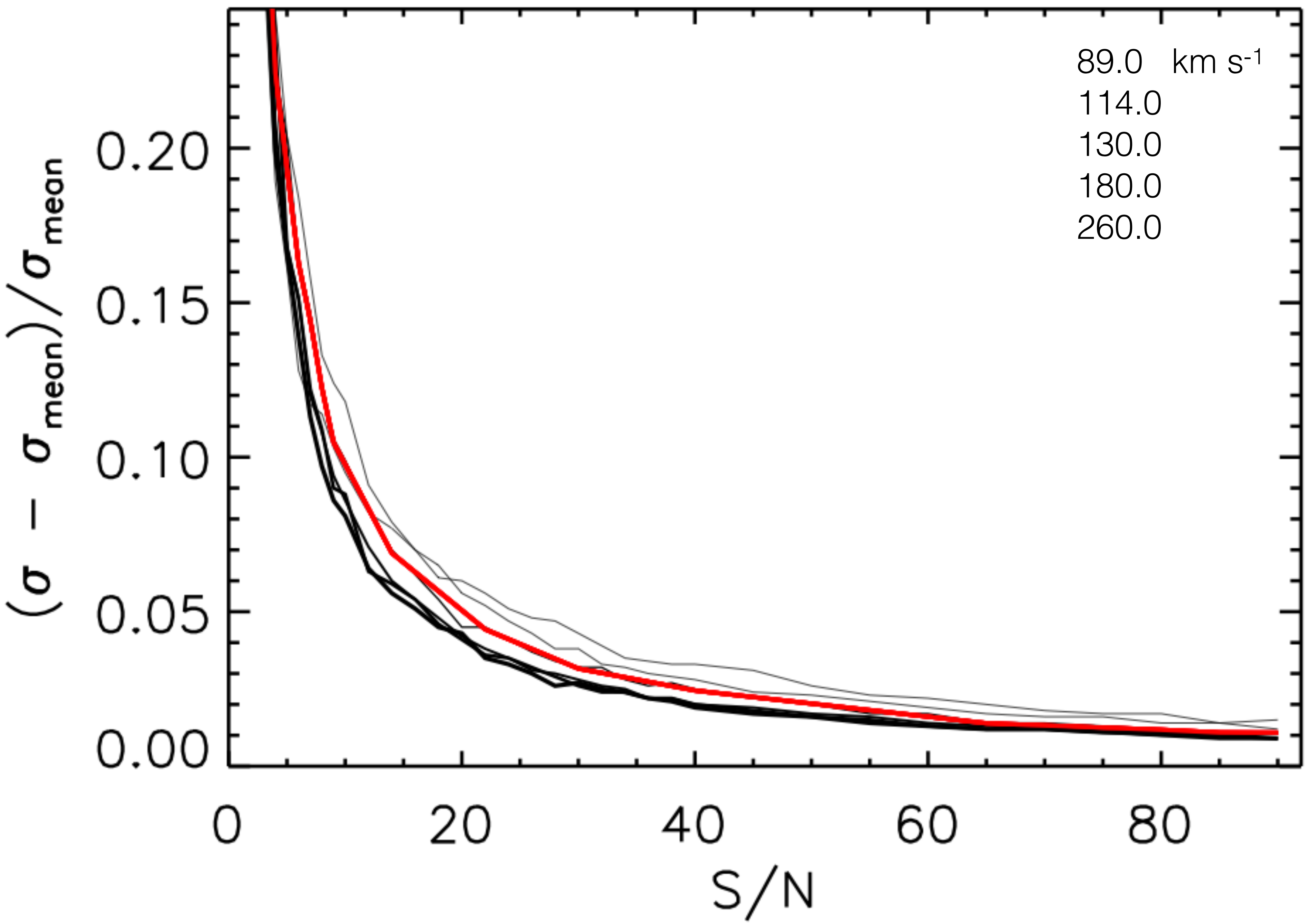


$$M_{mod}(x) = P(x)\ \{\sum_{j=1} w_j\ [T_j(x)\ \otimes\ G(x)]\} + C(x)$$

Stellar template mismatch

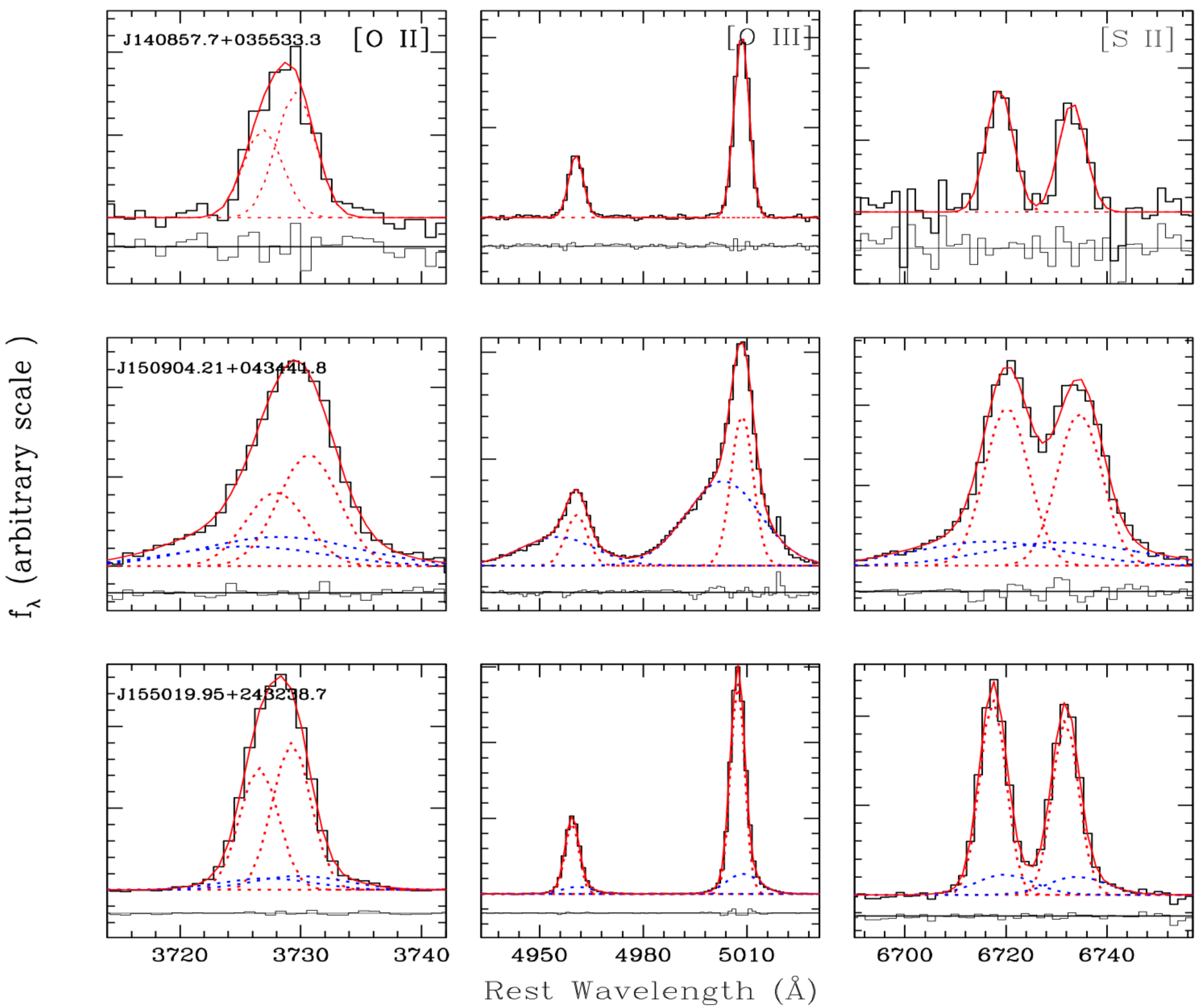


S/N

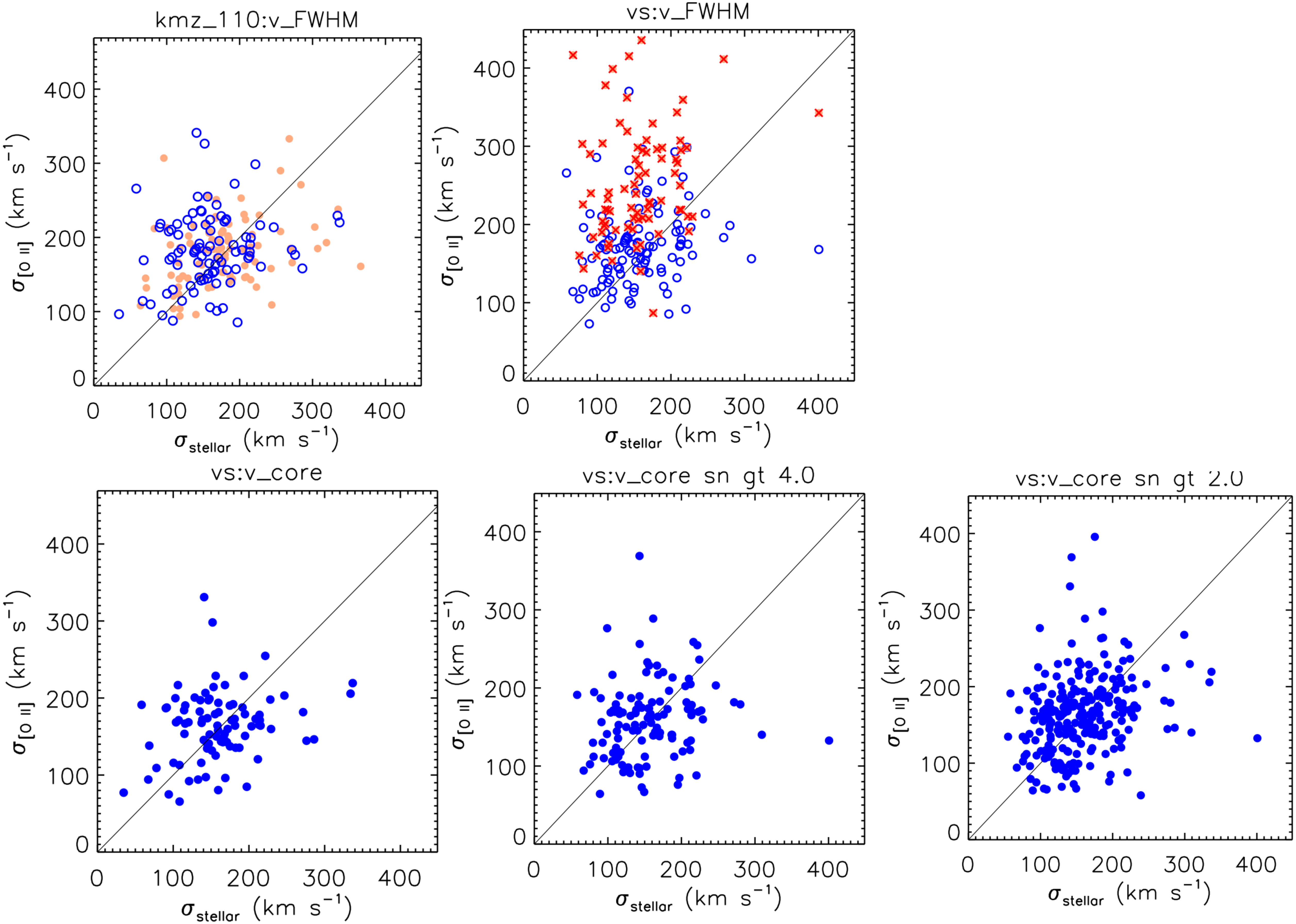


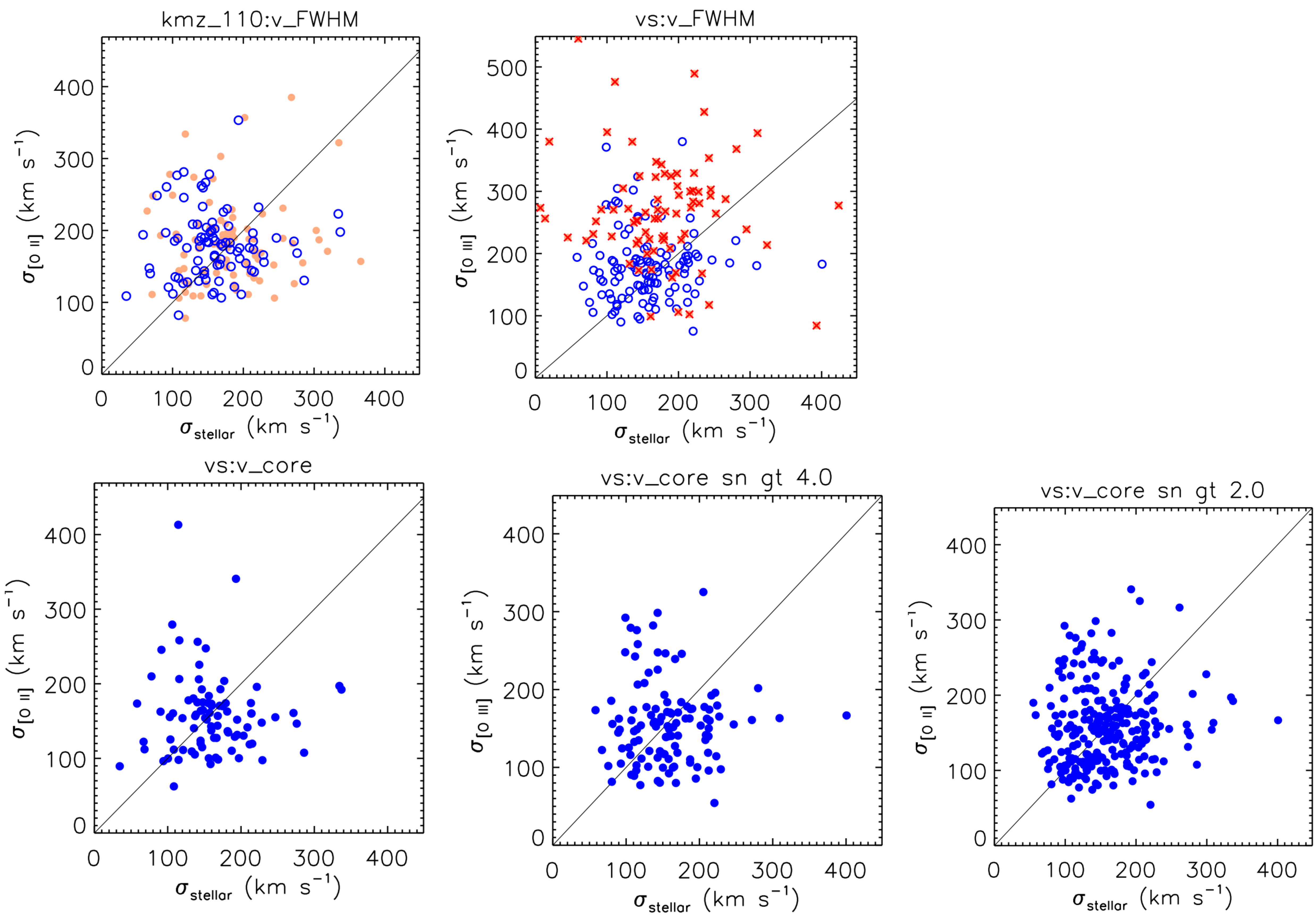
$$\sigma_{err} = \sqrt{\sigma_{err1}^{\ 2} + \sigma_{err2}^{\ 2} + \sigma_{err3}^{\ 2}}$$

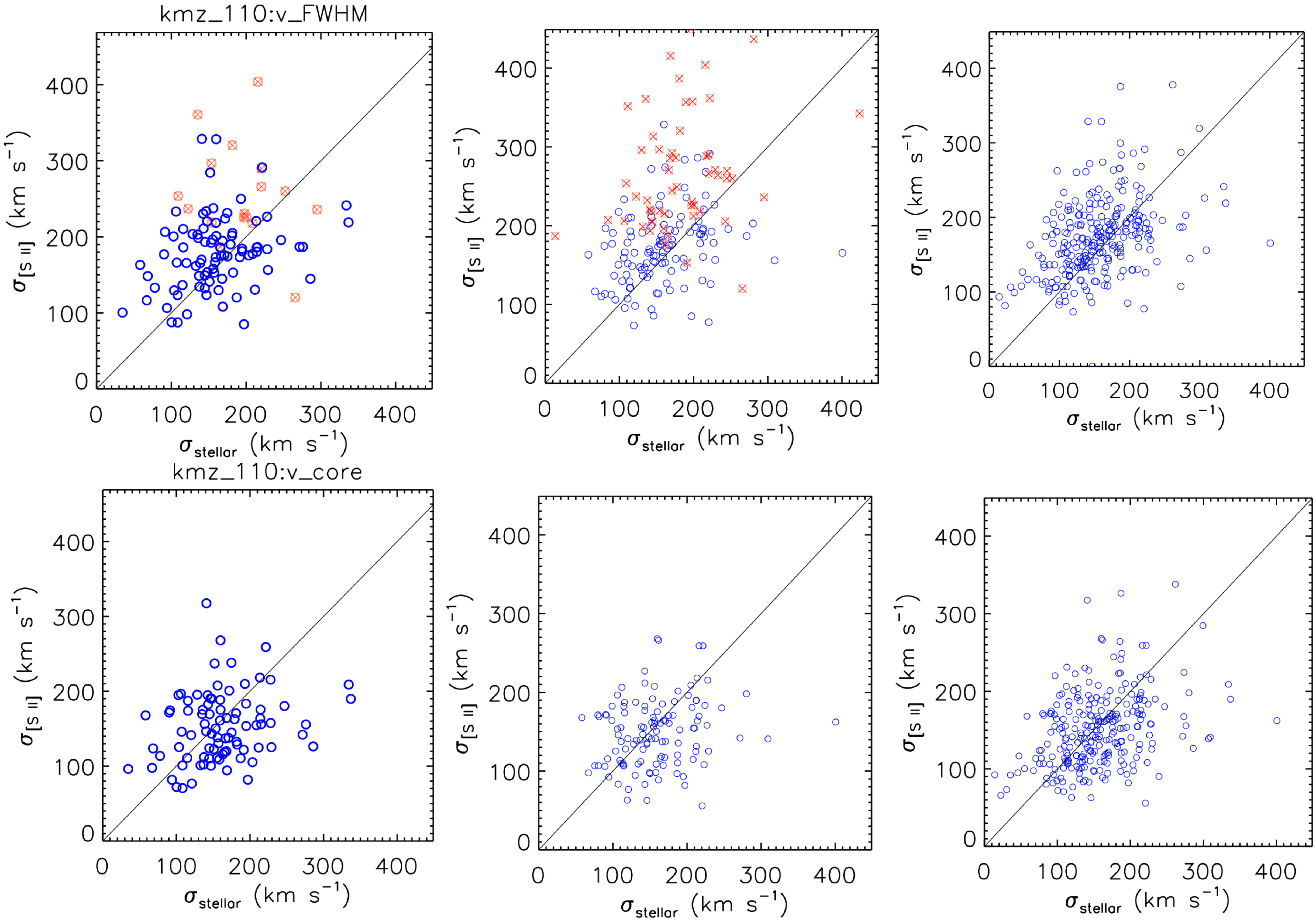
Measurement uncertainties for emission lines



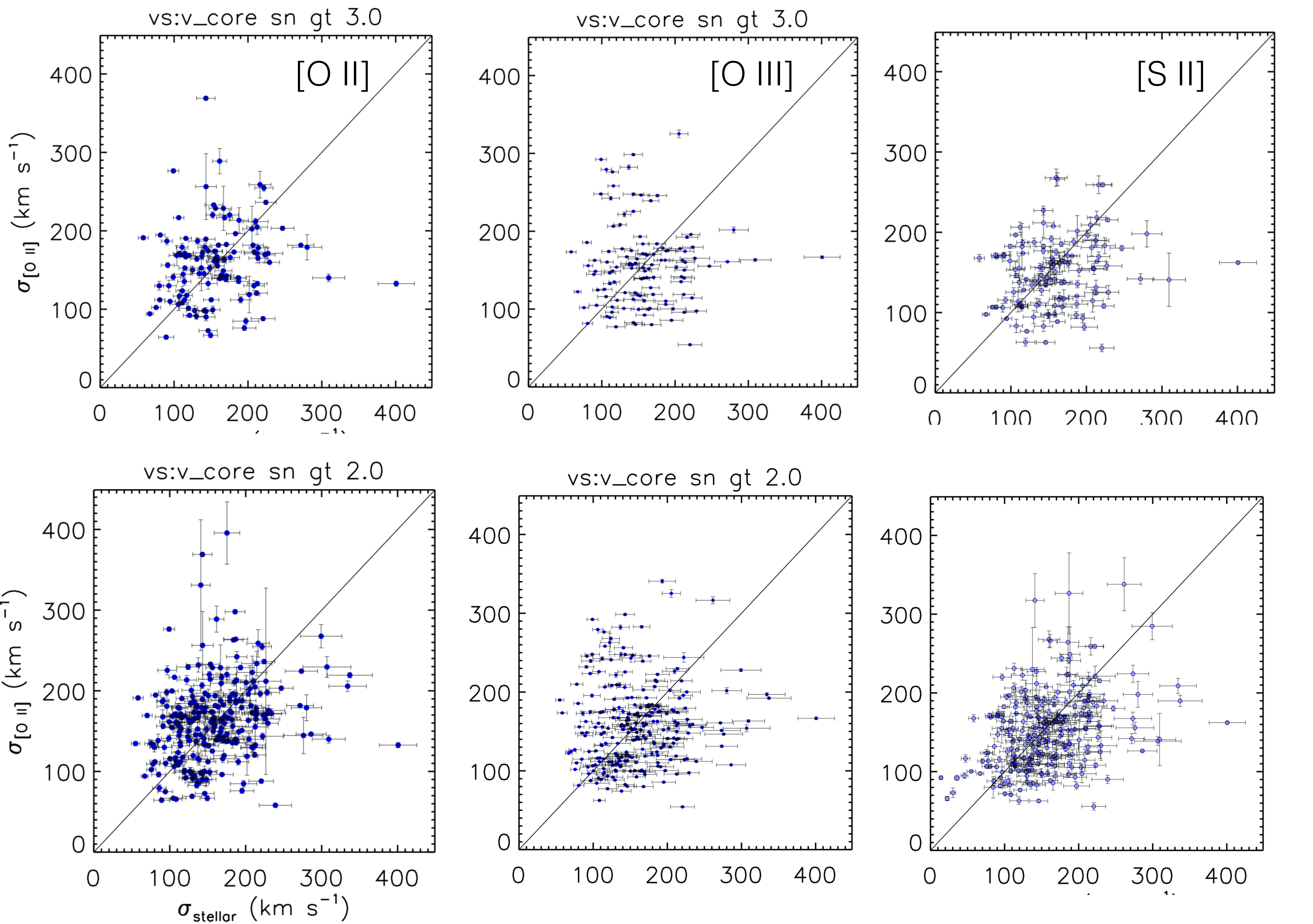
III, Results


kmz_110:v_FWHM
vs:v_FWHM
vs:v_core
vs:v_core sn gt 4.0
vs:v_core sn gt 2.0
$\sigma_{[O\ II]}$ (km s^{-1})
$\sigma_{stellar}$ (km s^{-1})
0
100
200
300
400


kmz_110:v_FWHM
vs:v_FWHM
vs:v_core
vs:v_core sn gt 4.0
vs:v_core sn gt 2.0
σ[O II] (km s−1)
σ[O III] (km s−1)
σstellar (km s−1)
0
100
200
300
400
500



kmz_110:v_FWHM
kmz_110:v_core
σ[S II] (km s^-1)
σstellar (km s^-1)
0
100
200
300
400


vs:v_core sn gt 3.0
[O II]
vs:v_core sn gt 3.0
[O III]
[S II]
vs:v_core sn gt 2.0
vs:v_core sn gt 2.0
$\sigma_{[O\ II]}$ (km s^{-1})
$\sigma_{stellar}$ (km s^{-1})
0
100
200
300
400

Conclusions

- the line width of low ionization lines [S II], [O II] could roubstly represent for stellar velocity dispersions, with a scatter about 40% after removing the wing effects

- Some objects of [O III] are outliers

- M_{BH} estimation for this sample using those three kinds of emission lines based on spectra quality (next step work)