M_{BH} estimation
— for type 2 Qsos

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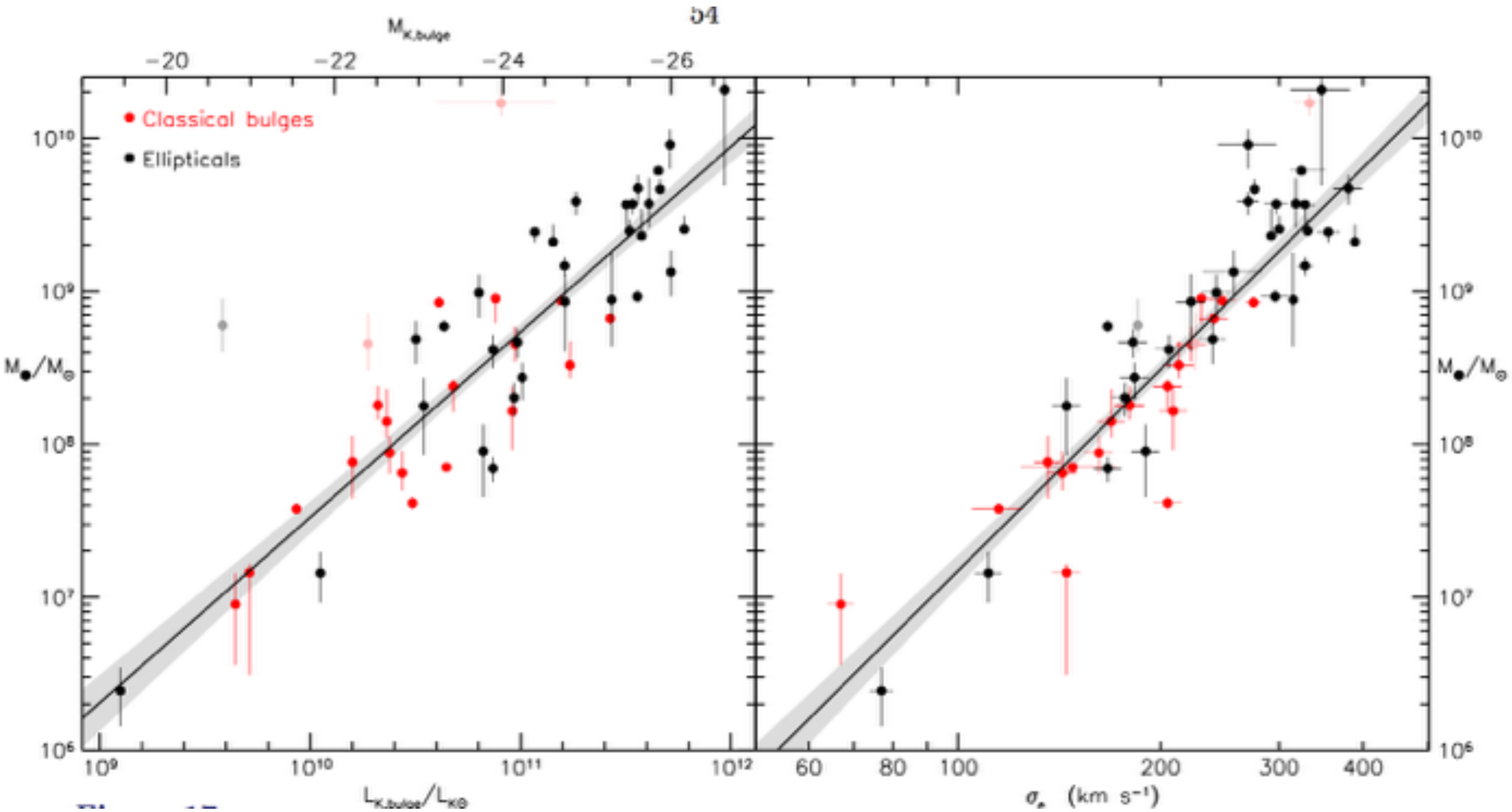
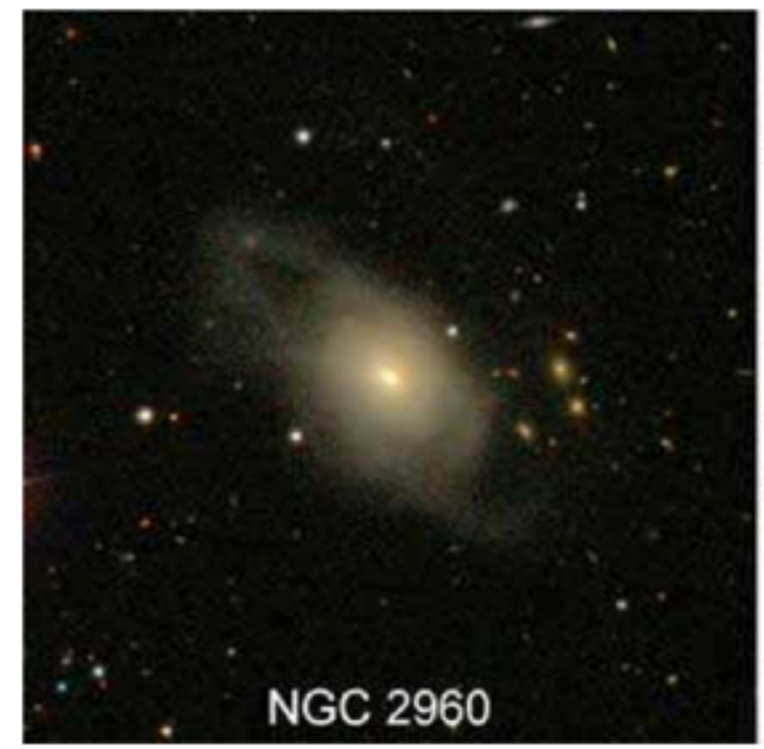
2014.08.1, KIAA.PKU

I, Background

Inportance of M_{BH} investigation

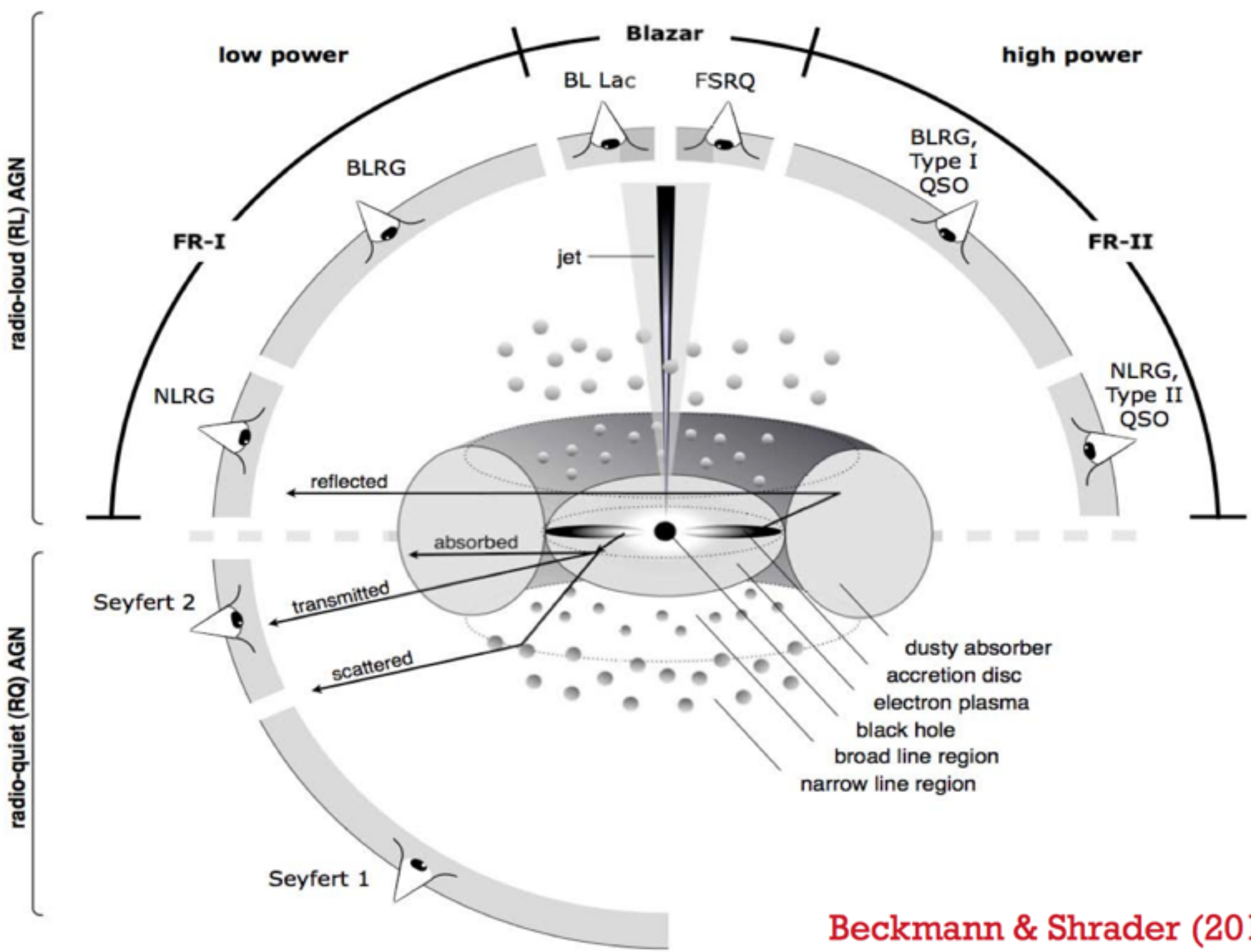
- there almost exist a BH in each center of AGNs/galaxies
- growth coevolution of BHs—galaxy





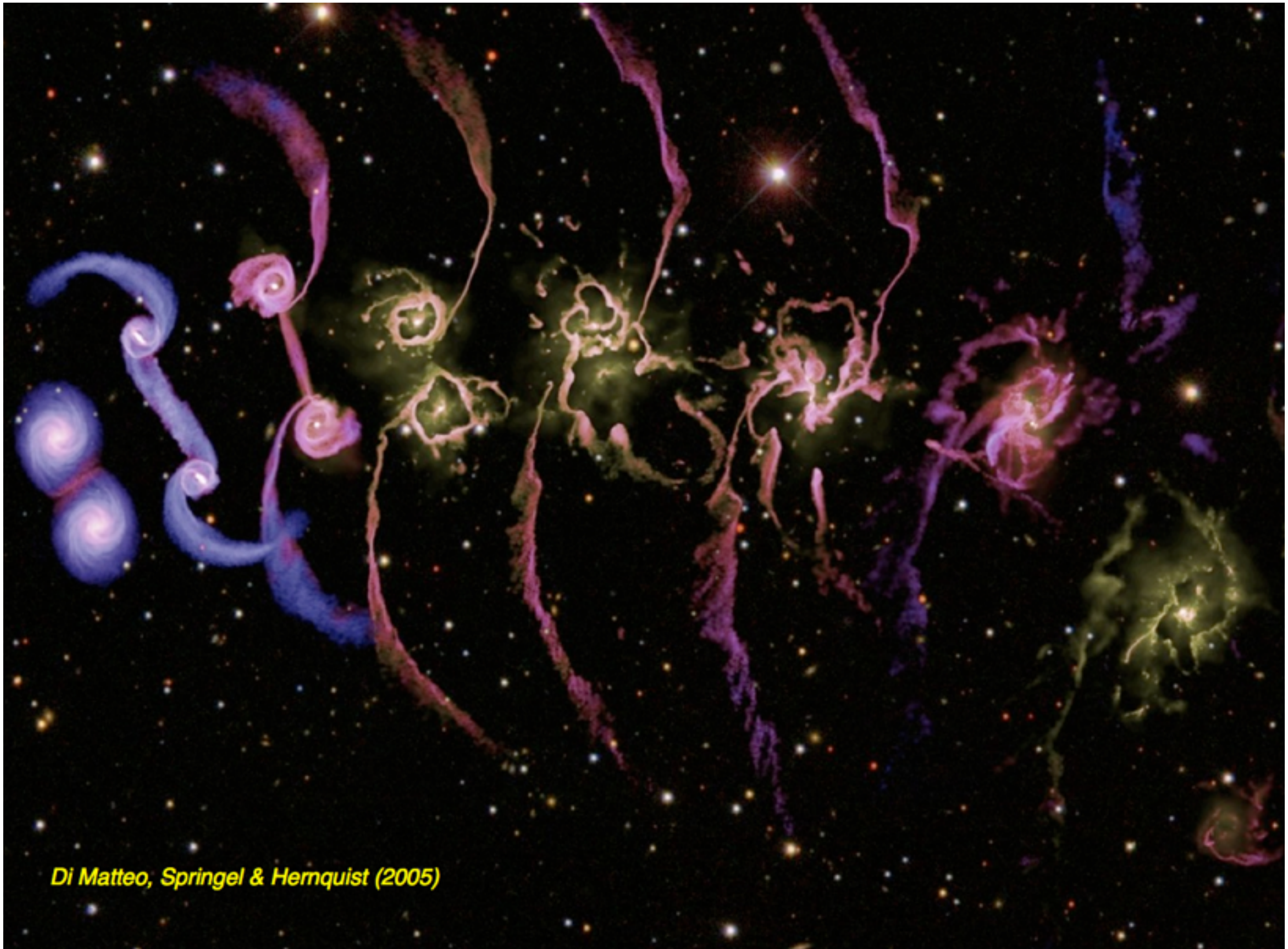
Kormendy & Ho 2014

Why is for type 2 Qsos



Beckmann & Shrader (2012)

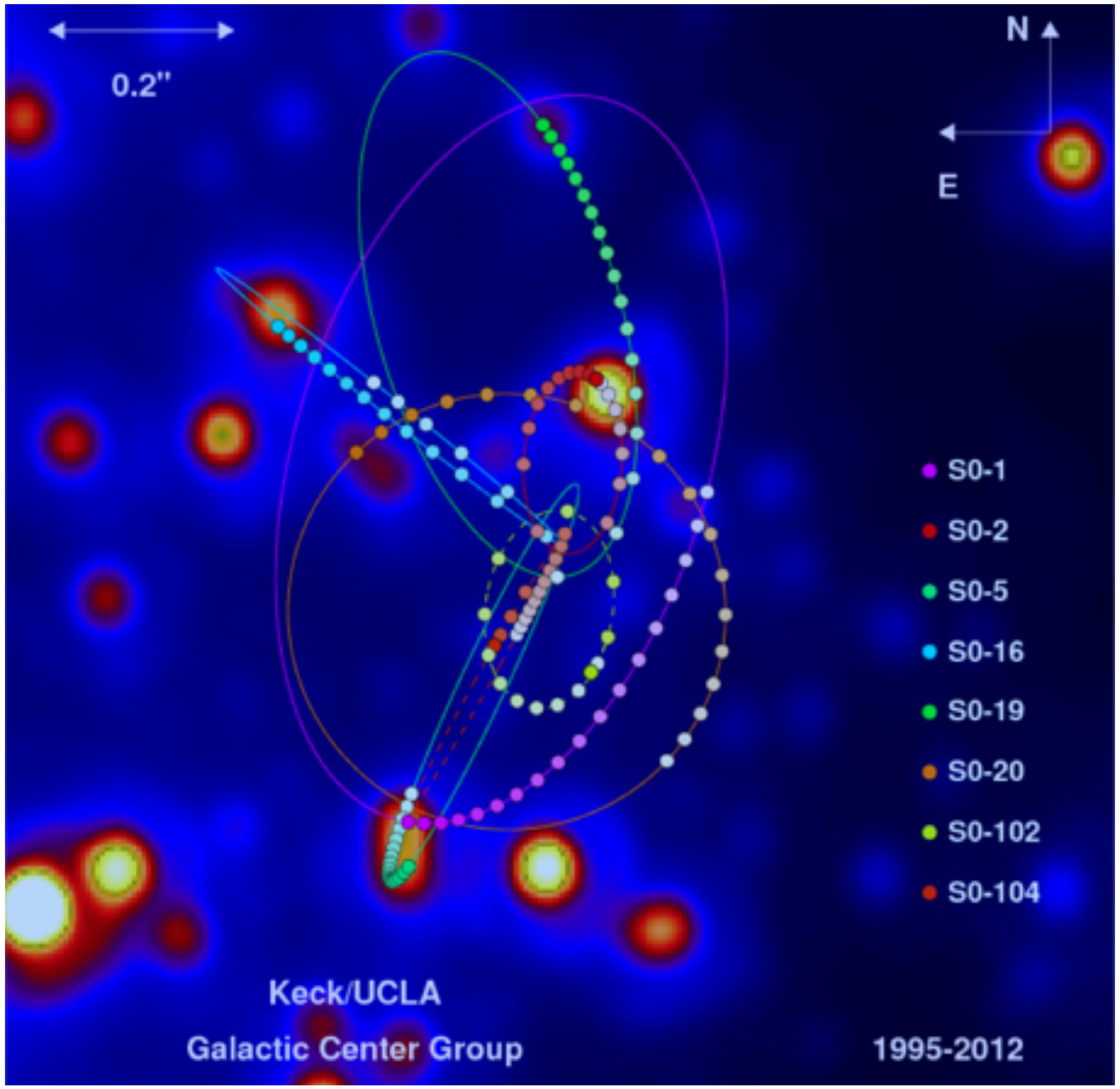
Coevolution of AGNs/host galaxy



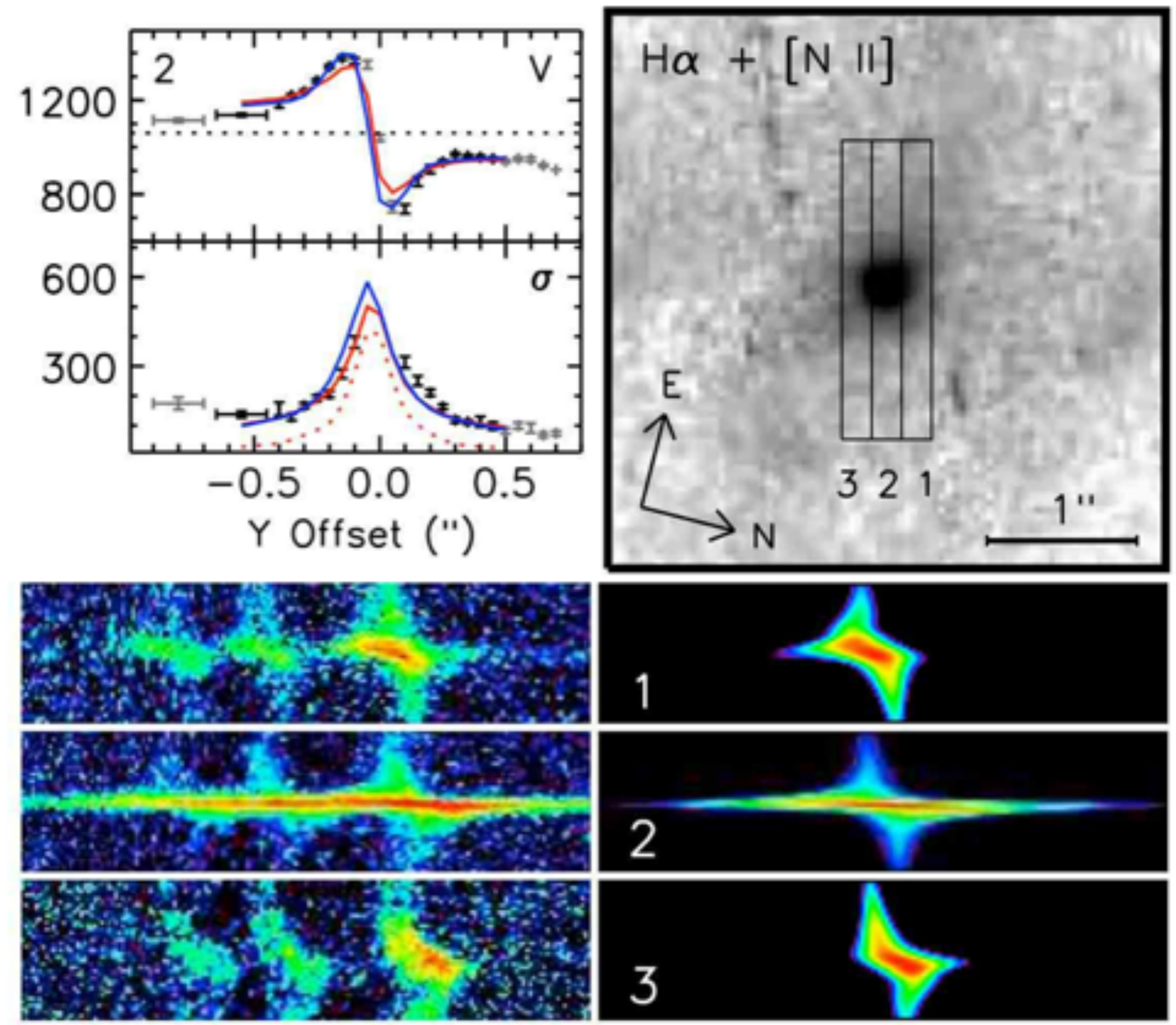
Methods of M_{BH} estimation I

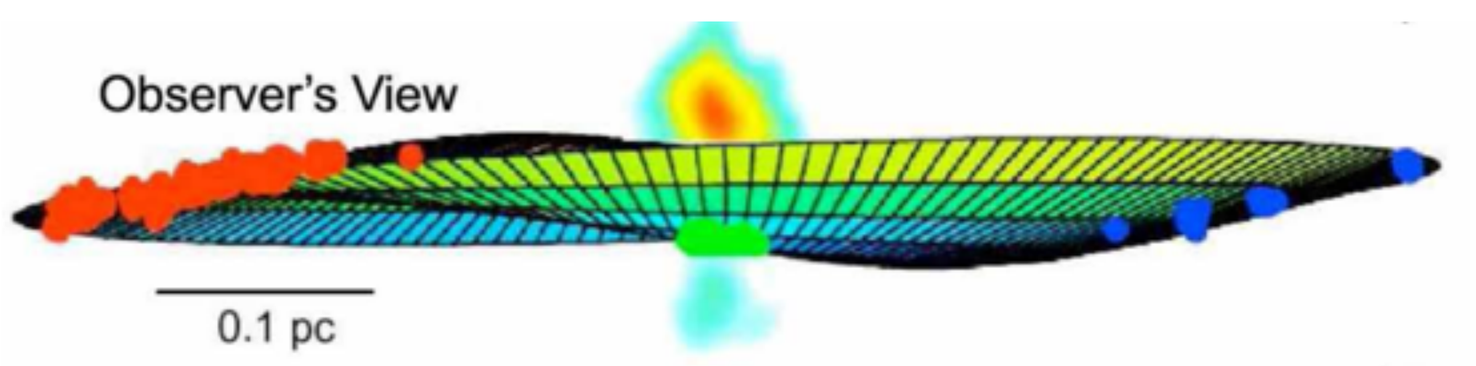
— Dynamics

• stellar dynamics



• ionized gas dynamics





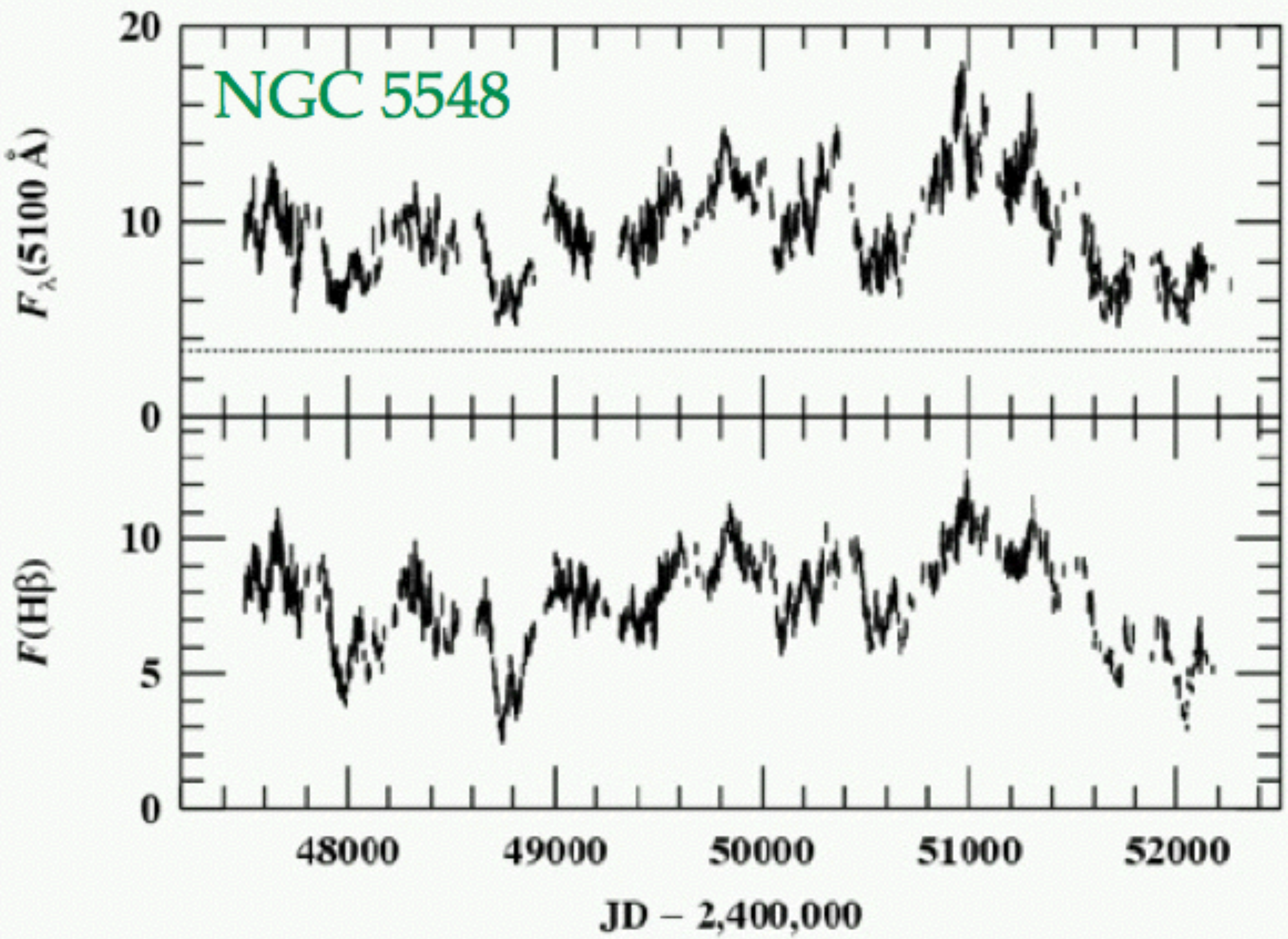
• maser dynamics

Methods of M_{BH} estimation II

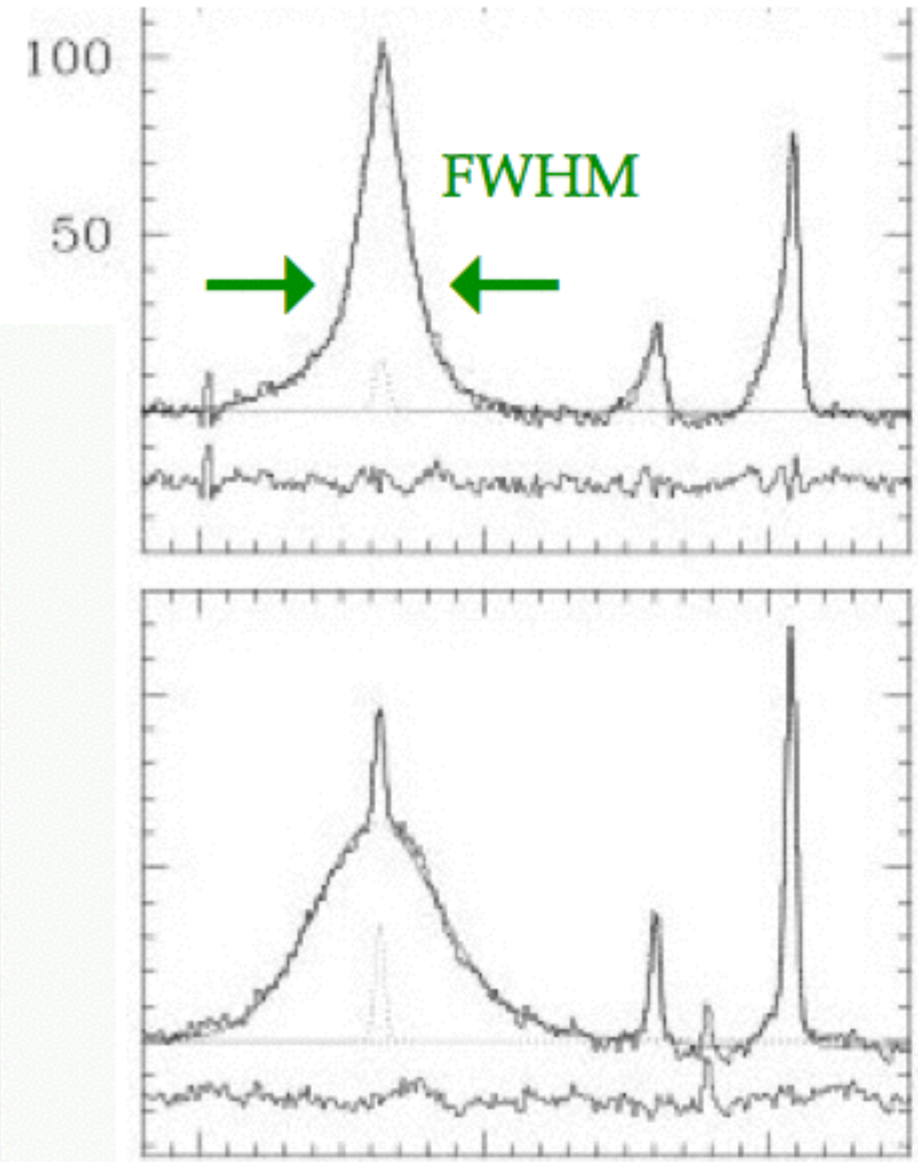
— Reverberation mapping

M_{BH} esitmation for type 1 AGNs

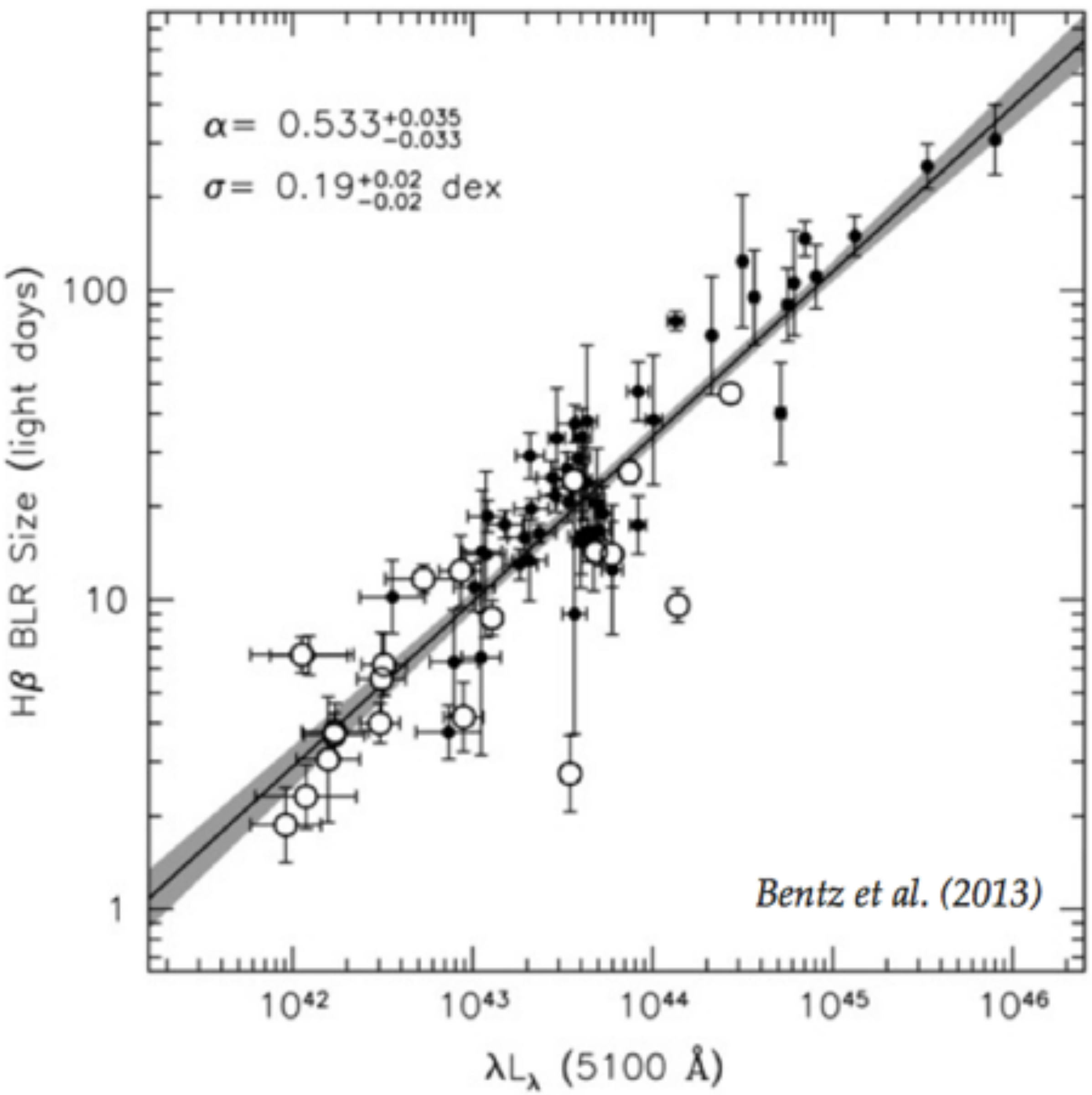
$$M_{virial} = f\,RV^2/G$$

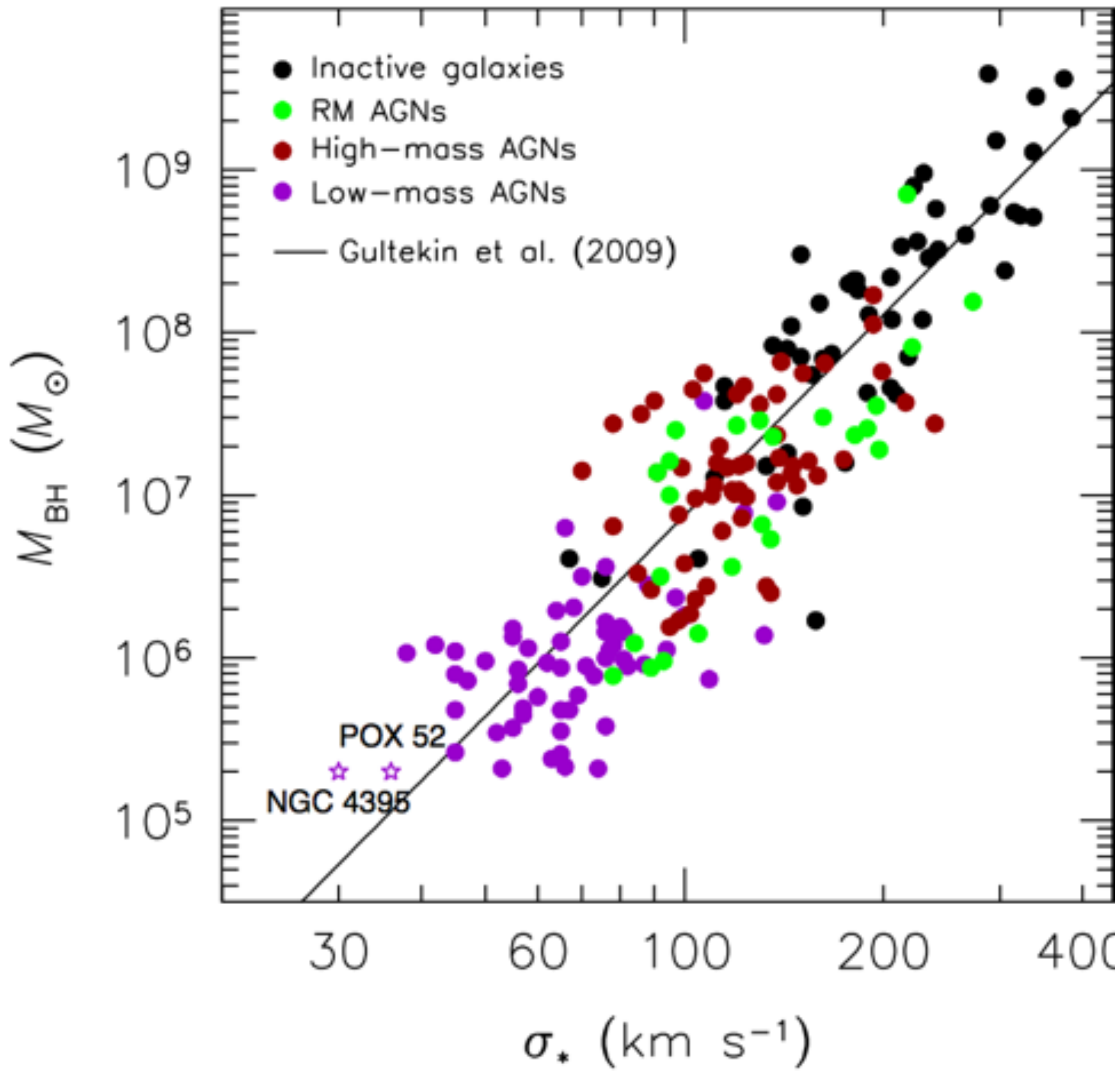


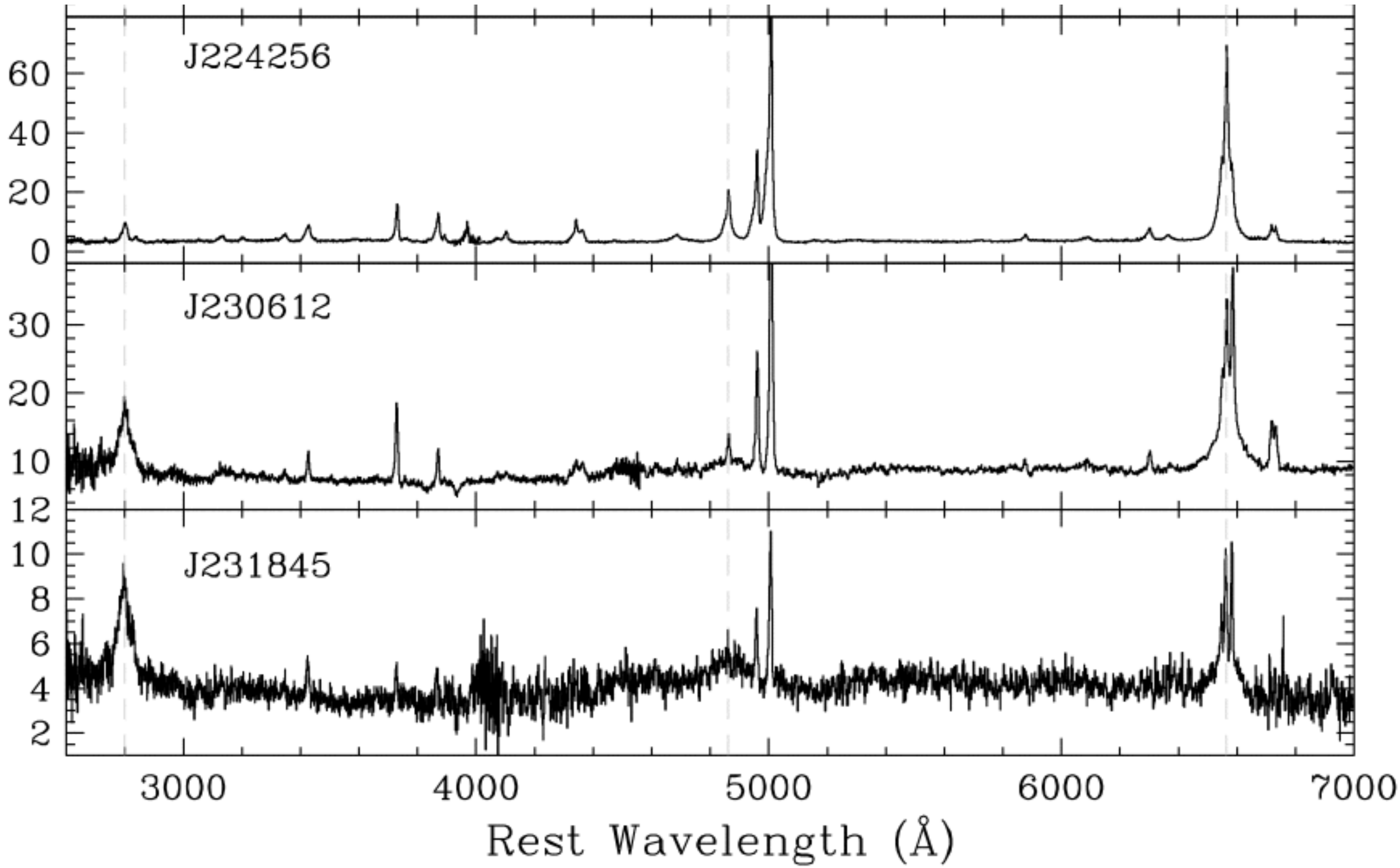
Peterson et al. (2002)



M_{BH} esitmation with empirical relationships

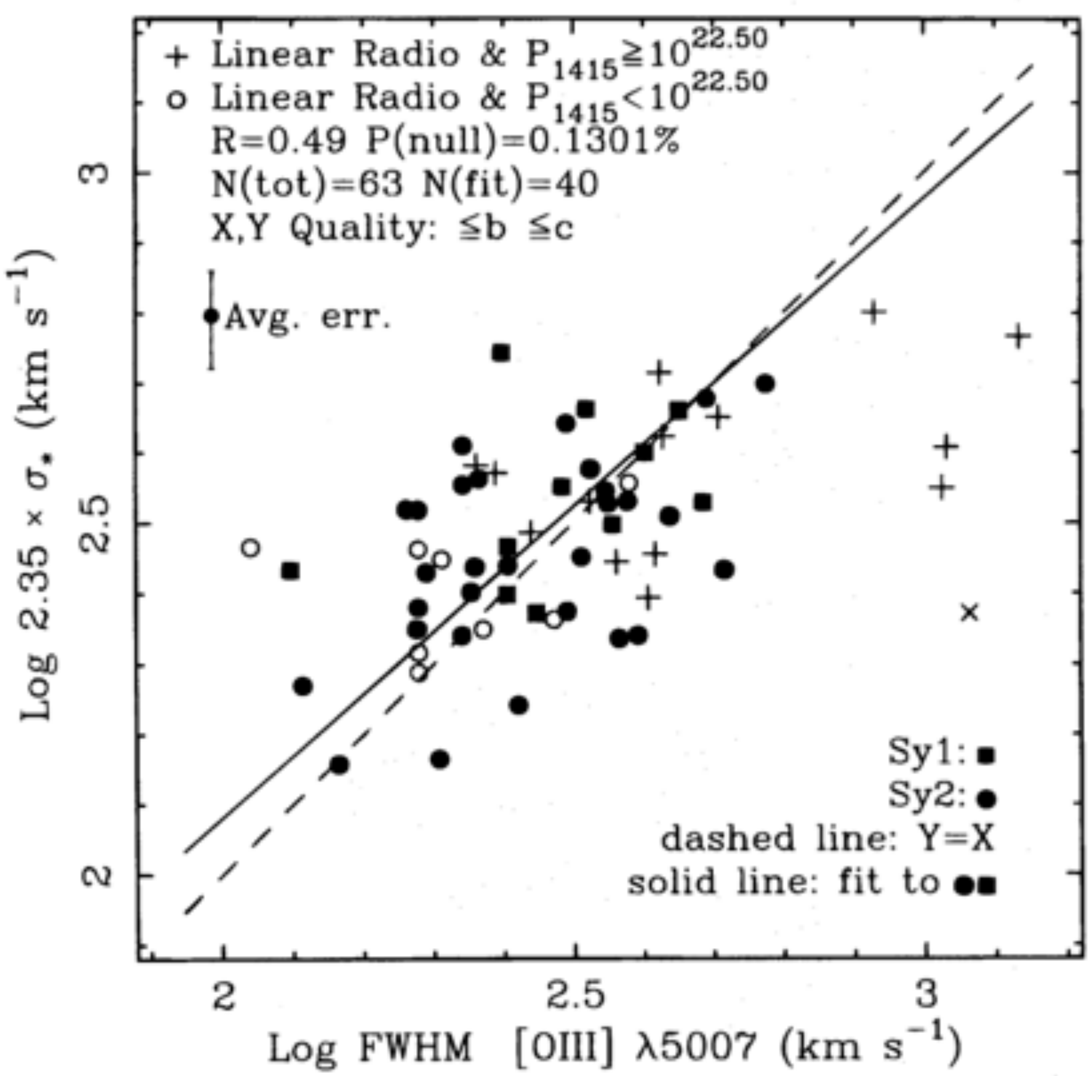




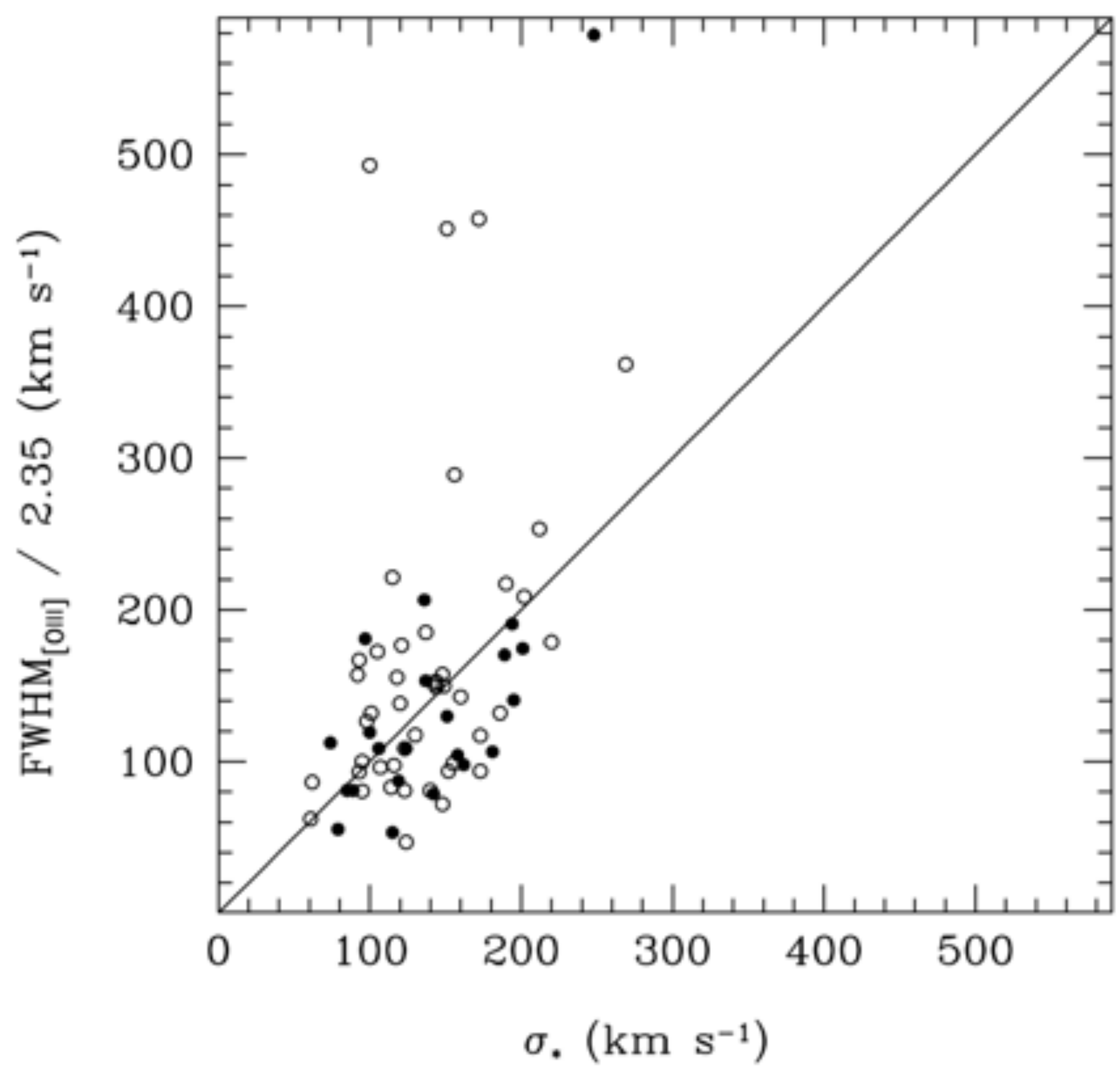


J224256
J230612
J231845
Rest Wavelength (Å)

Comparison of gas and stellar velocity dispersion

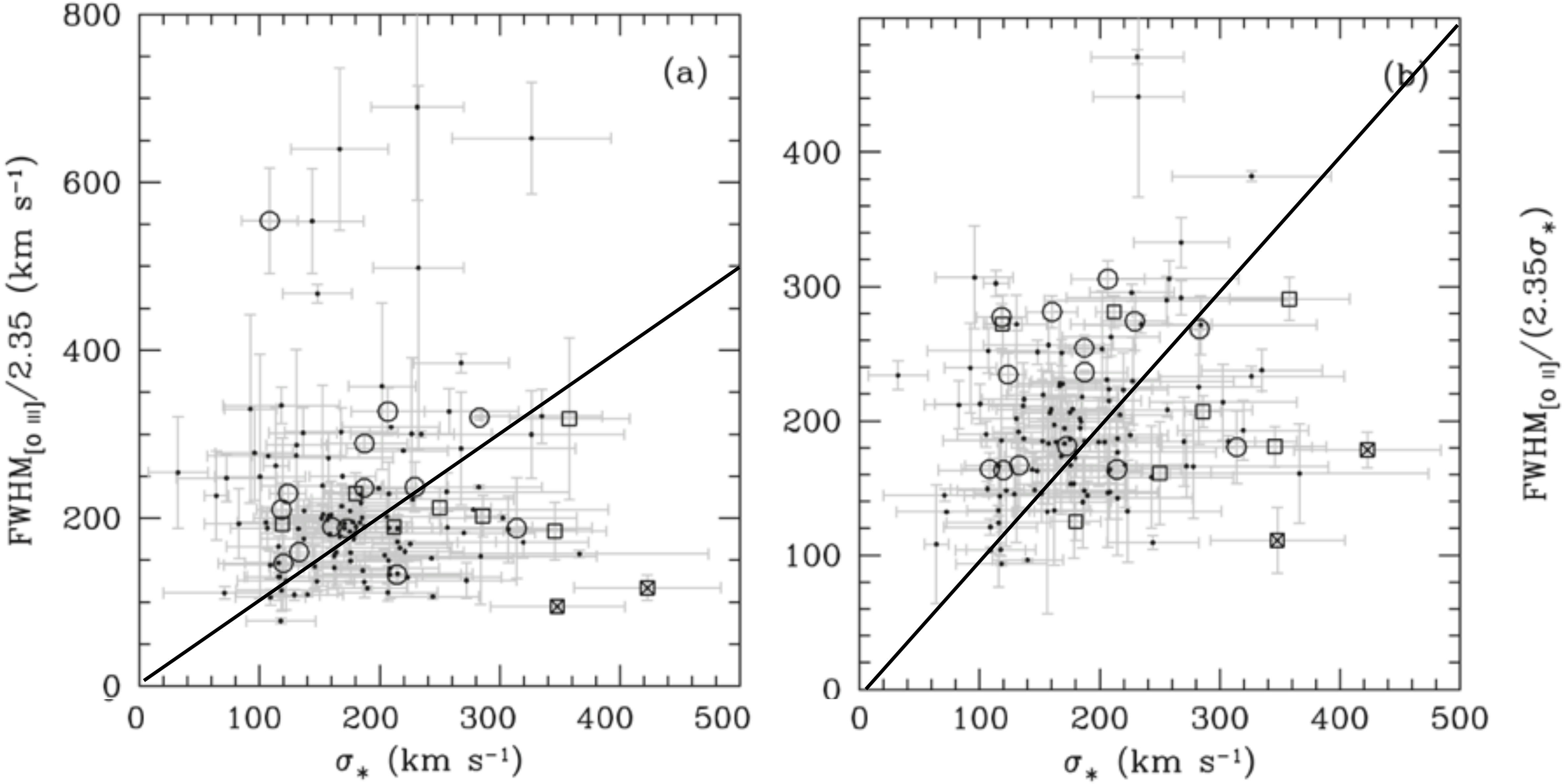


Nelson & Whittle 1996



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

- Check this relation for [S II] emission line

II, Sample and data reduction

Sample selection

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

- SDSS DR7
- 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

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

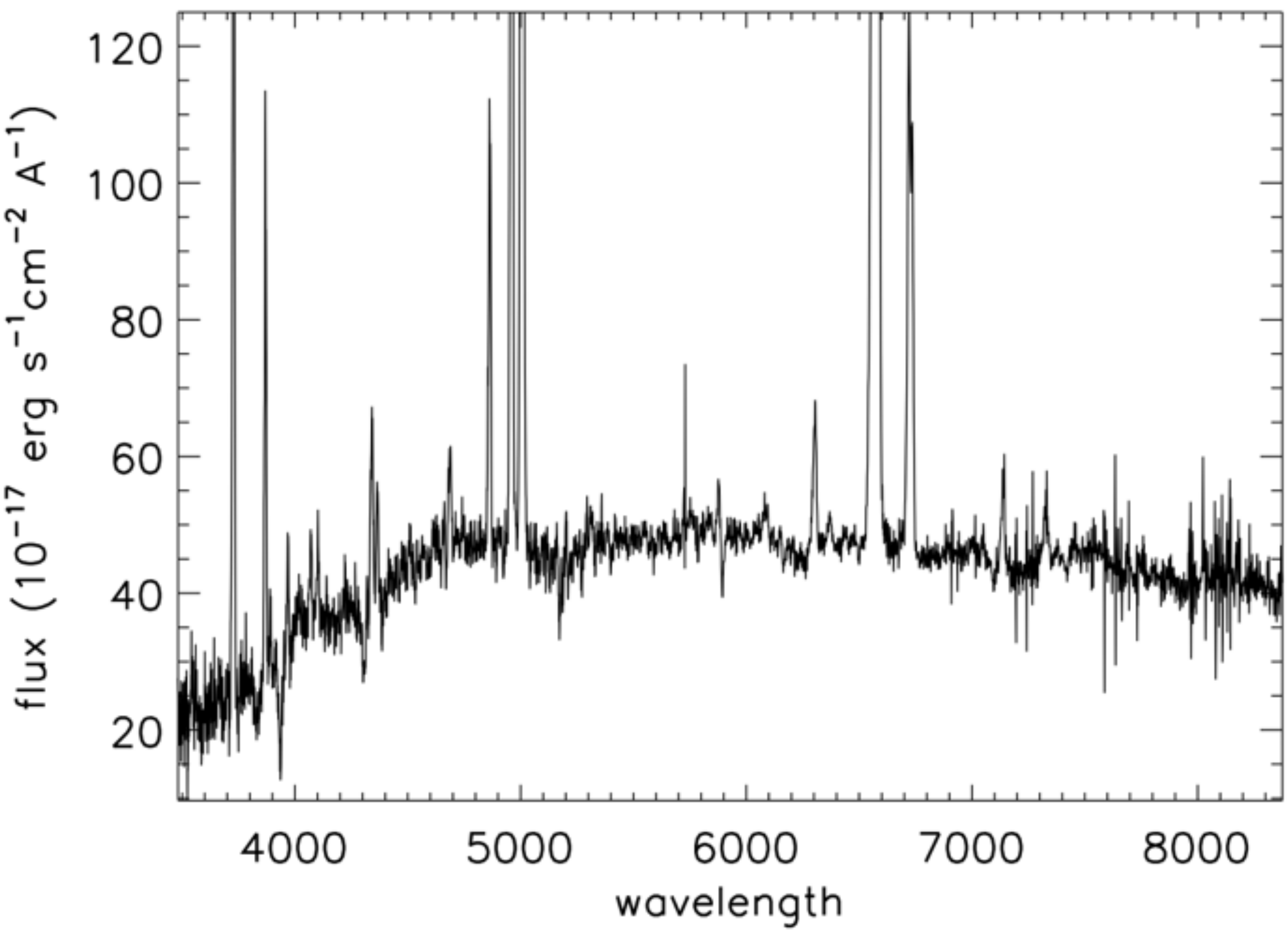
$$\mathcal{R} \equiv [\text{O III}]5007/\text{H}\beta$$

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

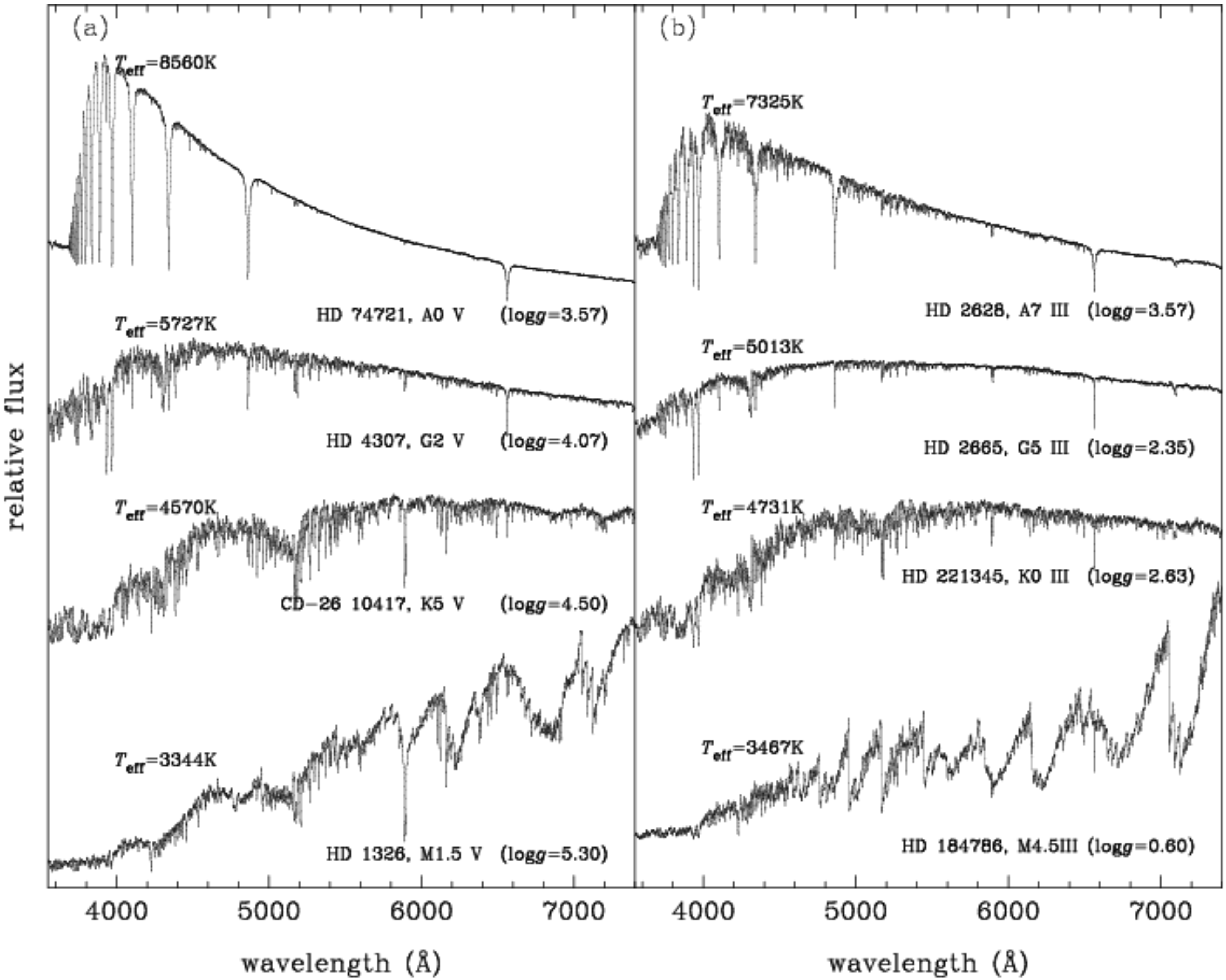
$\log(\mathcal{R}) > 0.3$, if Hβ is detected with S/N > 3 $\quad 0.36 \leqslant z < 0.83,$

- 887

Spectra of type 2 Qsos



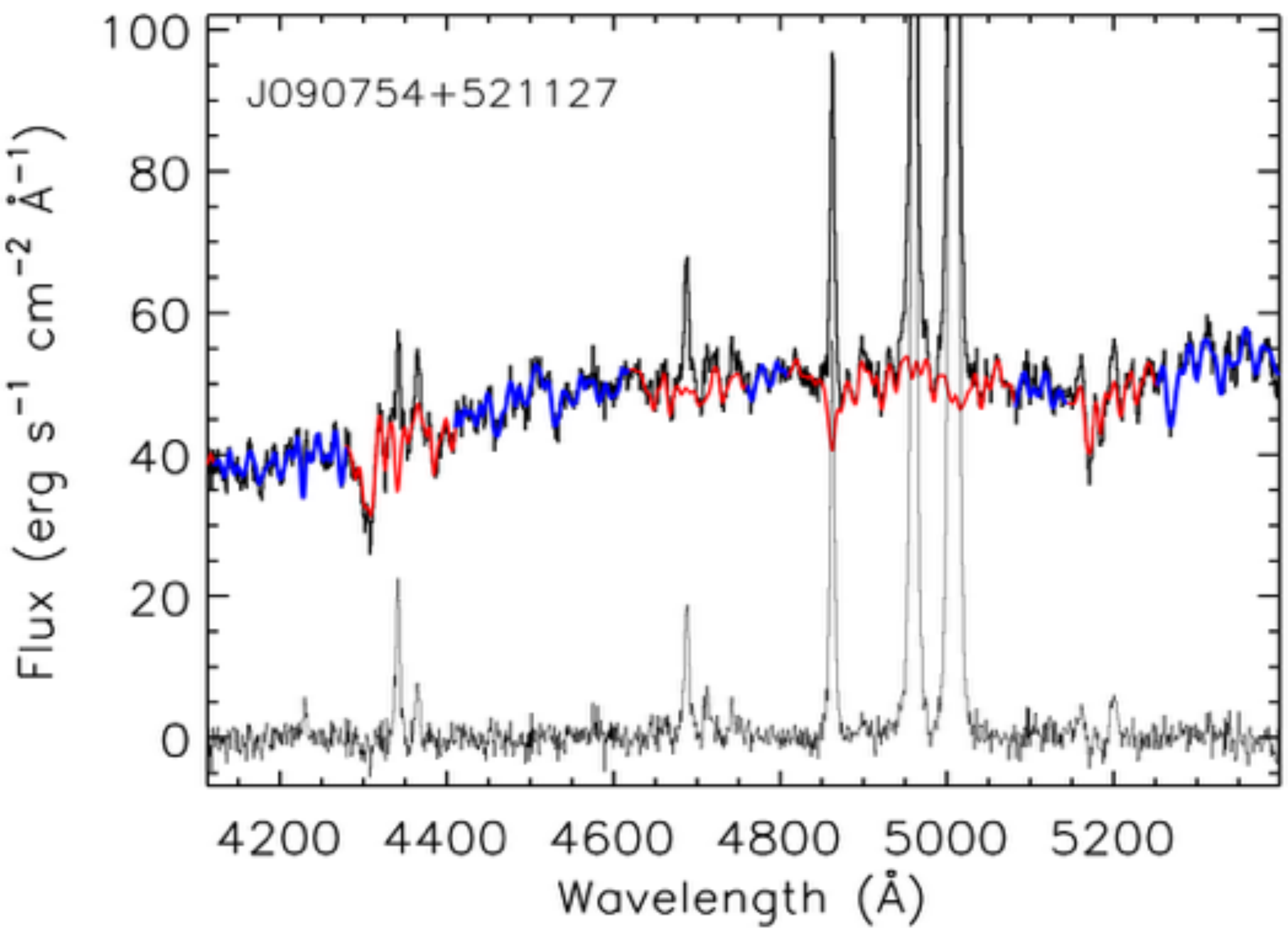
1. Contributions from Stellar absorption line
2. AGN continuum
3. emission lines



(a)
T_{eff}=8560K
HD 74721, A0 V (log$g$=3.57)
T_{eff}=5727K
HD 4307, G2 V (log$g$=4.07)
T_{eff}=4570K
CD−26 10417, K5 V (log$g$=4.50)
T_{eff}=3344K
HD 1326, M1.5 V (log$g$=5.30)
(b)
T_{eff}=7325K
HD 2628, A7 III (log$g$=3.57)
T_{eff}=5013K
HD 2665, G5 III (log$g$=2.35)
T_{eff}=4731K
HD 221345, K0 III (log$g$=2.63)
T_{eff}=3467K
HD 184786, M4.5III (log$g$=0.60)
relative flux
4000
5000
6000
7000
wavelength (Å)

Data reduction

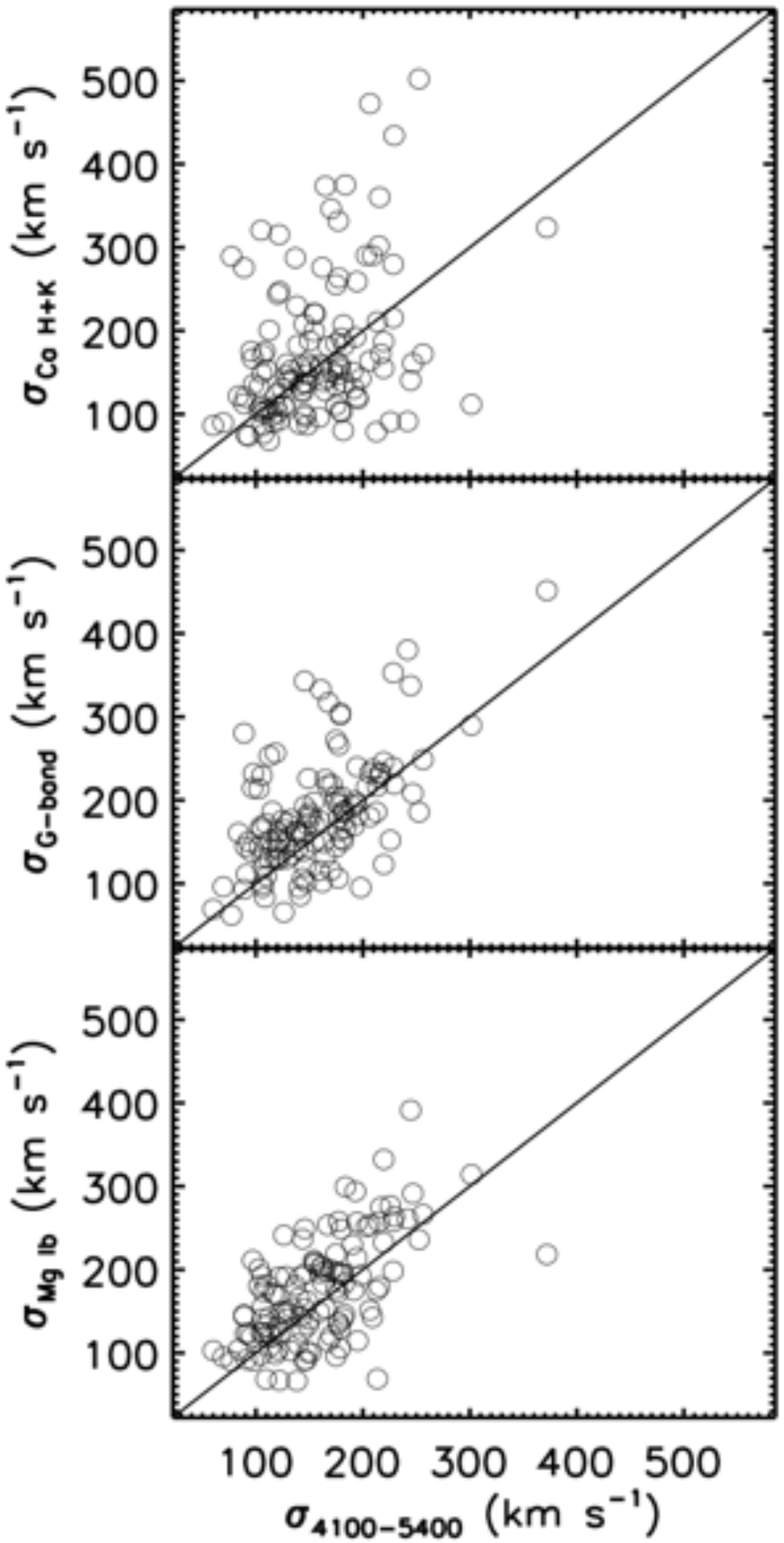
pPXF (http://www-astro.physics.ox.ac.uk/~mxc/software/)



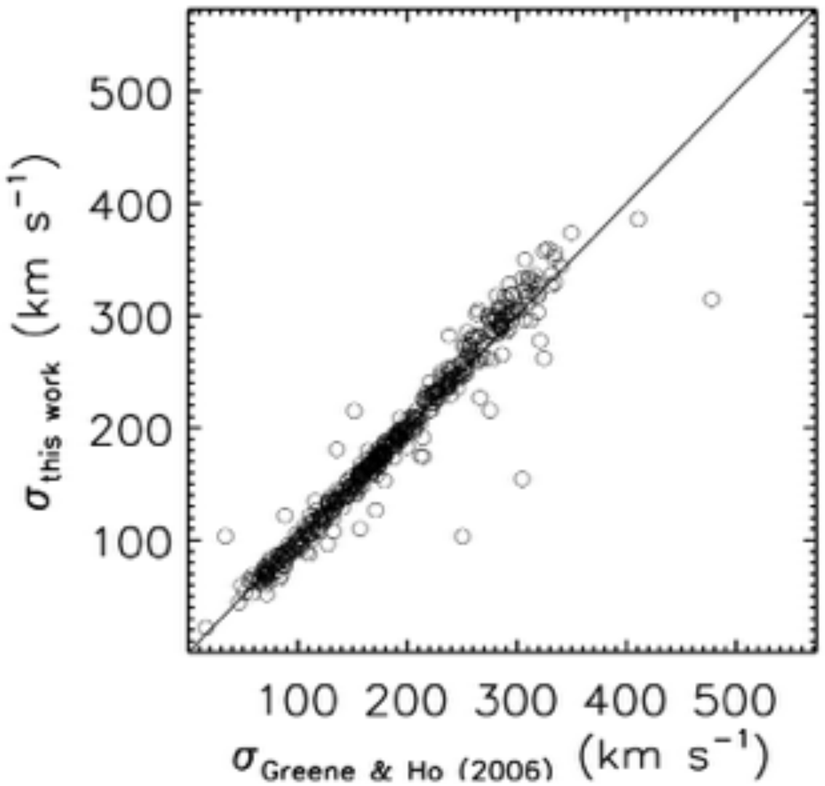
- galactic extinction
- redshift correction
- mask emision lines (800 km s^{-1})
- stellar measurements *(stellar library: Valdes et al. 2004)*

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

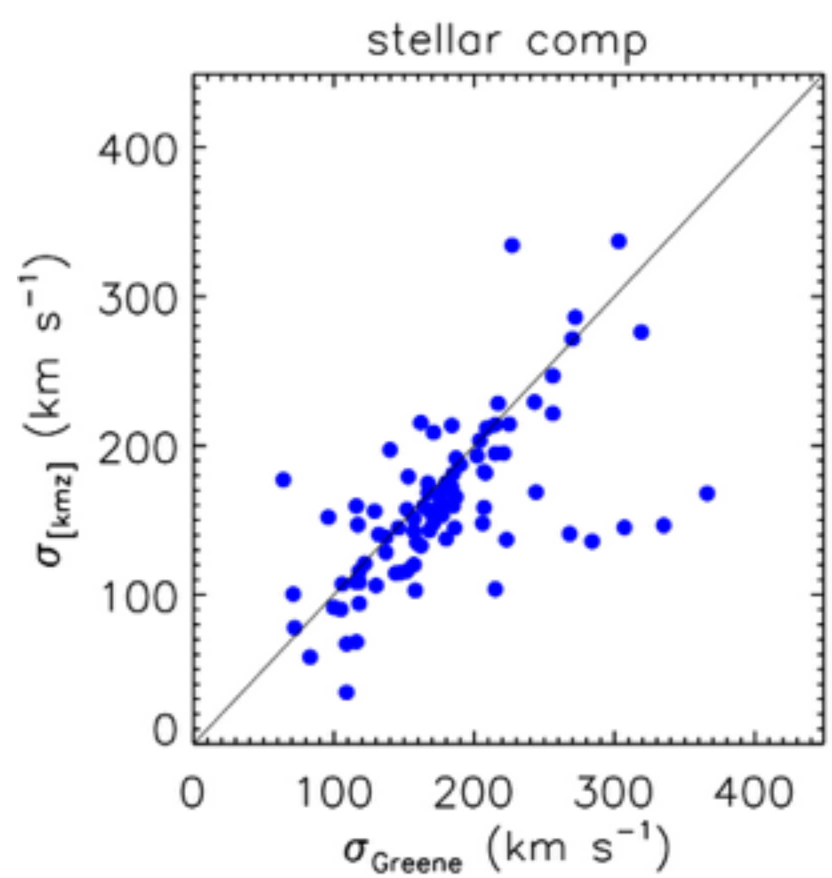
Data check



$\sigma_{\mathrm{Ca\ H+K}}$ (km s^{-1})
$\sigma_{\mathrm{G-band}}$ (km s^{-1})
$\sigma_{\mathrm{Mg\ Ib}}$ (km s^{-1})
100 200 300 400 500
$\sigma_{4100-5400}$ (km s^{-1})

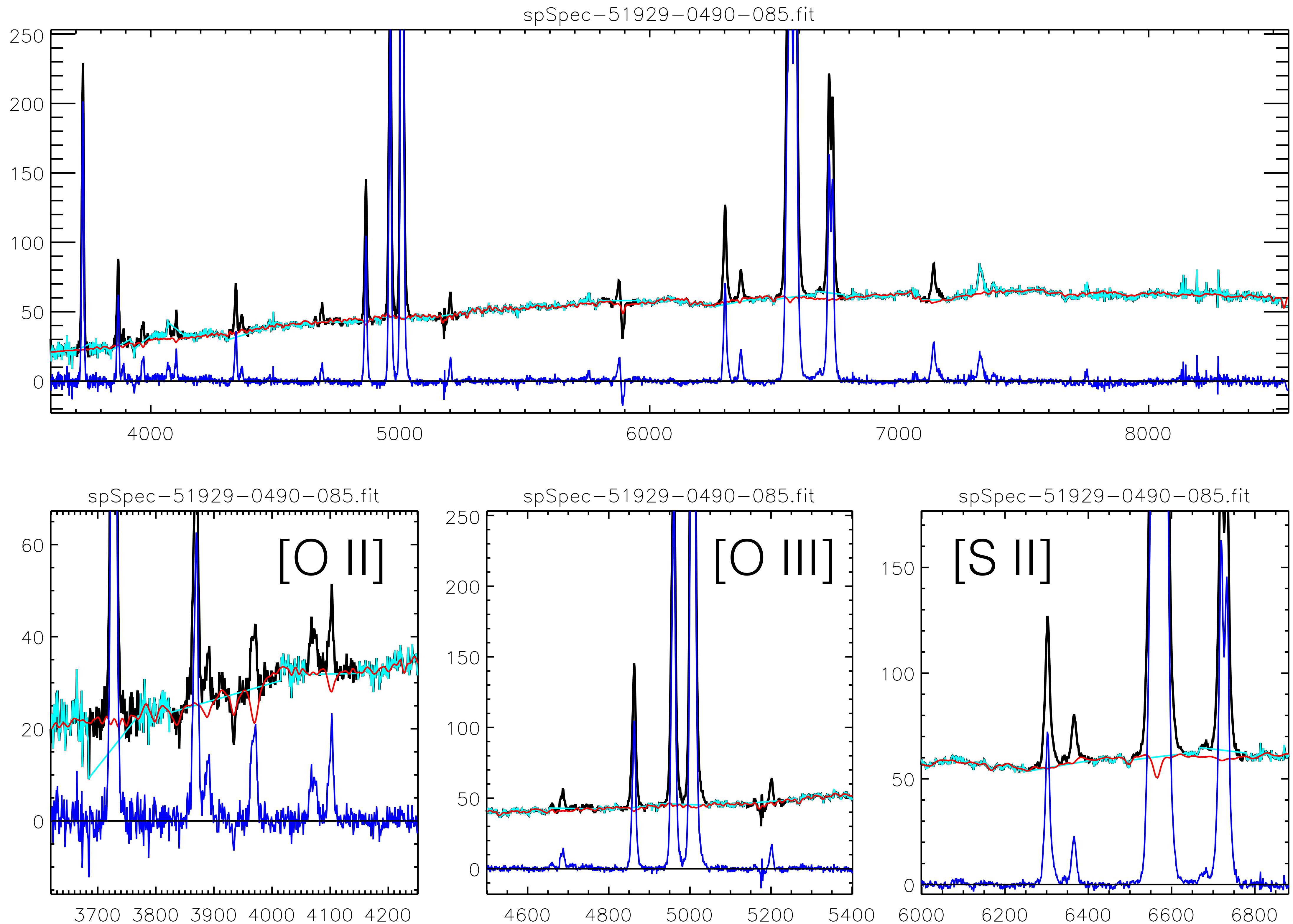


$\sigma_{\mathrm{this\ work}}$ (km s^{-1})
100 200 300 400 500
$\sigma_{\mathrm{Greene\ \&\ Ho\ (2006)}}$ (km s^{-1})

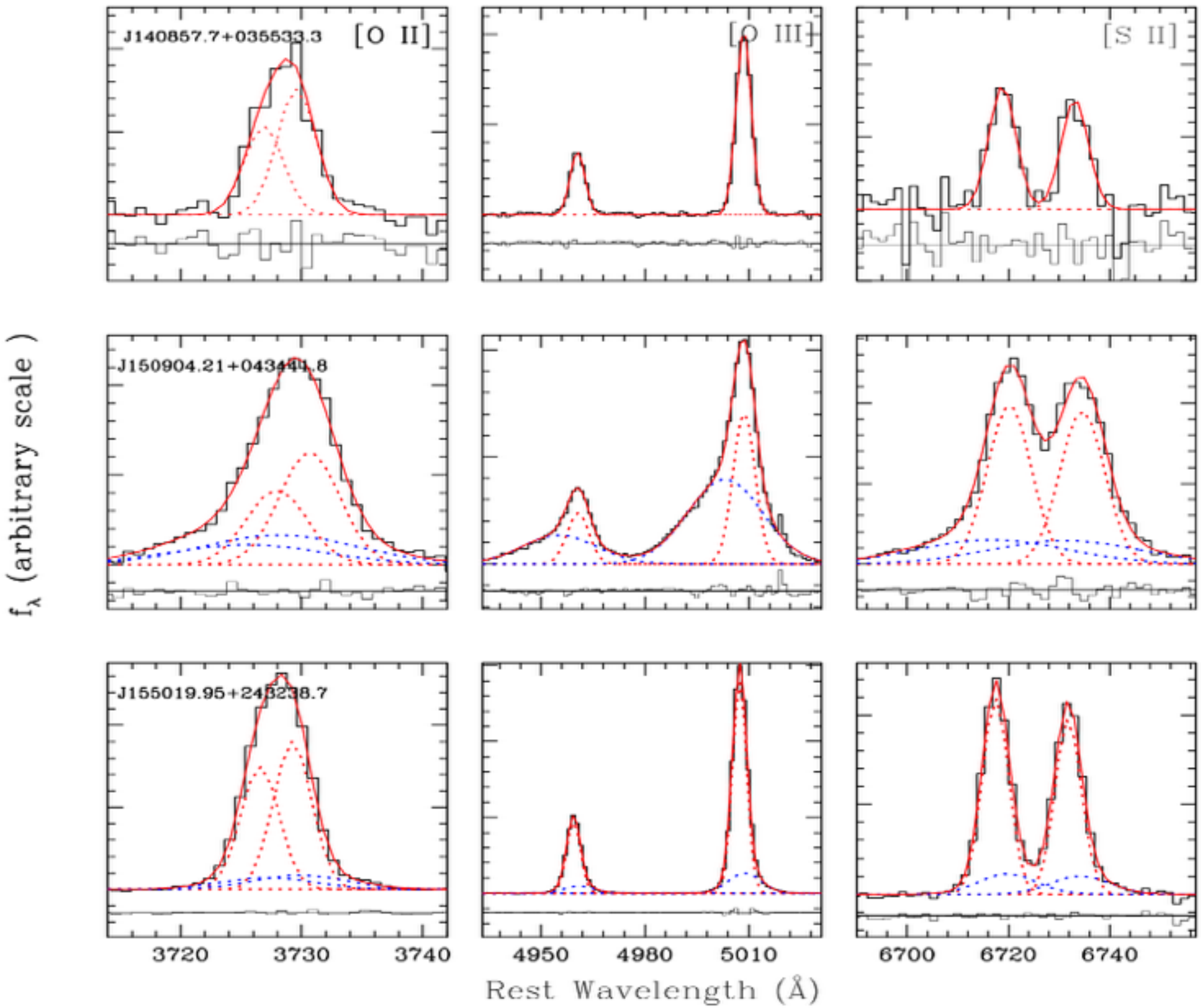


stellar comp
$\sigma_{[\mathrm{kmz}]}$ (km s^{-1})
0 100 200 300 400
σ_{Greene} (km s^{-1})

Emission line measurements

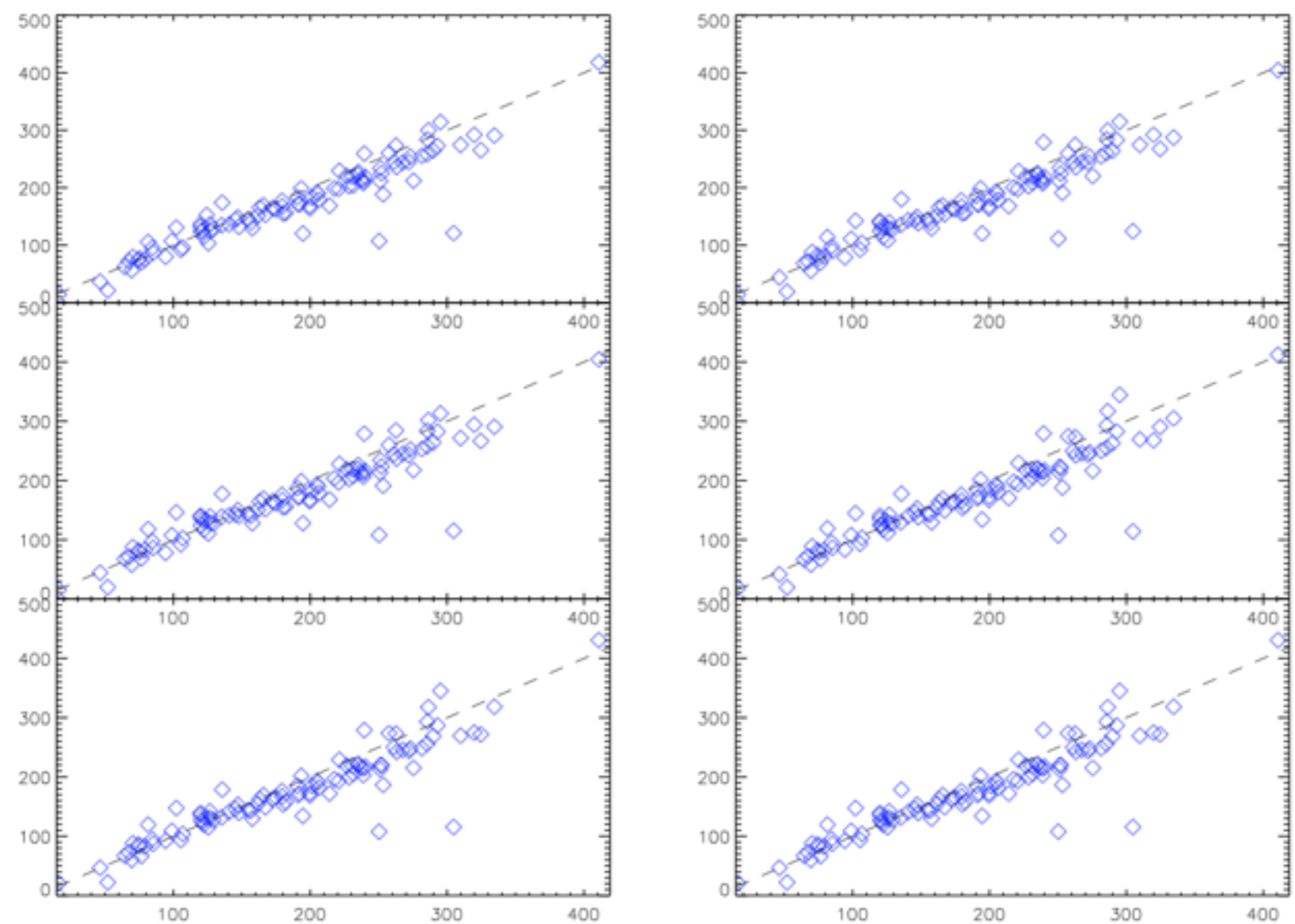


Emission line fitting



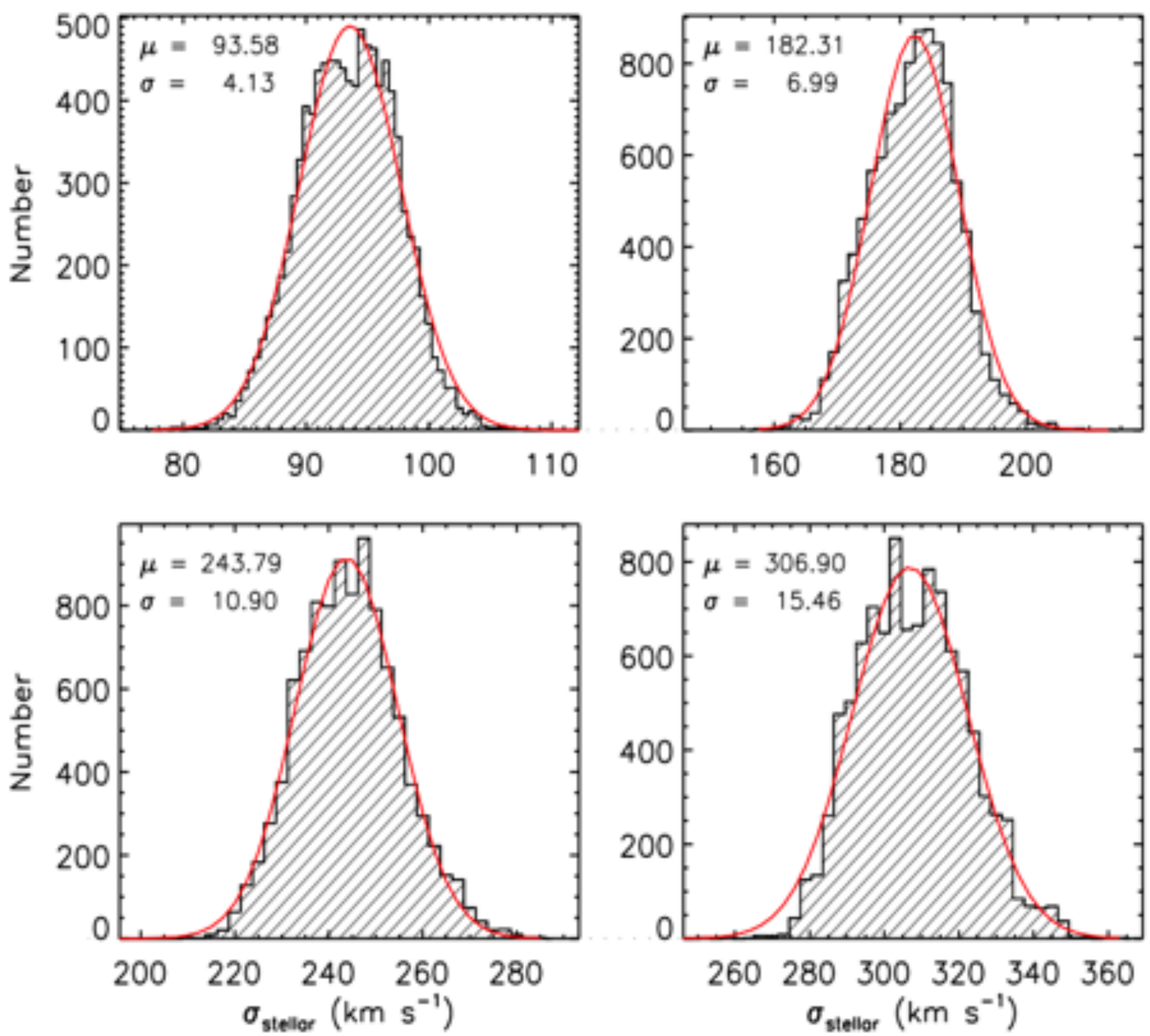
Data uncertainties

order of
P(x),C(x)

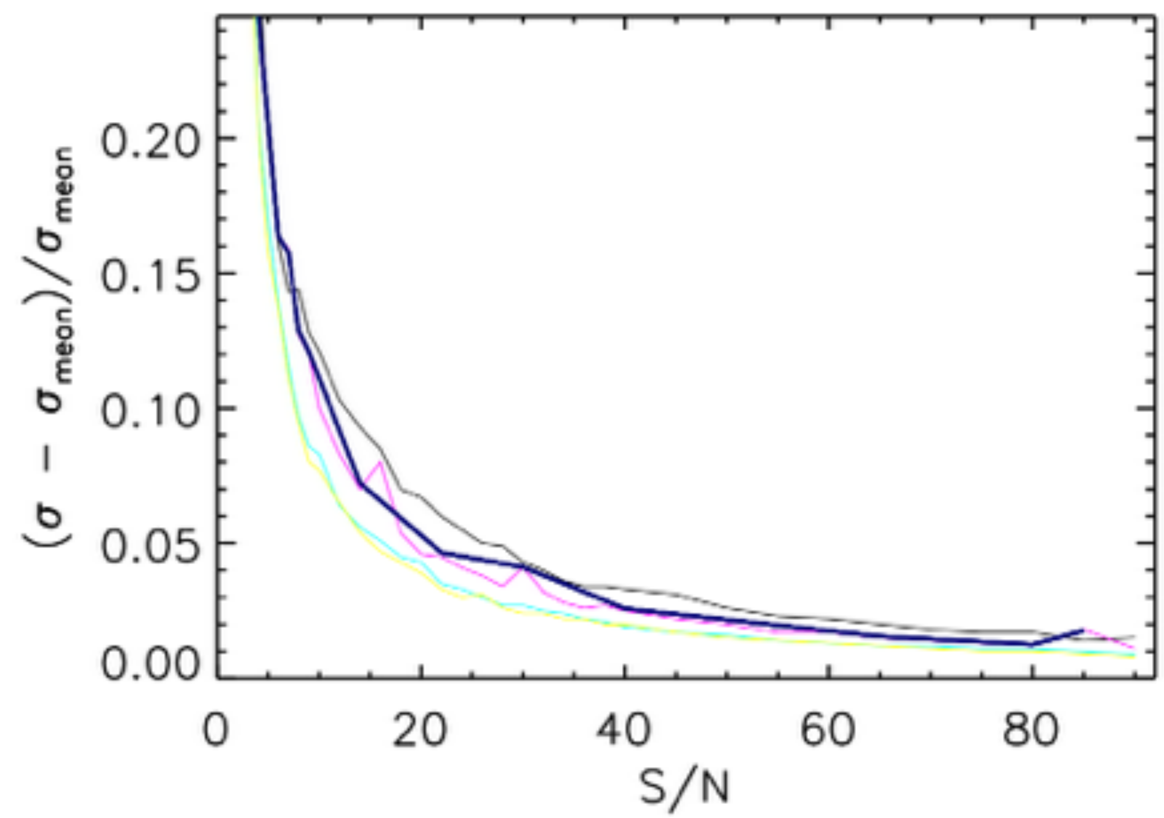


$$M_{mod}(x) = P(x) \left\{ \sum_{j=1} w_j \left[T_j(x) \otimes G(x) \right] \right\} + C(x)$$

template mismatch

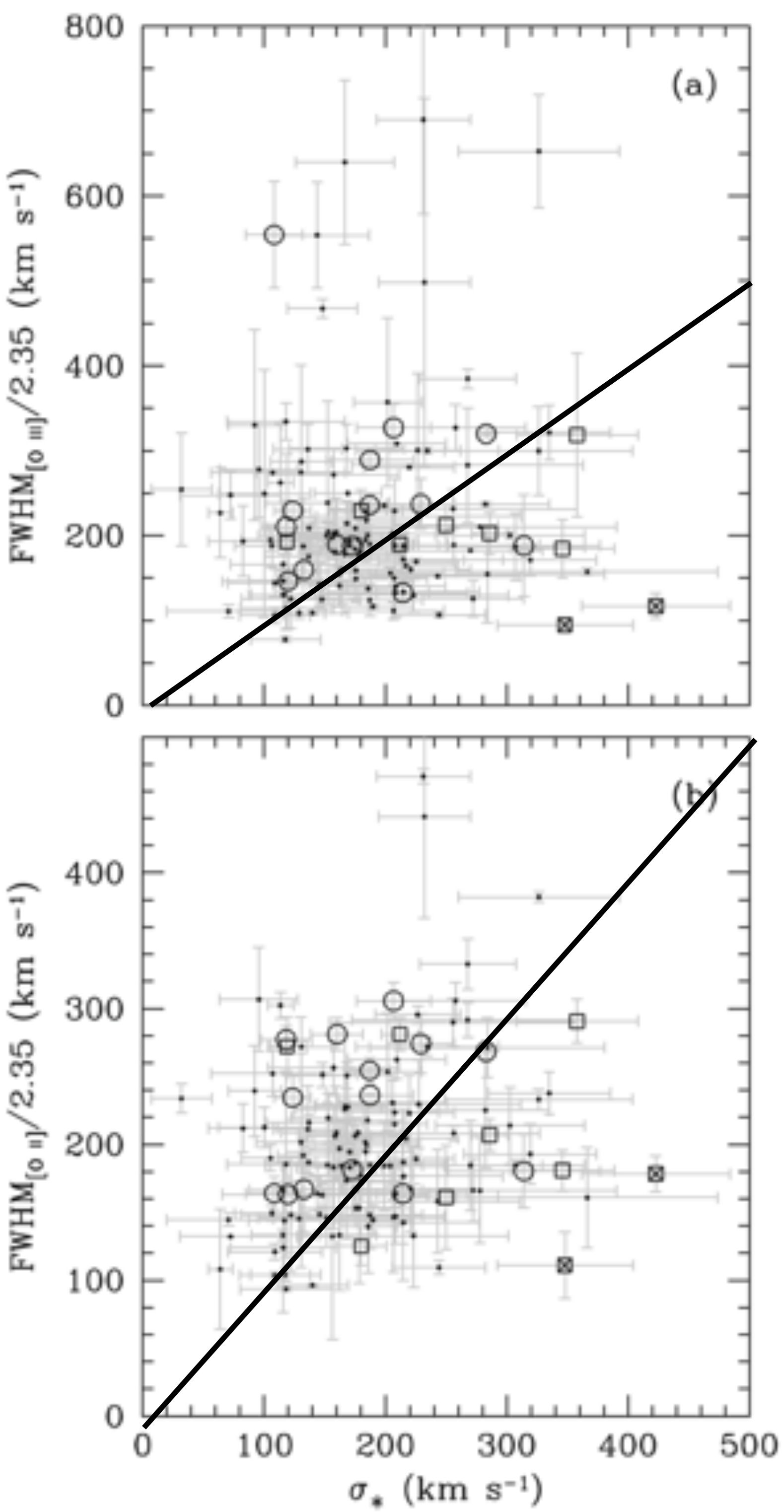


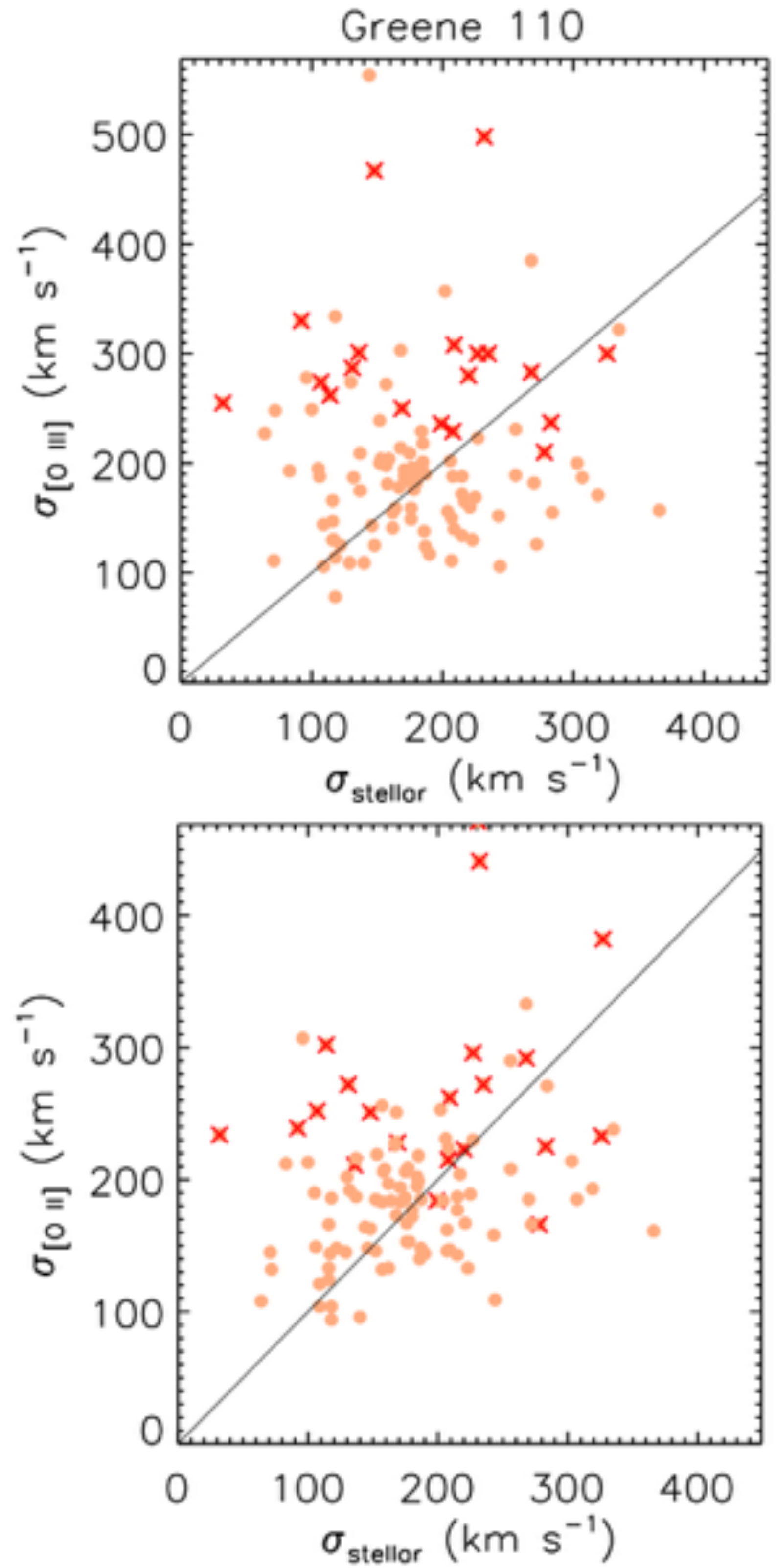
S/N

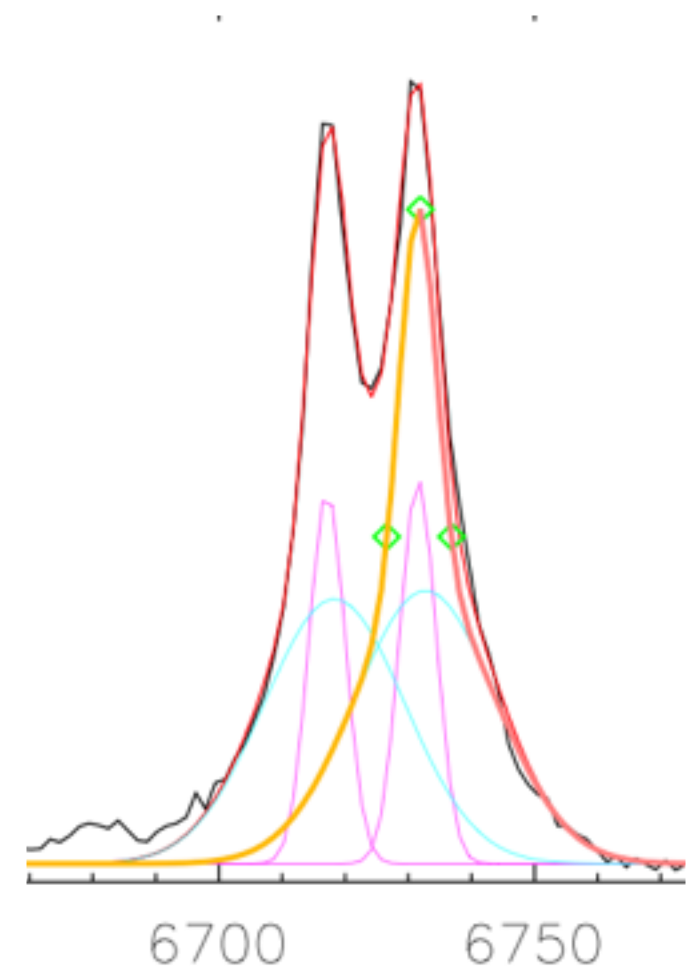


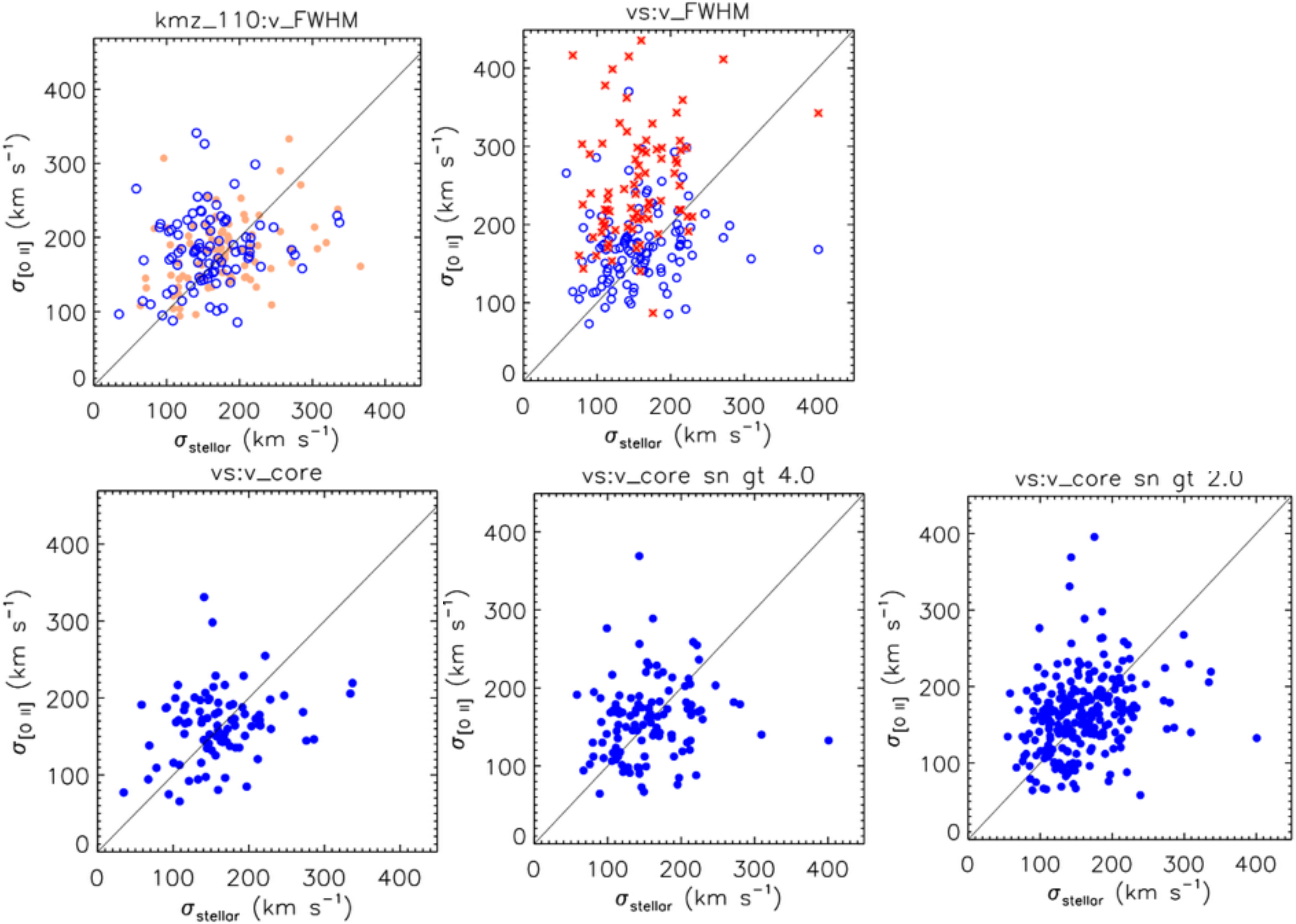
$$\sigma_{err} = \sqrt{{\sigma_{err1}}^2 + {\sigma_{err2}}^2 + {\sigma_{err3}}^2}$$

Results

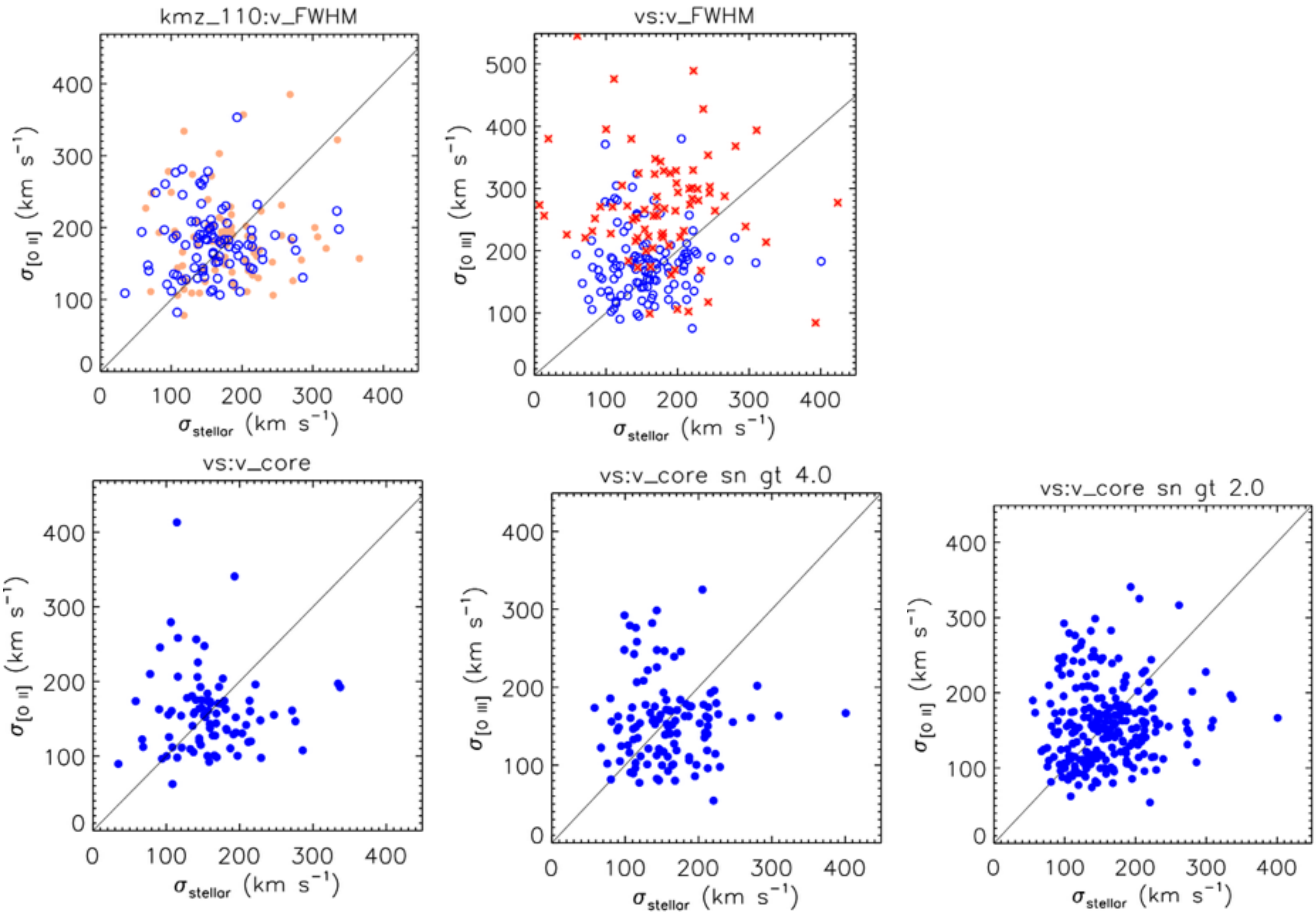

(a)
(b)
FWHM[O III]/2.35 (km s-1)
FWHM[O II]/2.35 (km s-1)
σ* (km s-1)
0
100
200
300
400
500
600
800

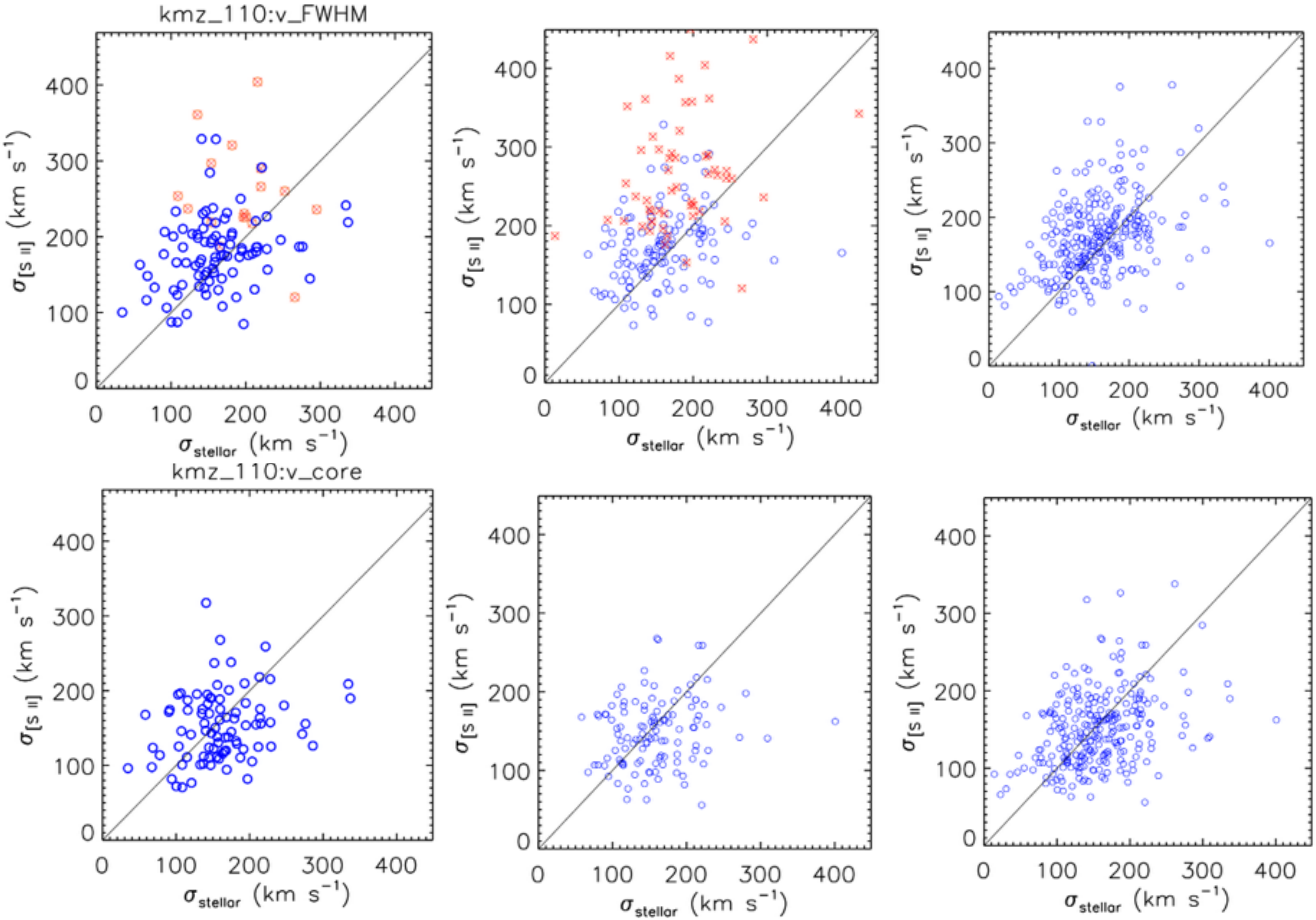

Greene 110
σ[O III] (km s-1)
σ[O II] (km s-1)
σstellor (km s-1)
σstellar (km s-1)
0
100
200
300
400
500


6700
6750



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})


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})
$\sigma_{[O\,III]}$ (km s^{-1})
$\sigma_{stellar}$ (km s^{-1})



kmz_110:v_FWHM
kmz_110:v_core
σ[S II] (km s⁻¹)
σstellar (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)