M_{BH} estimation
— for type 2 Qsos

Speaker : Minzhi Kong

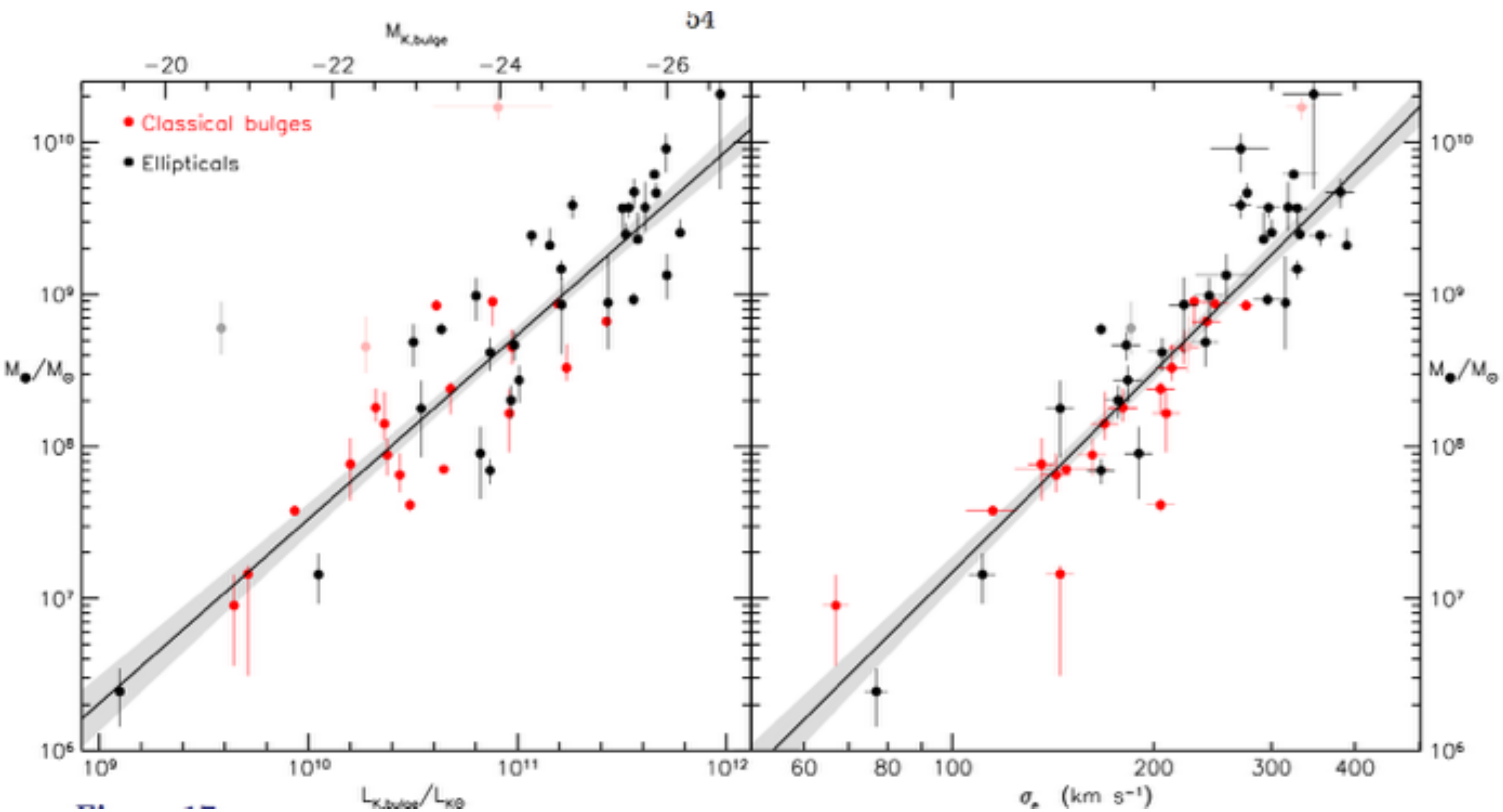
Collaborator : Luis Ho

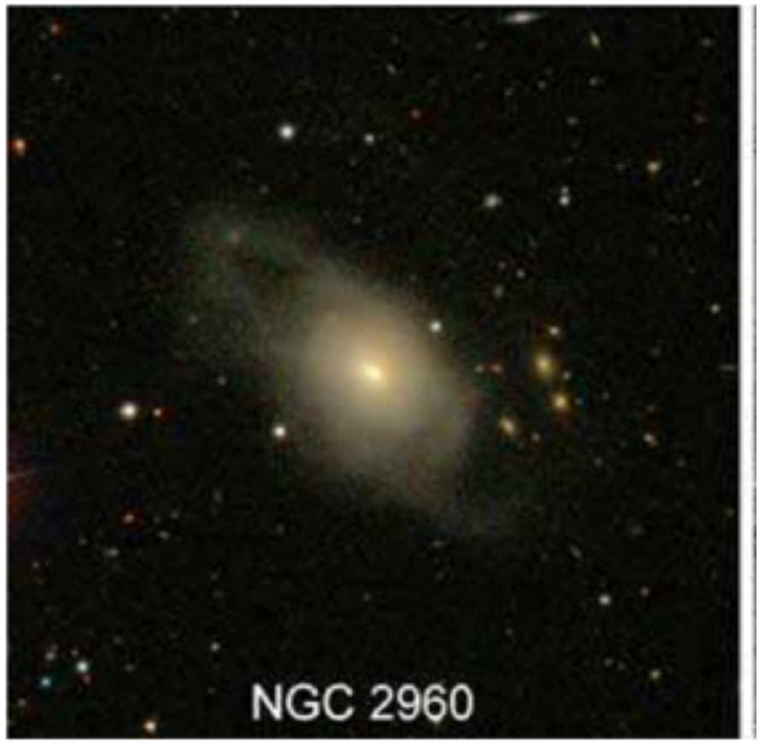
2014.08.1, KIAA.PKU

I, Background

Inportance of M_{BH} investigation

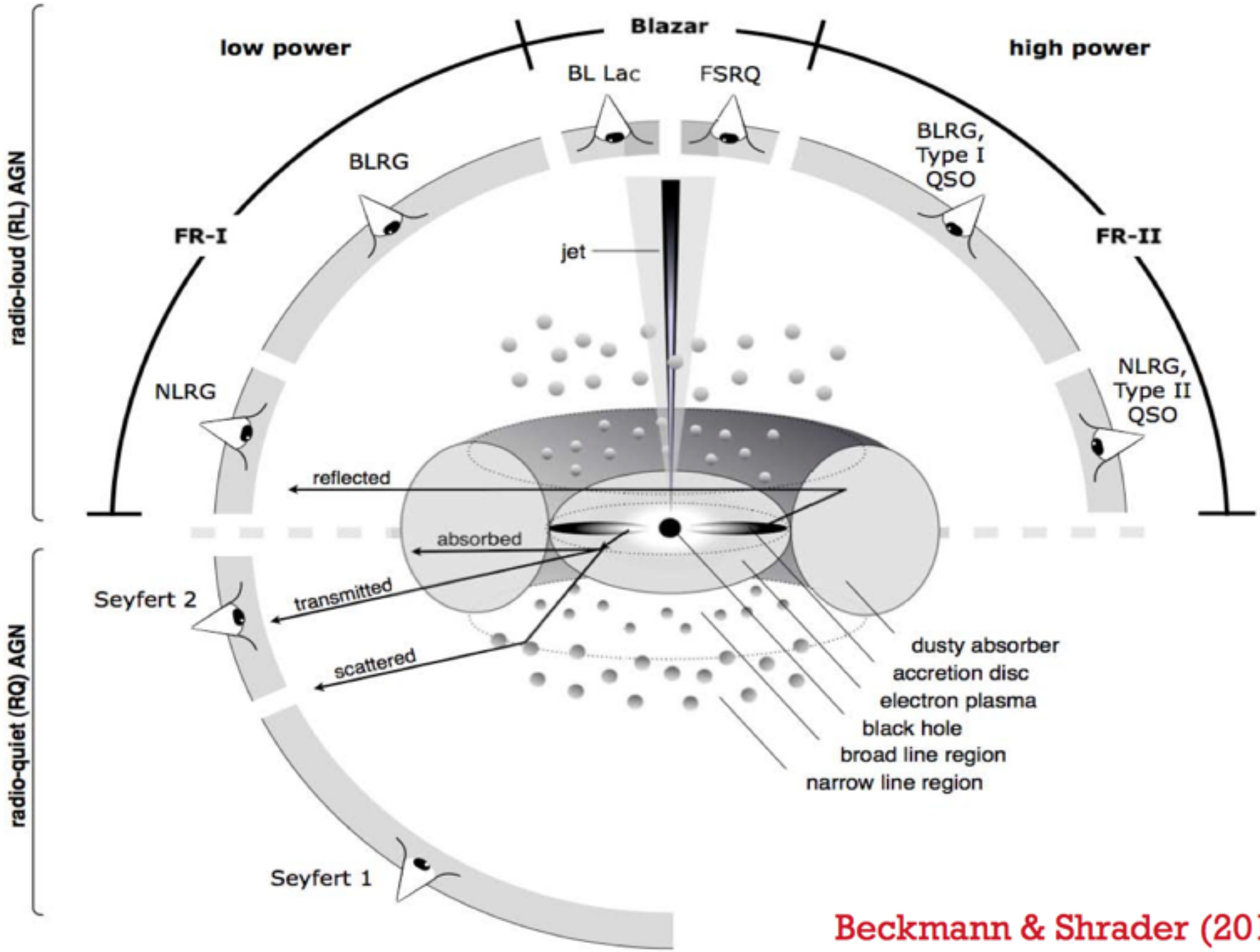
- there almost exist a BH in each center of AGNs/galaxies
- growth coevolution of BHs—galaxy





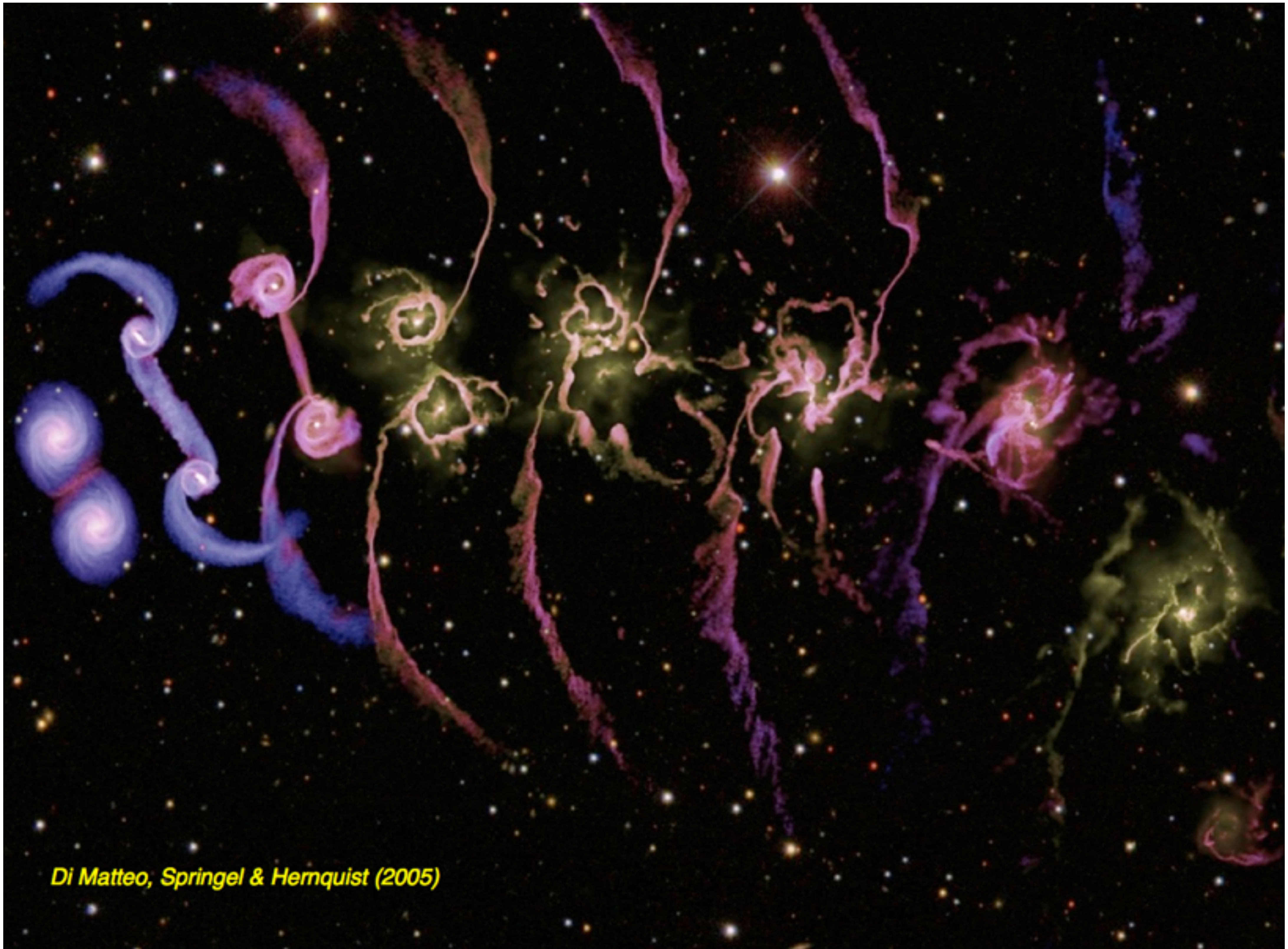
Kormendy & Ho 2014

Why is for type 2 Qsos



Beckmann & Shrader (2012)

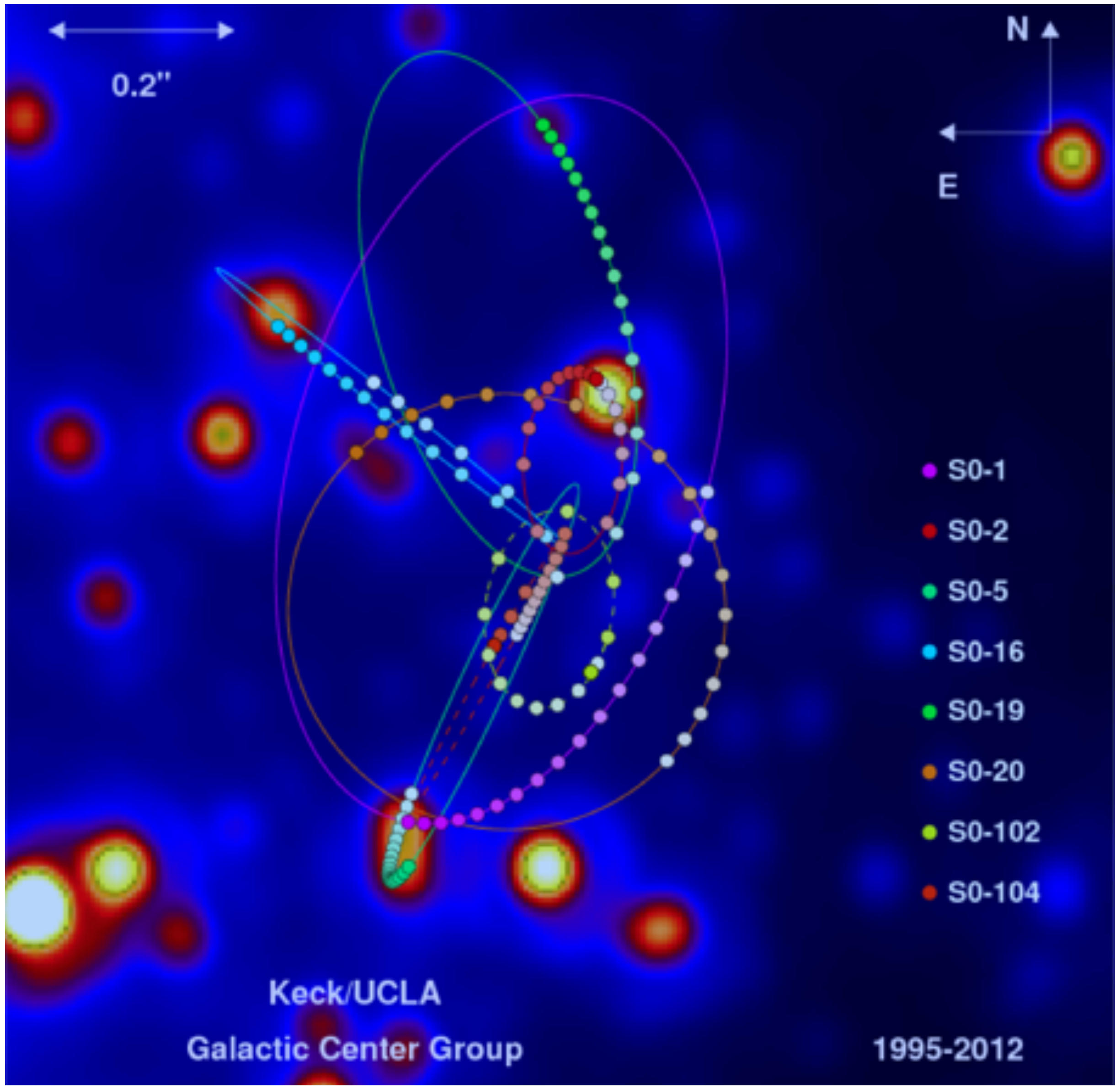
Coevolution of AGNs/host galaxy



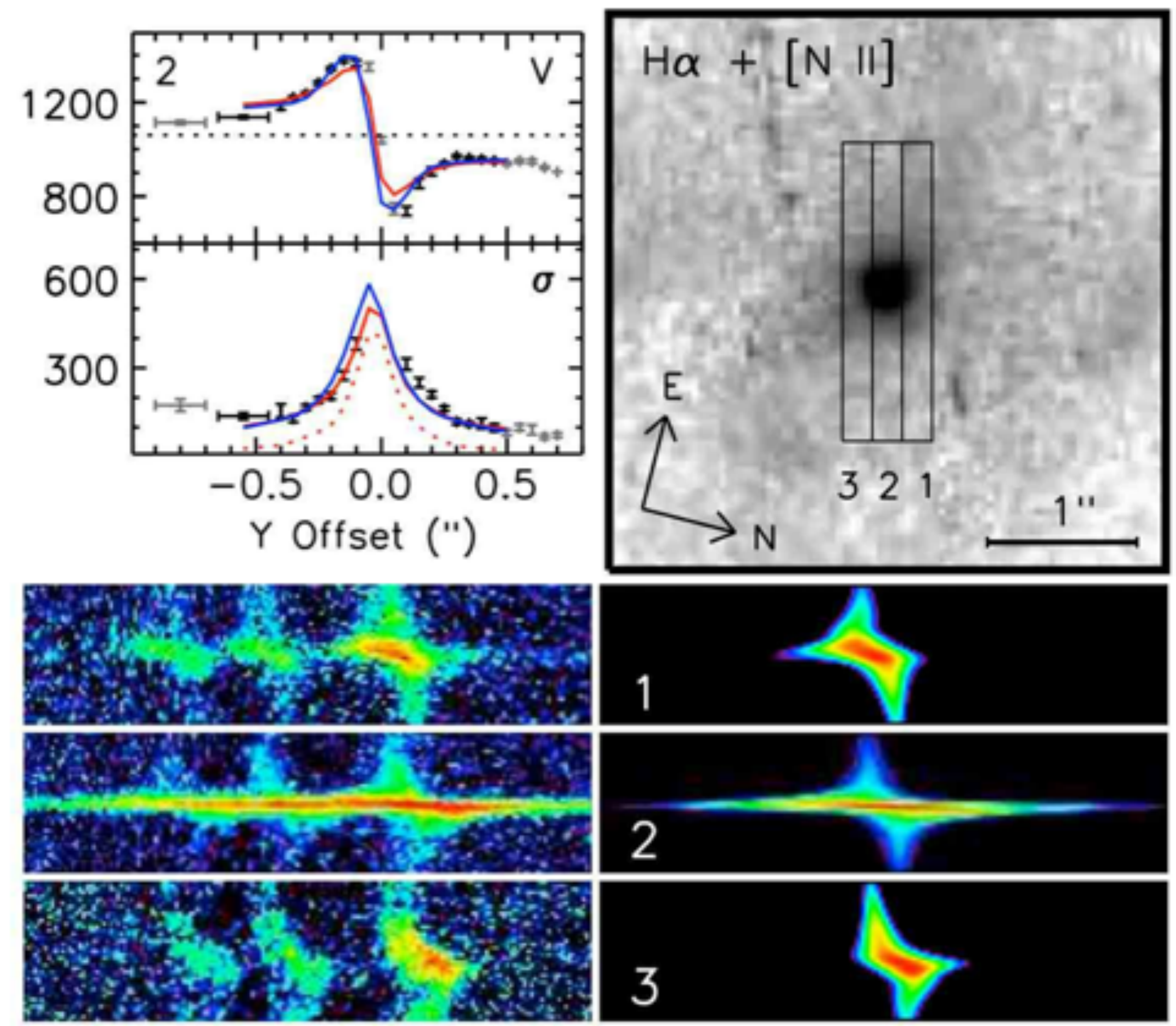
Methods of M_{BH} estimation I

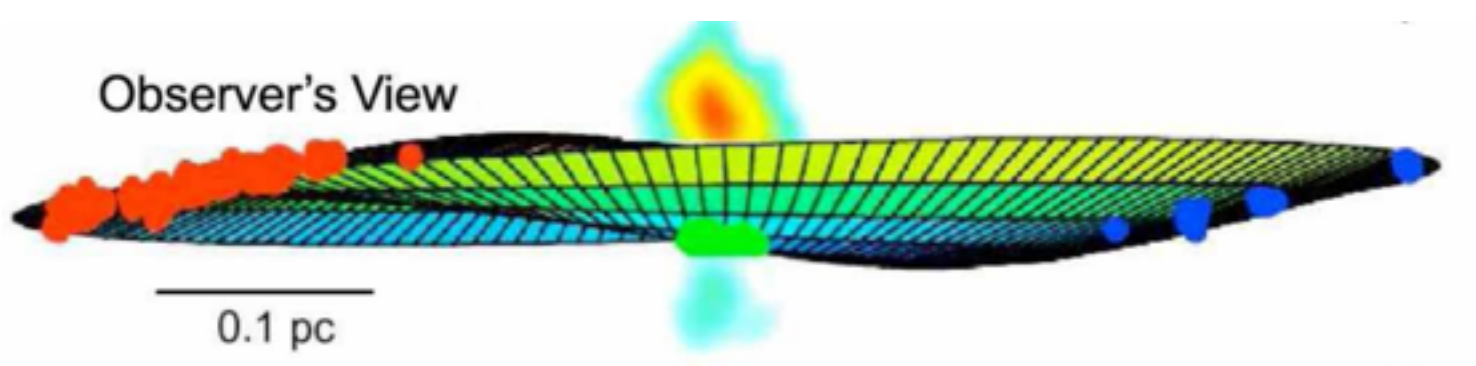
— Dynamics

• stellar dynamics



• ionized gas dynamics





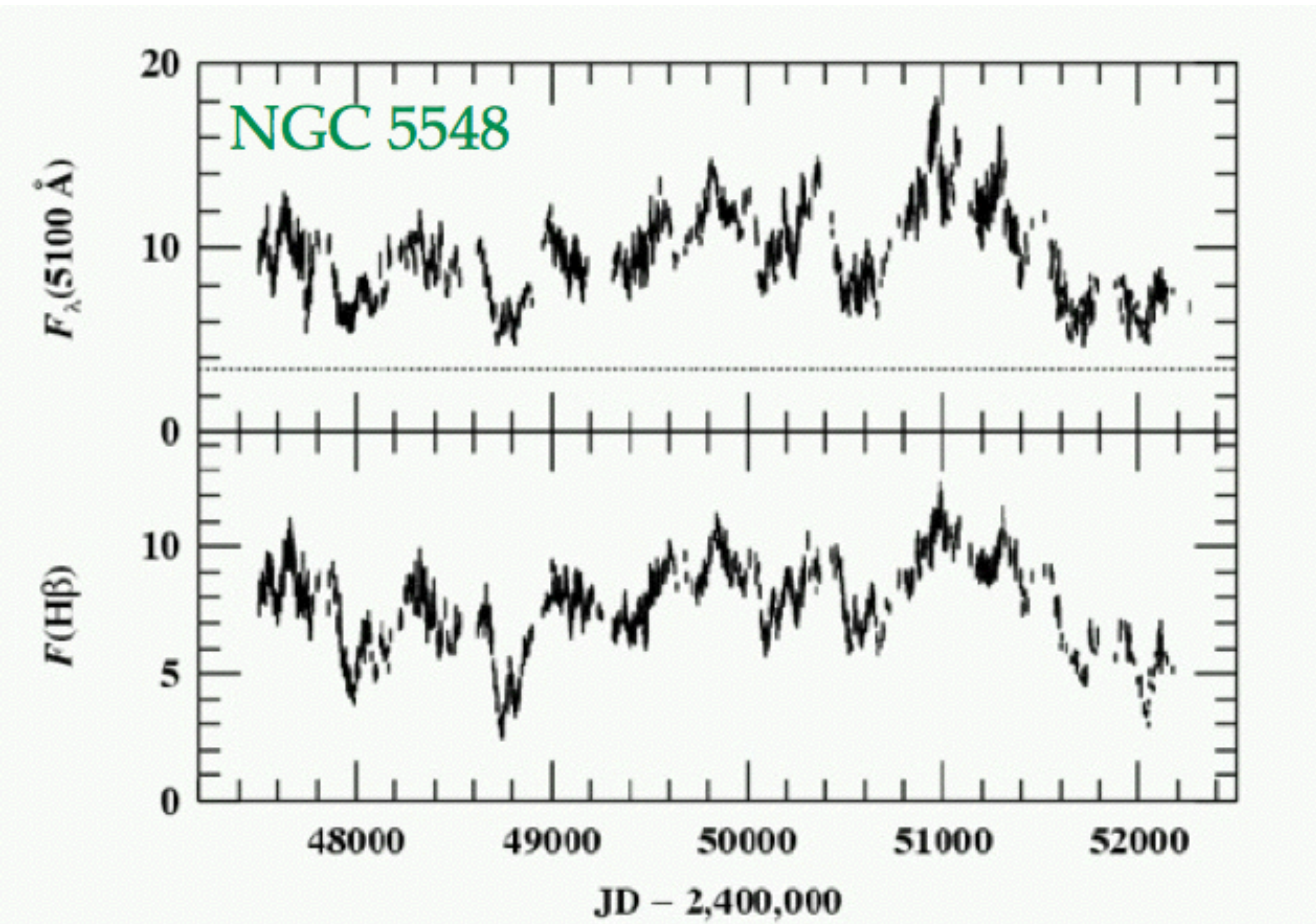
• maser dynamics

Methods of M_{BH} estimation II

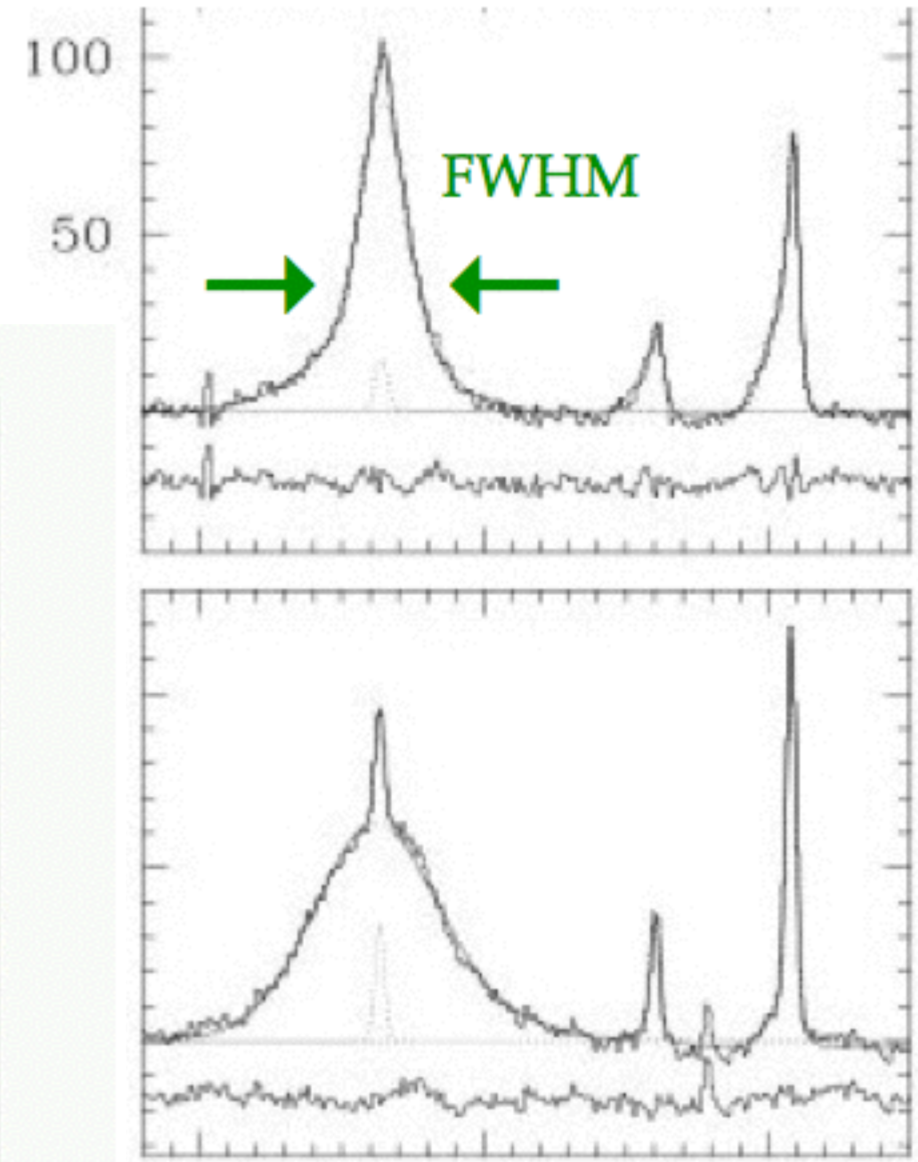
— Reverberation mapping

M_{BH} esitmation for type 1 AGNs

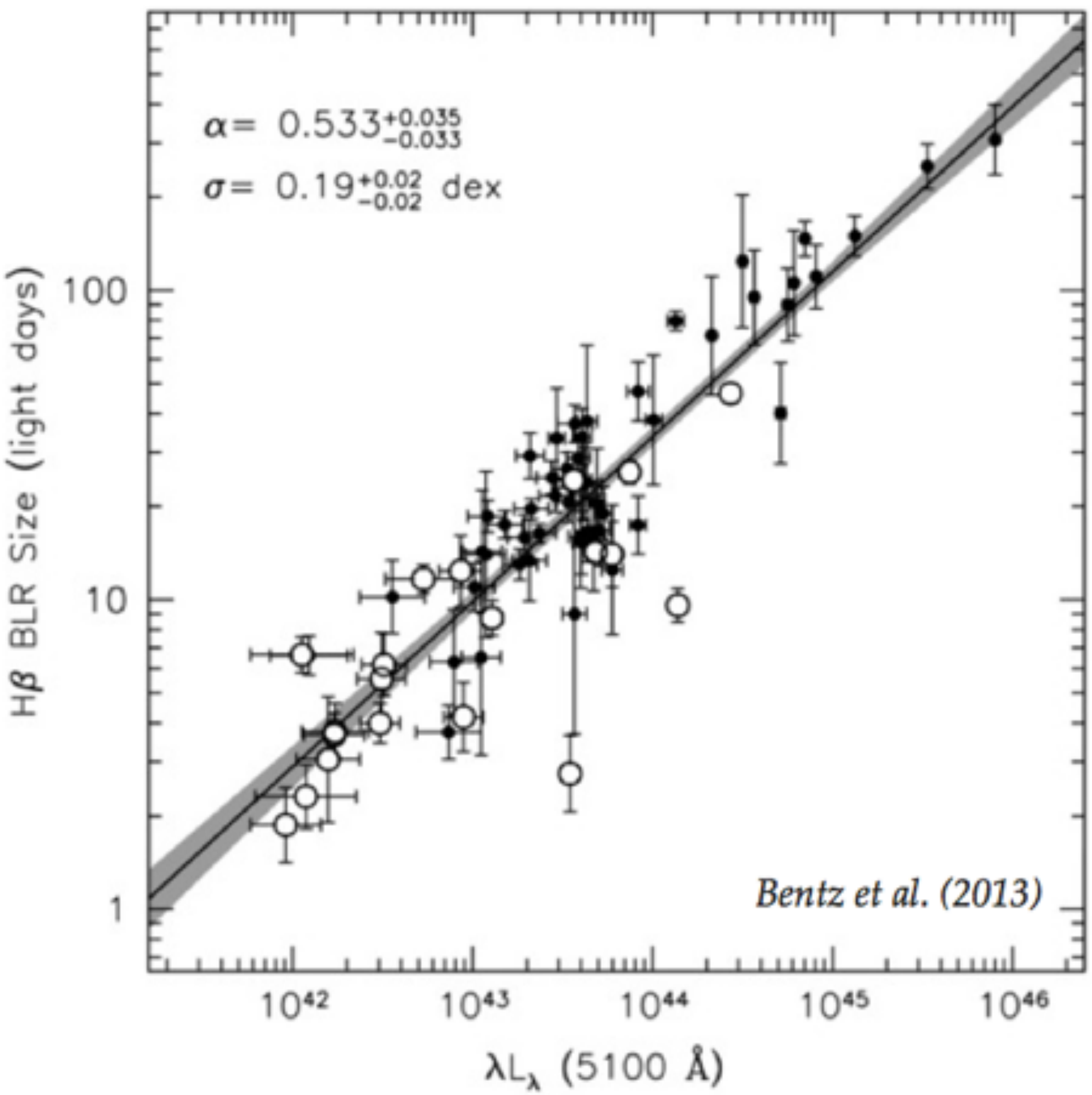
$$M_{\rm virial} = f\,RV^2/G$$

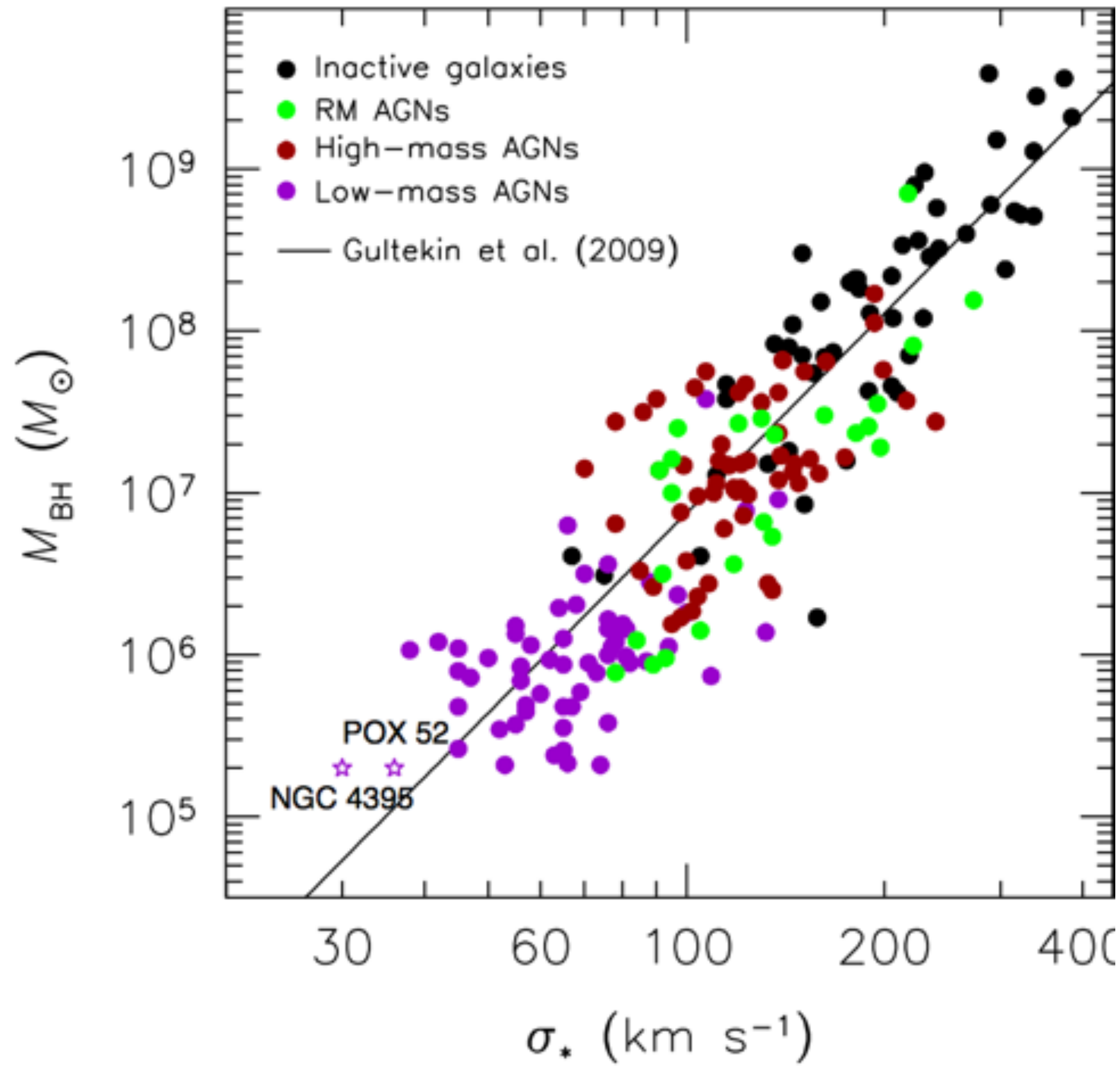


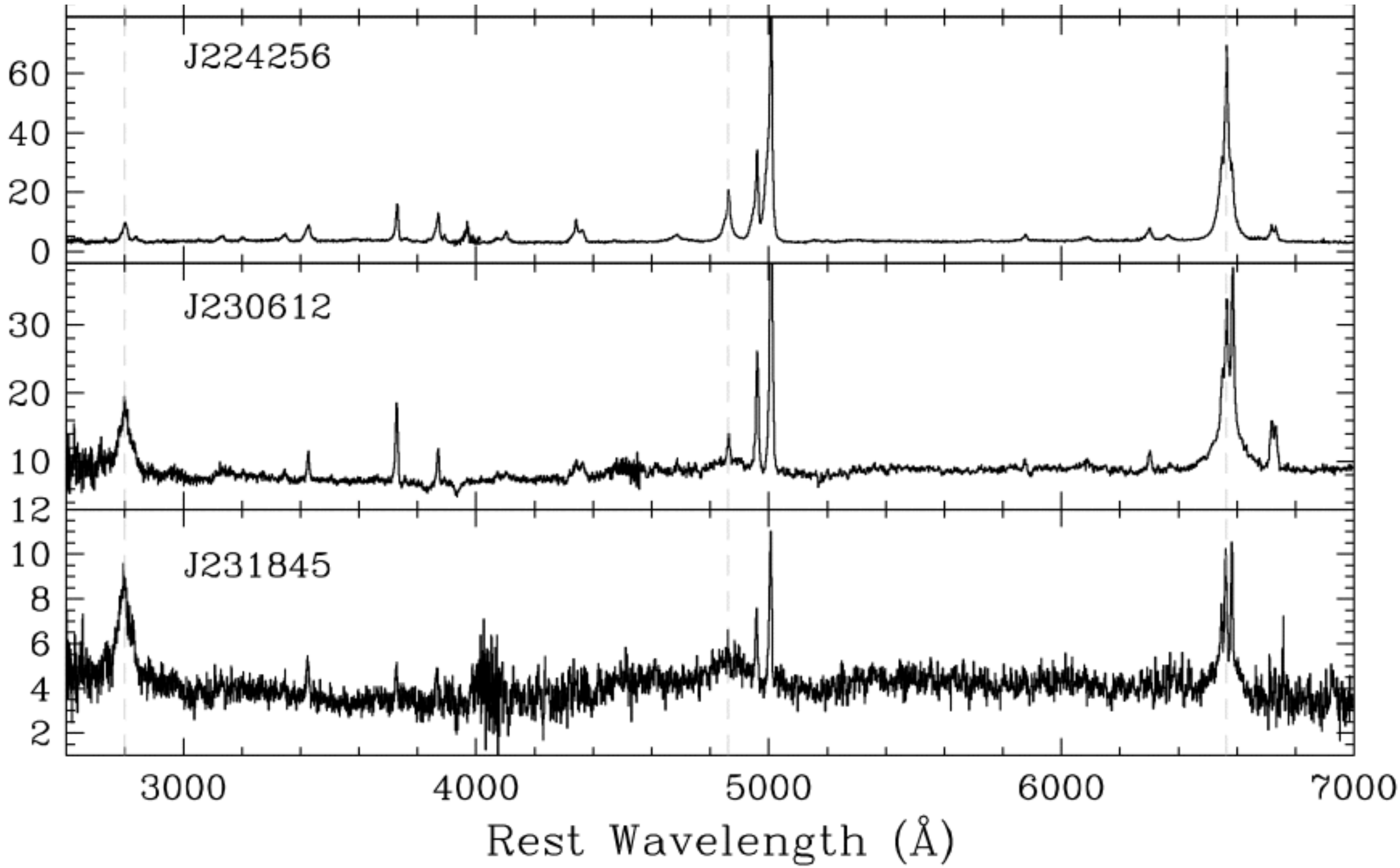
Peterson et al. (2002)



M_{BH} esitmation with empirical relationships

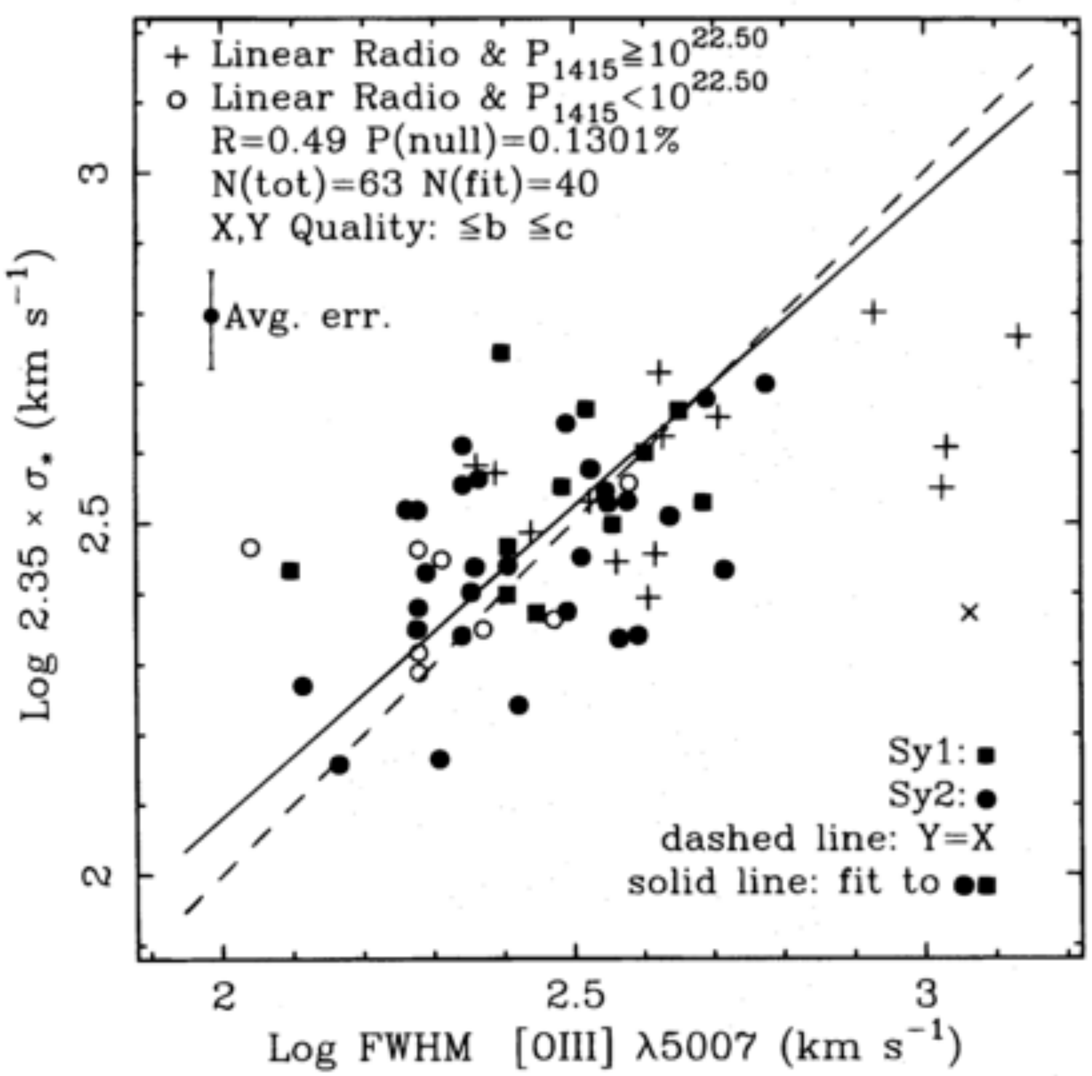




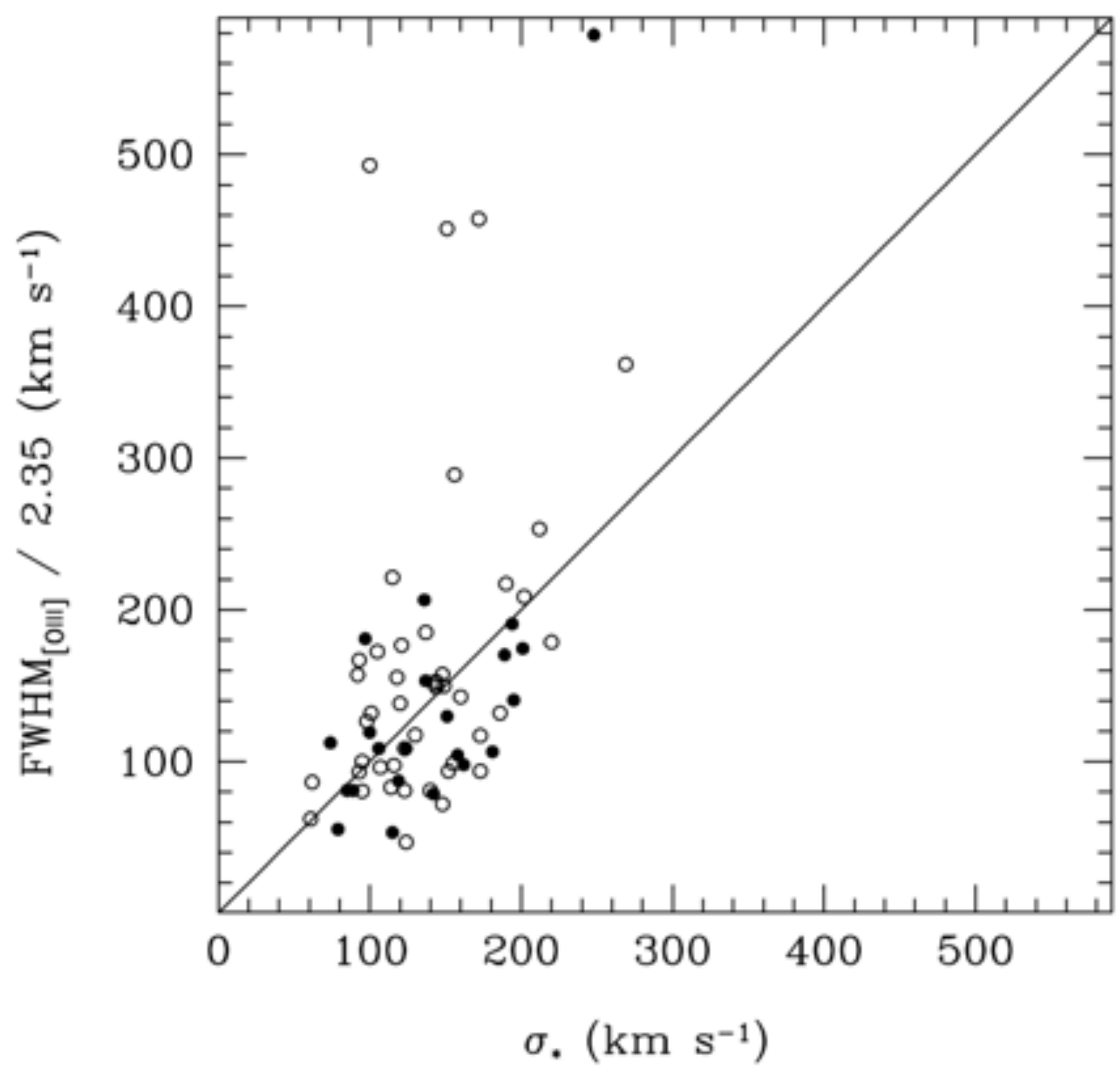


J224256
J230612
J231845
Rest Wavelength (Å)

Comparison of gas and stellar velocity dispersion

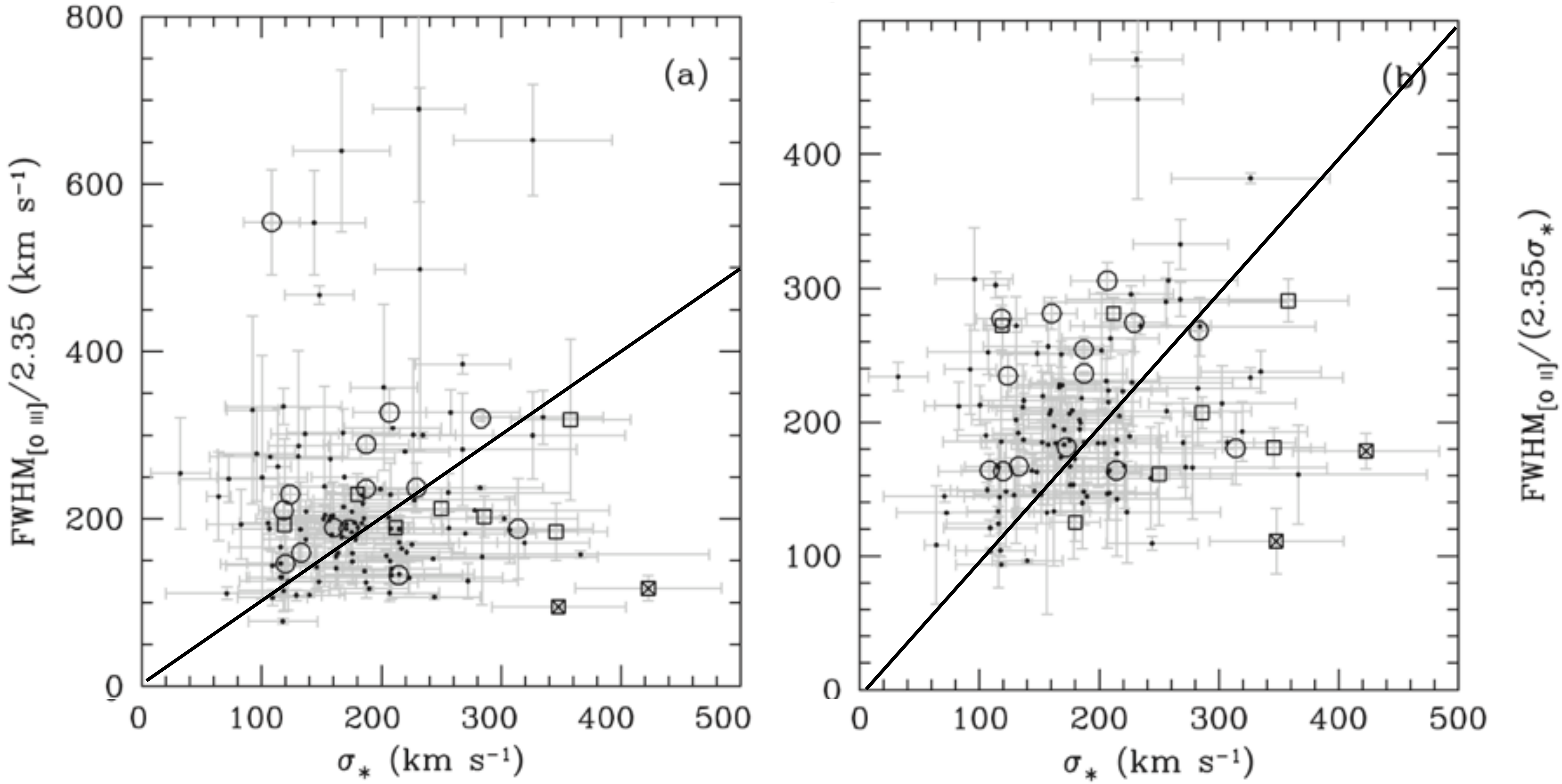


Nelson & Whittle 1996



Greene & Ho 2005

Similar comparison for type 2 Qsos



Greene et al. 2009

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

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

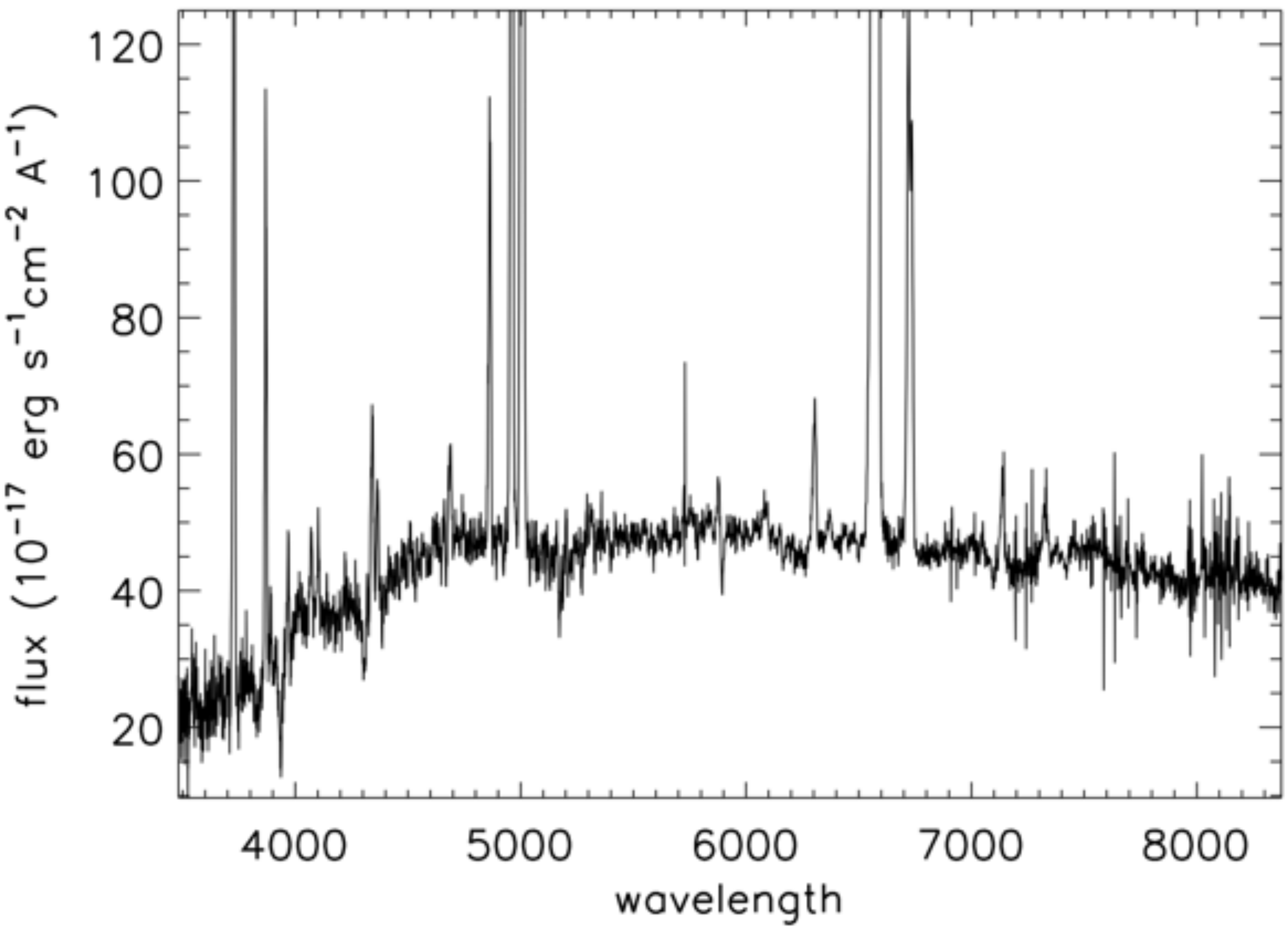
$$\mathcal{R} \equiv [\mathrm{O\,III}]5007/\mathrm{H}\beta$$

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

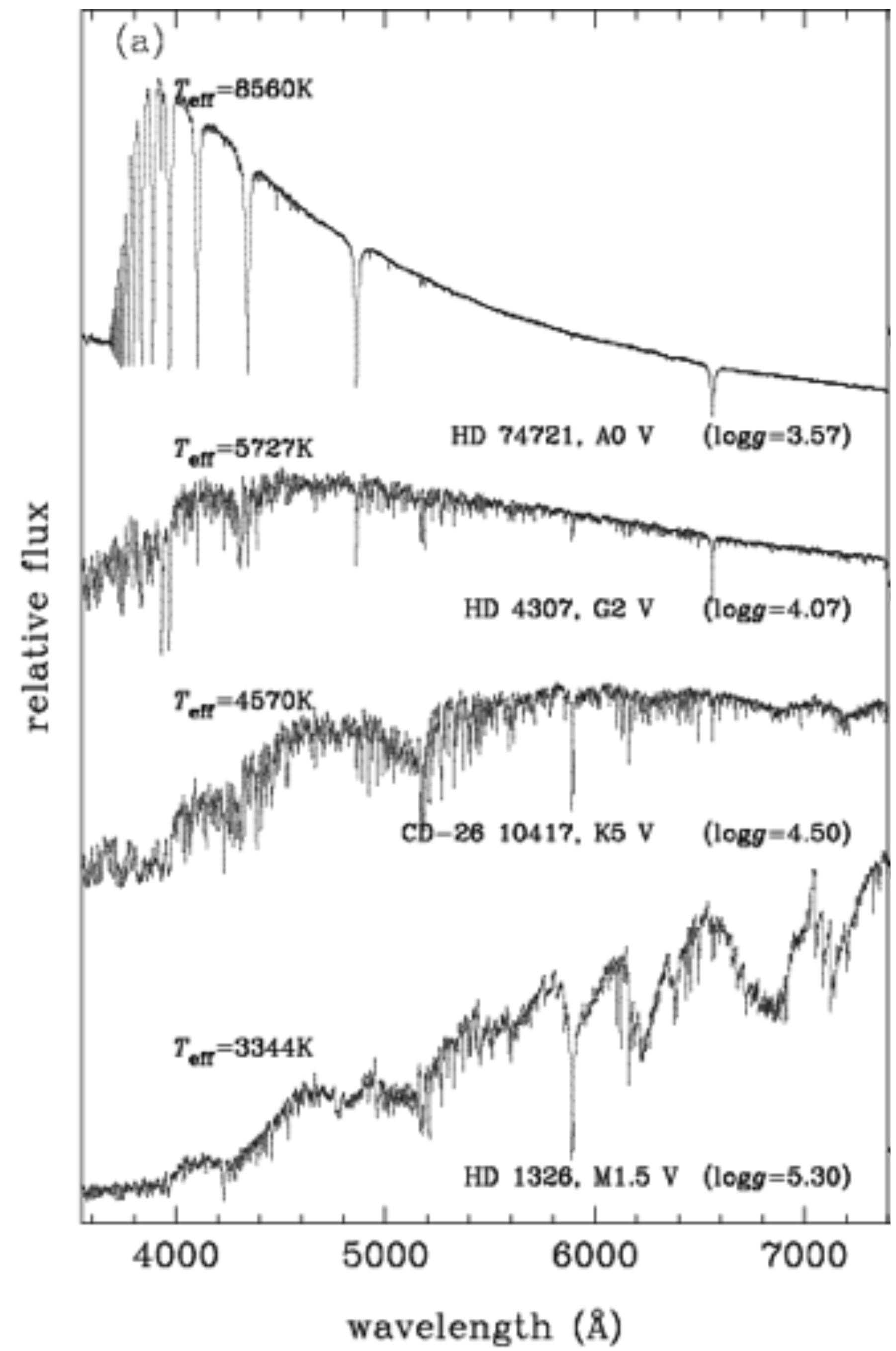
$\log(\mathcal{R}) > 0.3$, if Hβ is detected with S/N > 3 $\quad 0.36 \leqslant z < 0.83,$

- 887

Spectra of type 2 Qsos



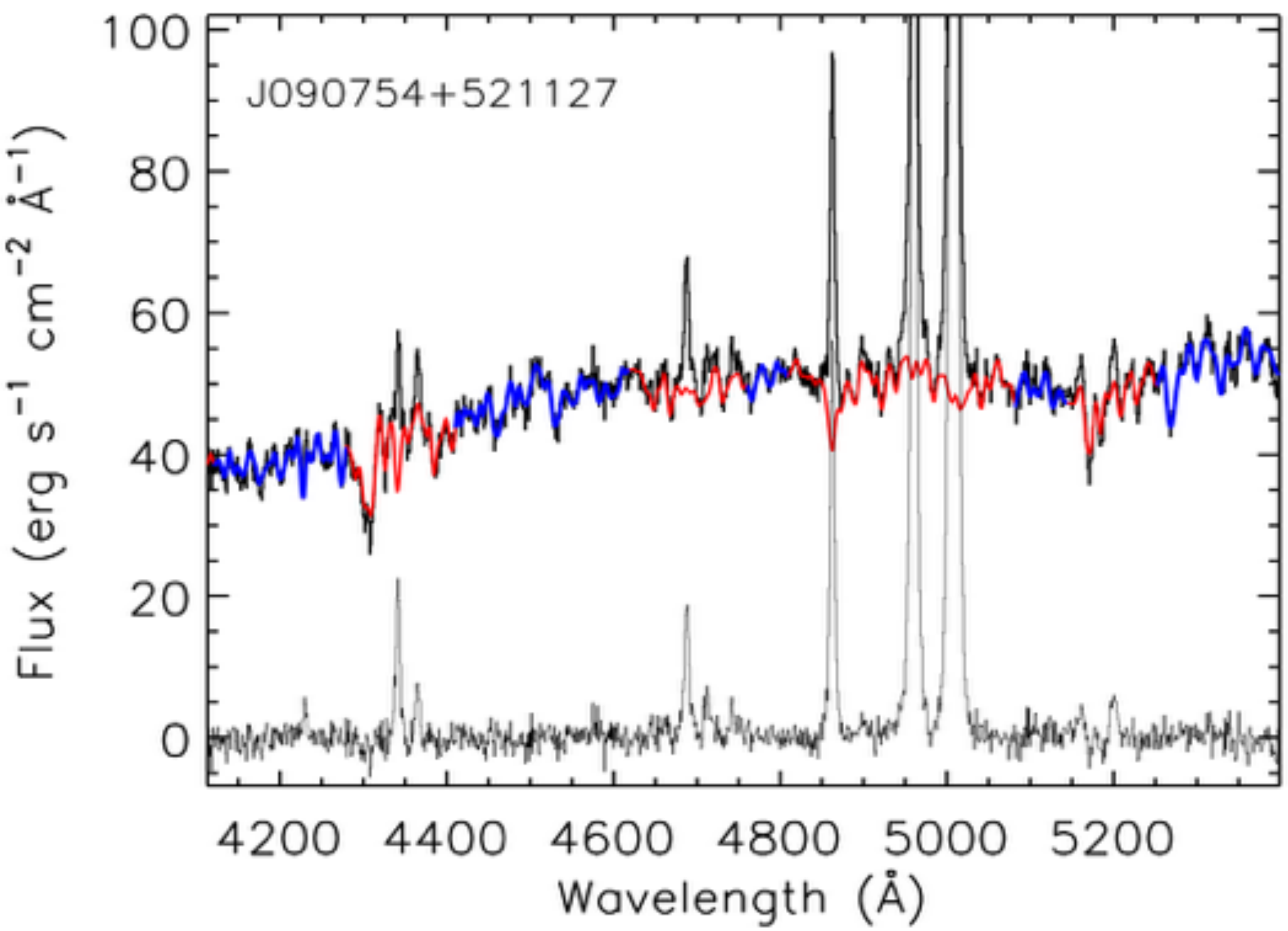
O B A F G K M



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

Data reduction

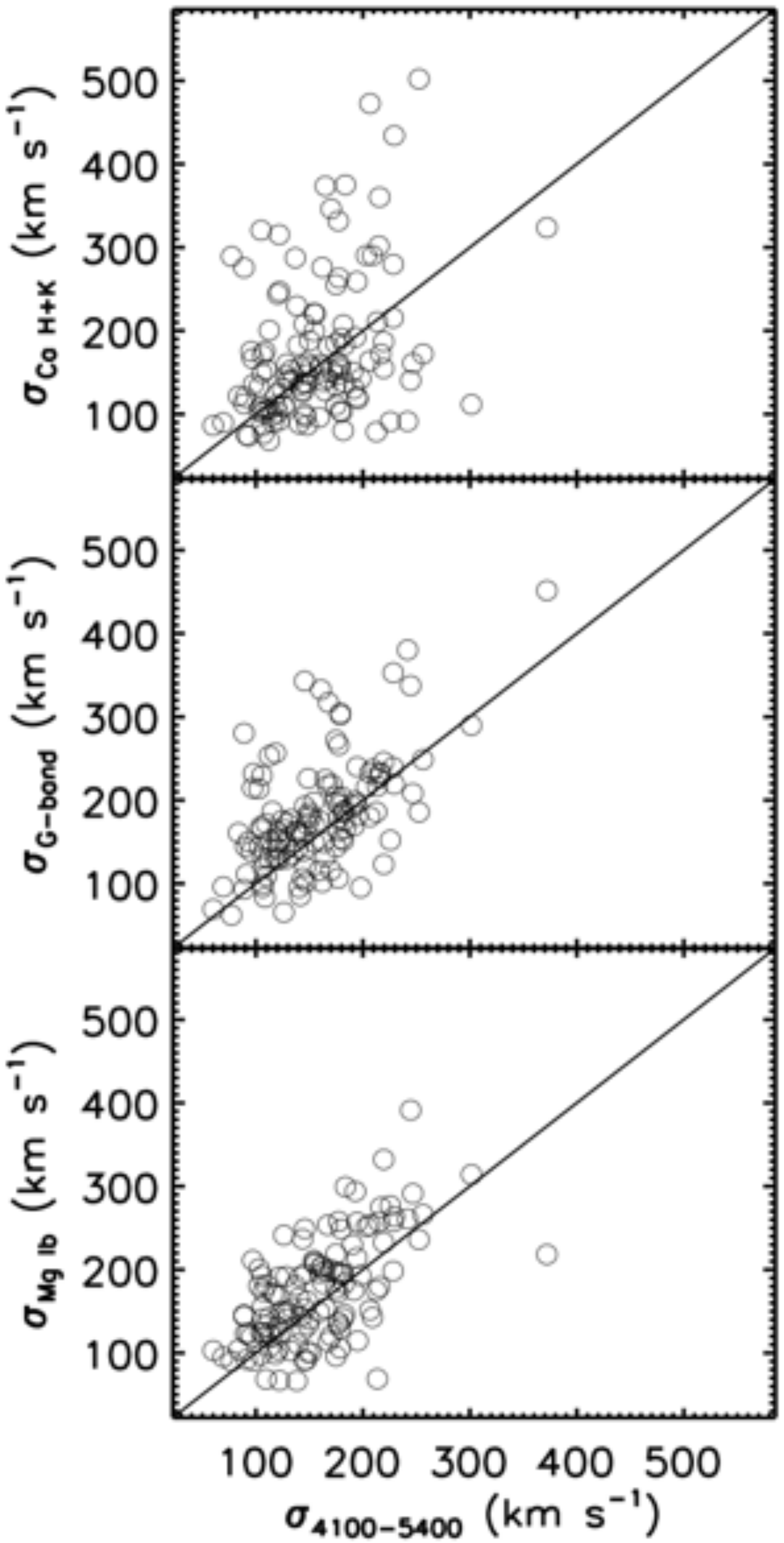
pPXF (http://www-astro.physics.ox.ac.uk/~mxc/software/)

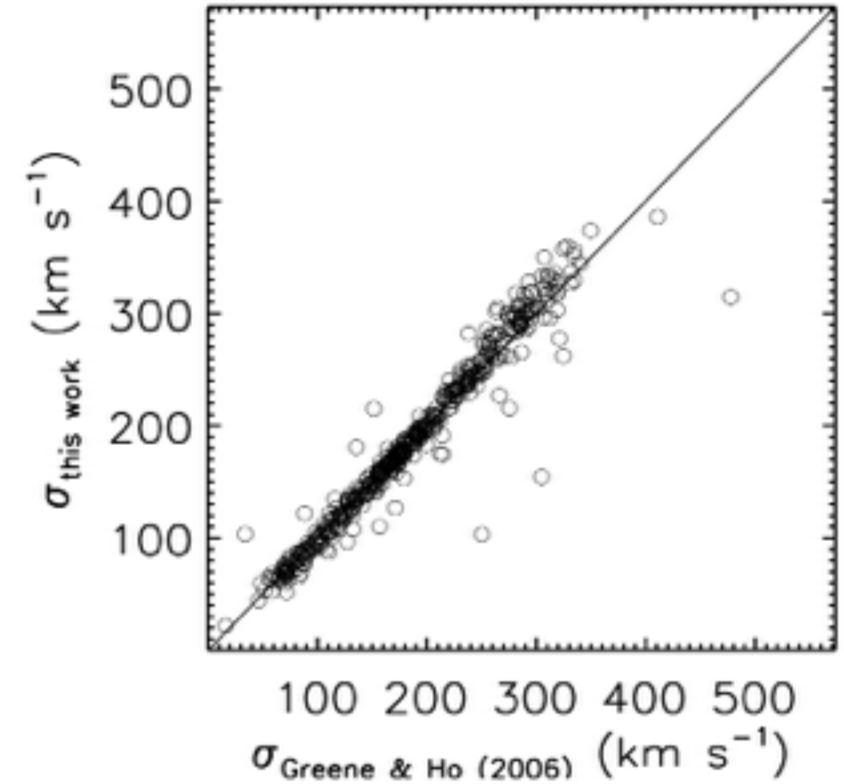


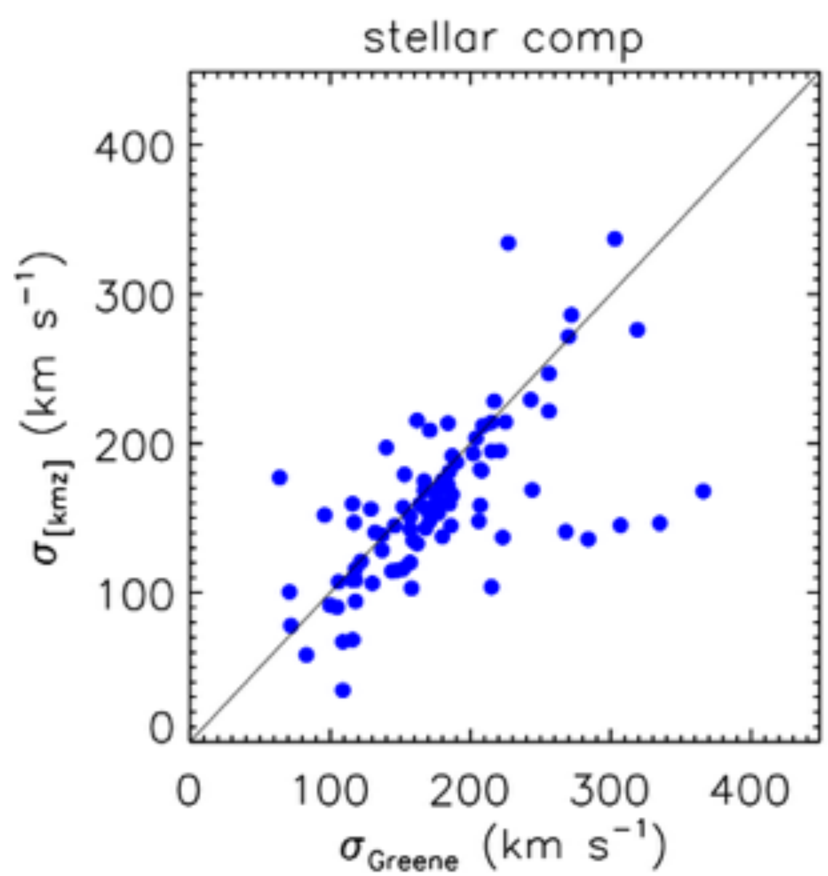
- galactic extinction
- mask emision lines (800 km s^{-1})
- stellar measurements *(stellar library: Valdes et al. 2004)*
- emission line measurements

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

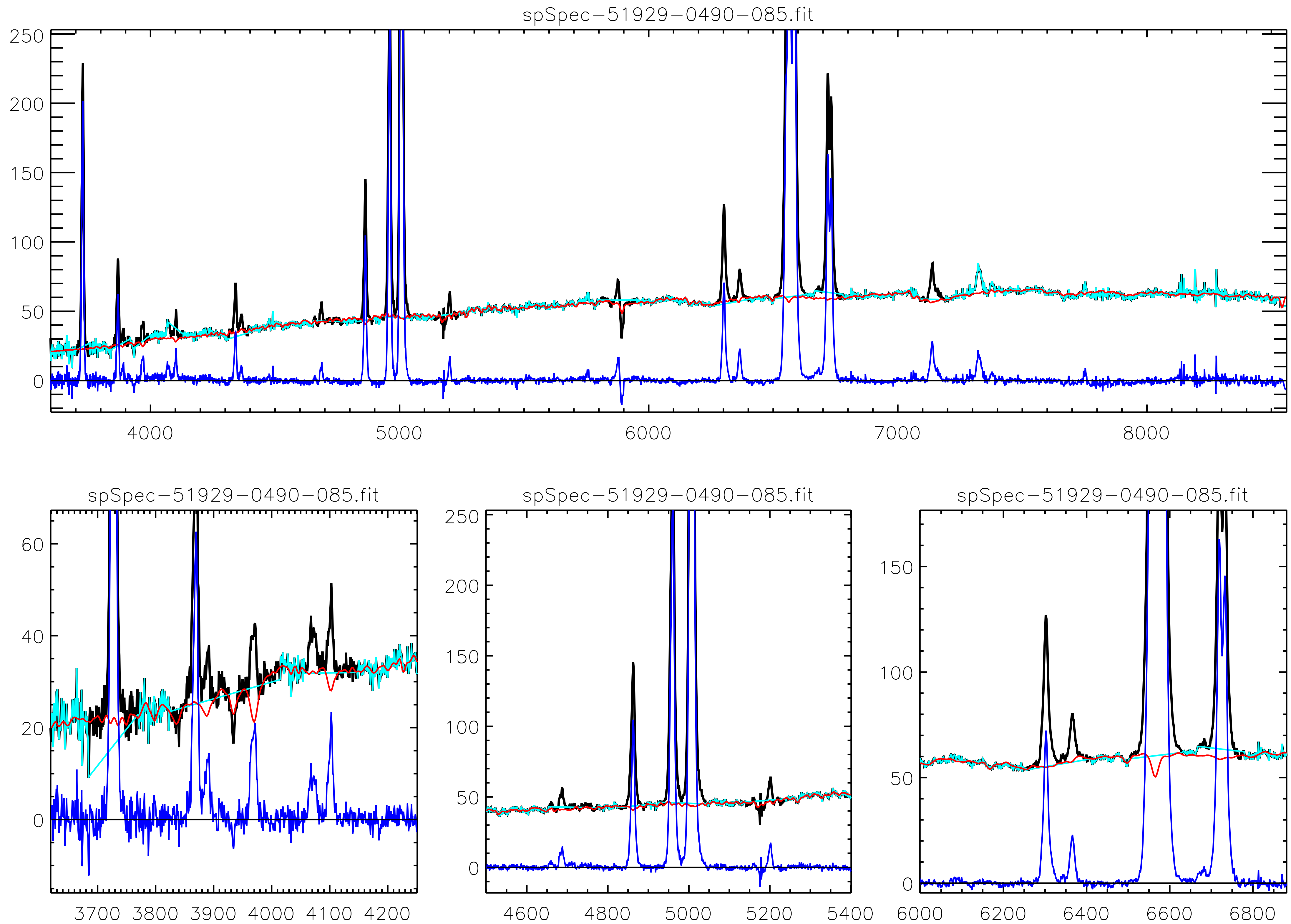
Data check

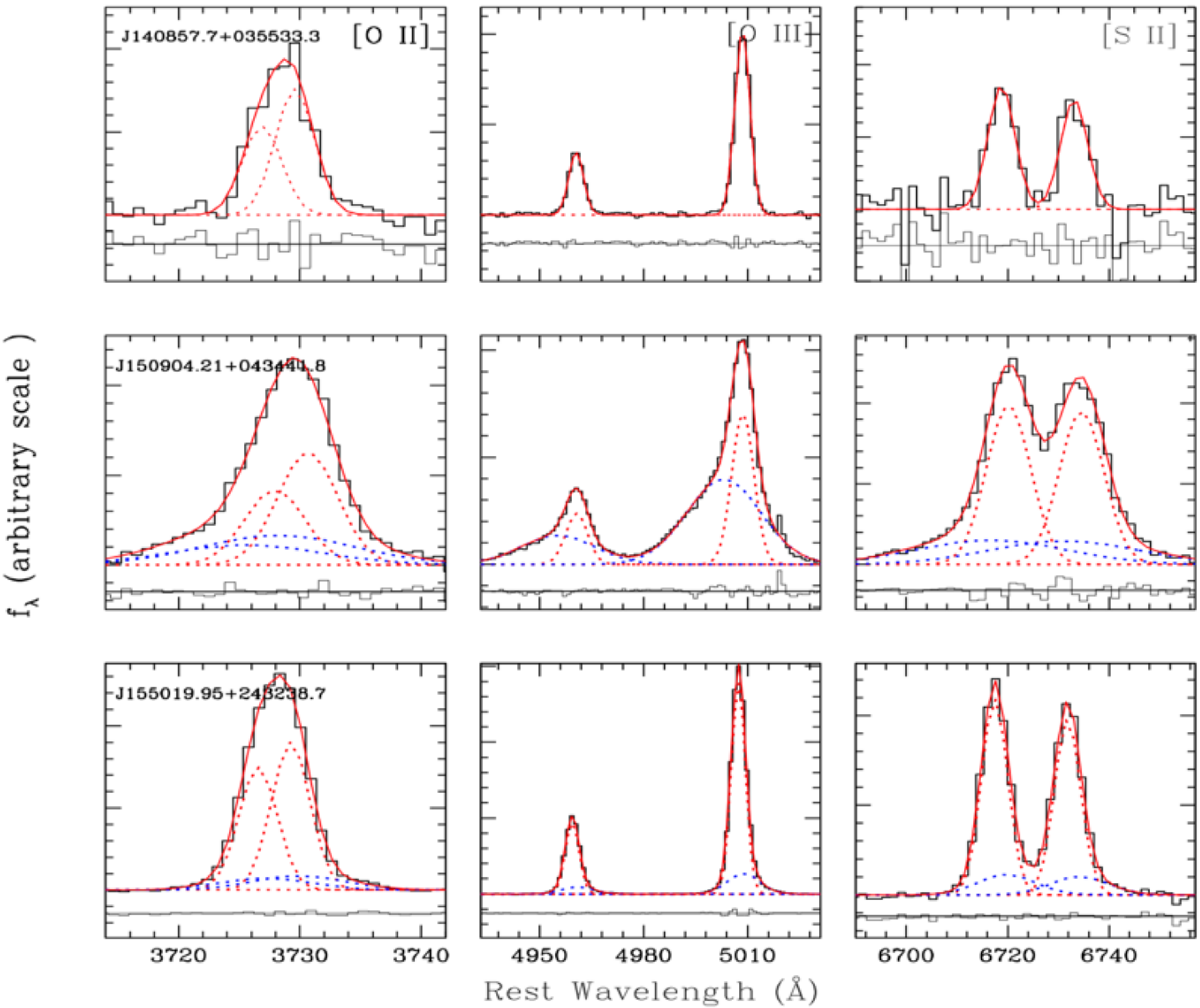

500
400
300
200
100
$\sigma_{Ca\ H+K}$ (km s^{-1})
$\sigma_{G\text{-}band}$ (km s^{-1})
$\sigma_{Mg\ Ib}$ (km s^{-1})
100 200 300 400 500
$\sigma_{4100-5400}$ (km s^{-1})


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


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

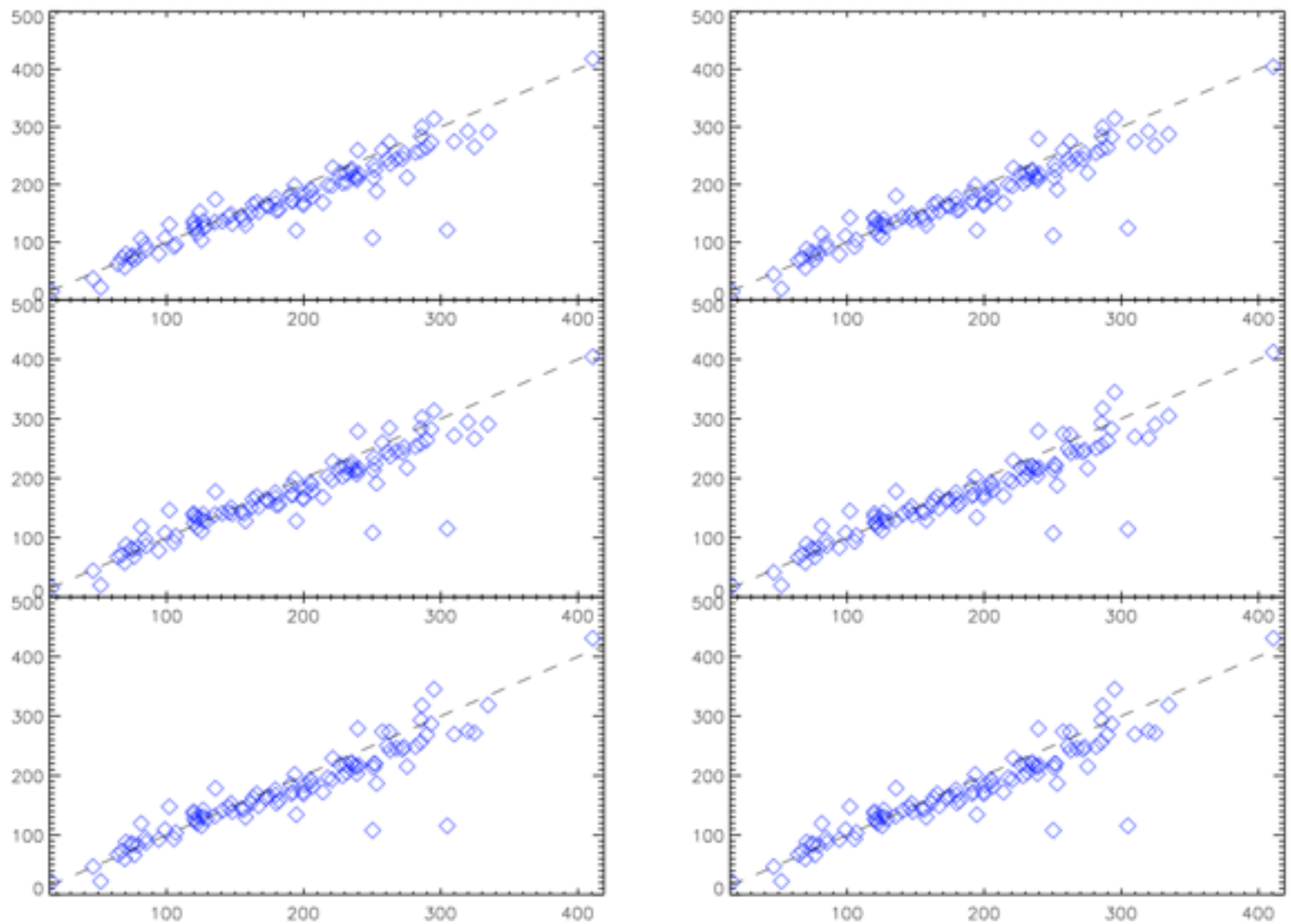
Emission line measurements





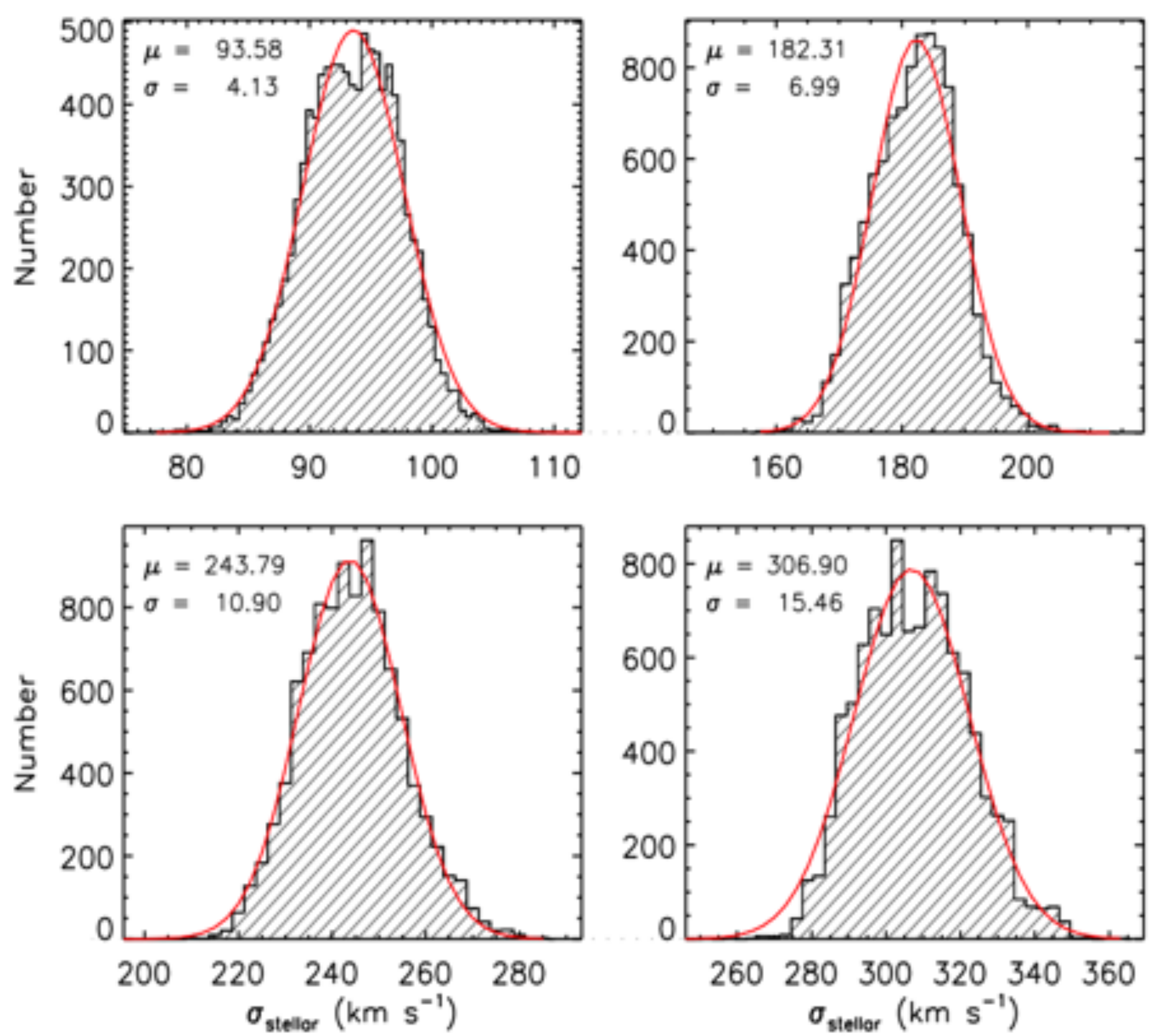
J140857.7+035533.3
[O II]
[O III]
[S II]
J150904.21+043441.8
J155019.95+243238.7
3720
3730
3740
4950
4980
5010
6700
6720
6740
Rest Wavelength (Å)
f_λ (arbitrary scale)

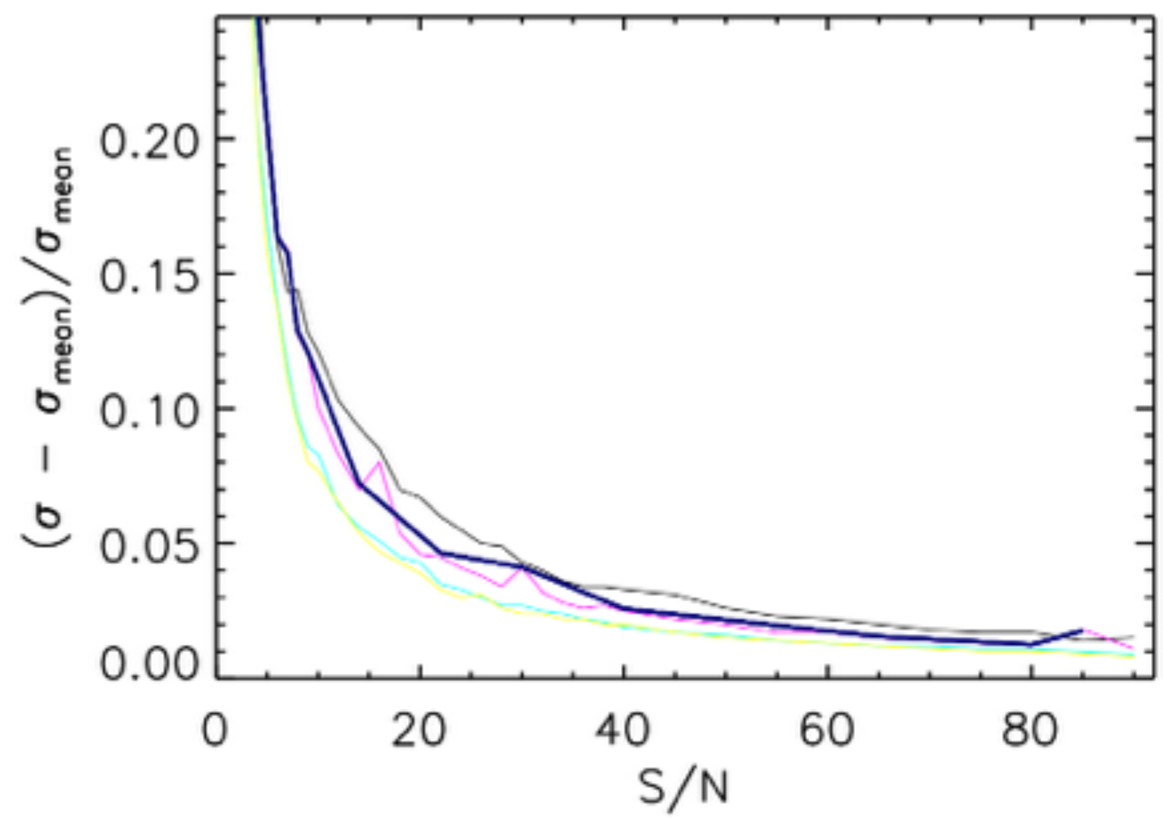
Data uncertainties I



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

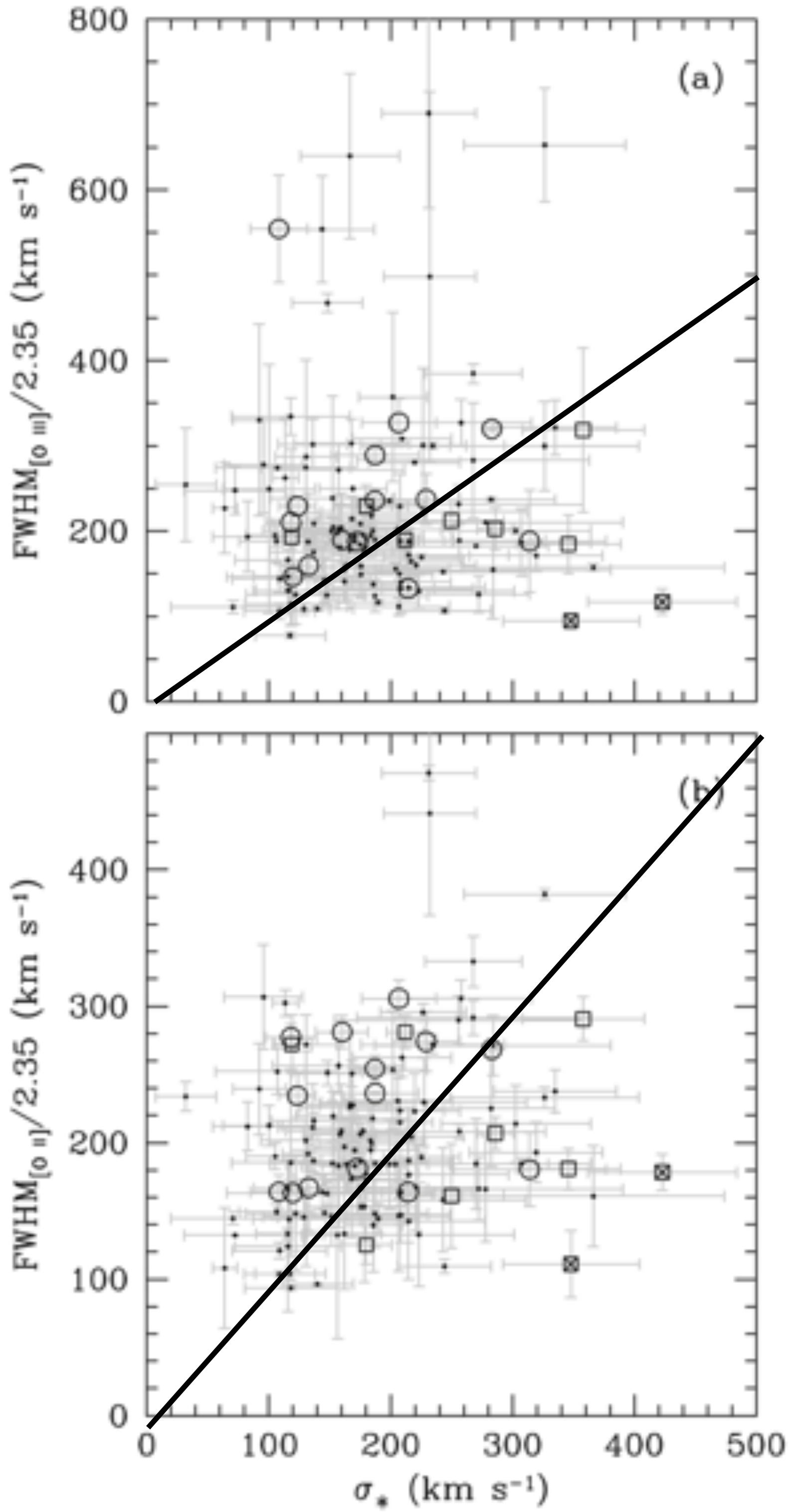
Data uncertainties II



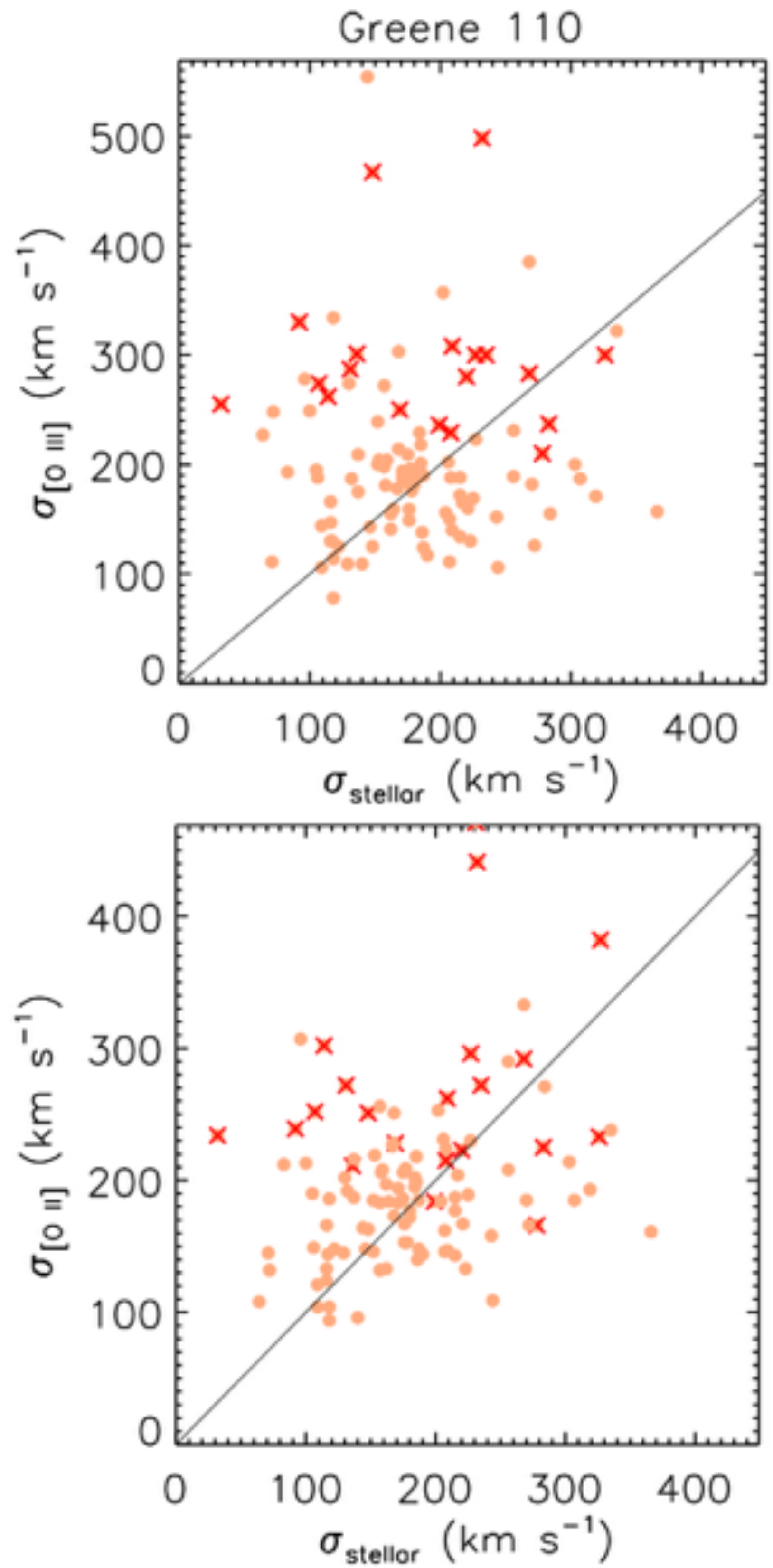


$$\sigma_{err} = \sqrt{\sigma_{err1}^{\ 2} + \sigma_{err2}^{\ 2} + \sigma_{err3}^{\ 2}}$$

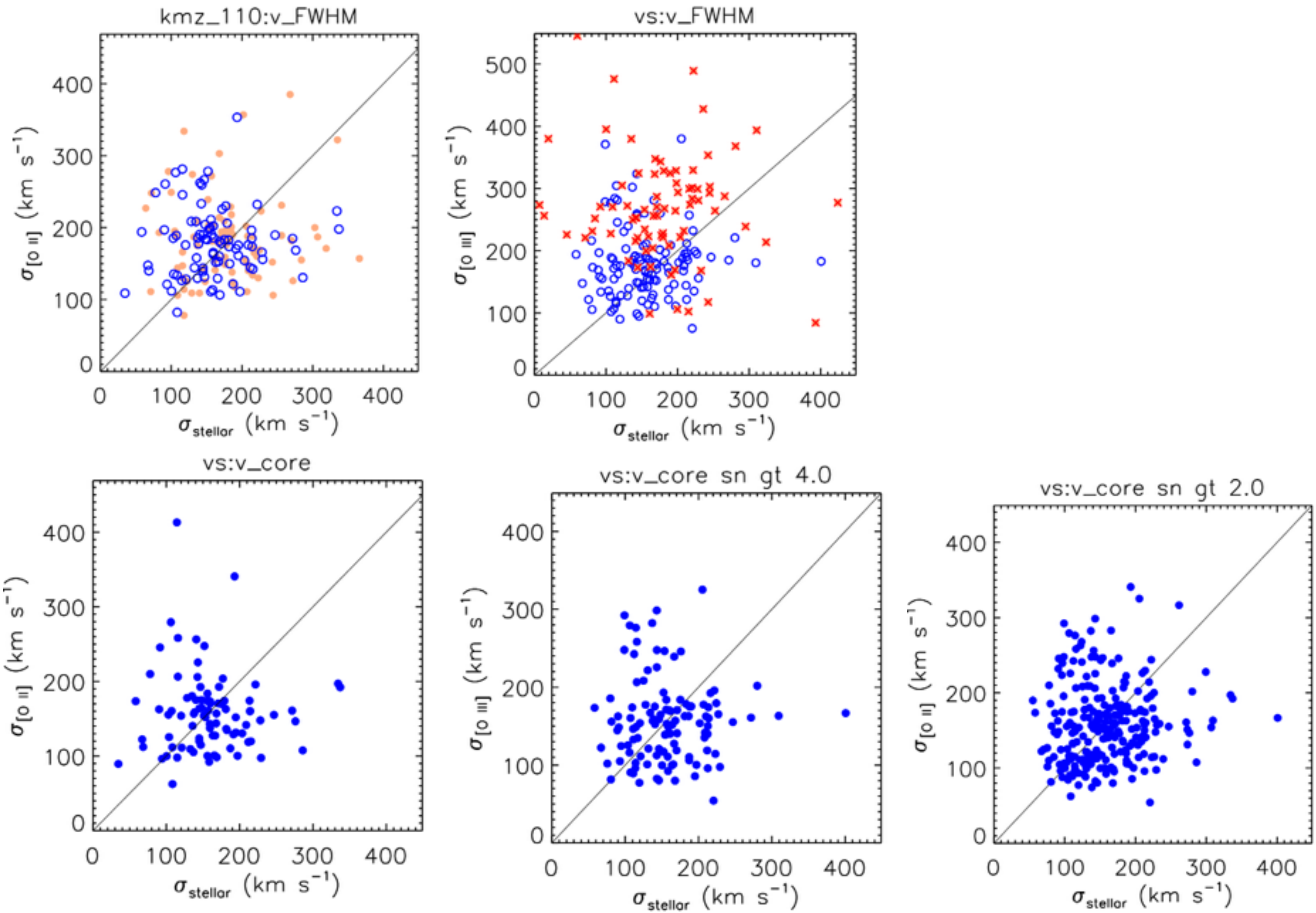
Results

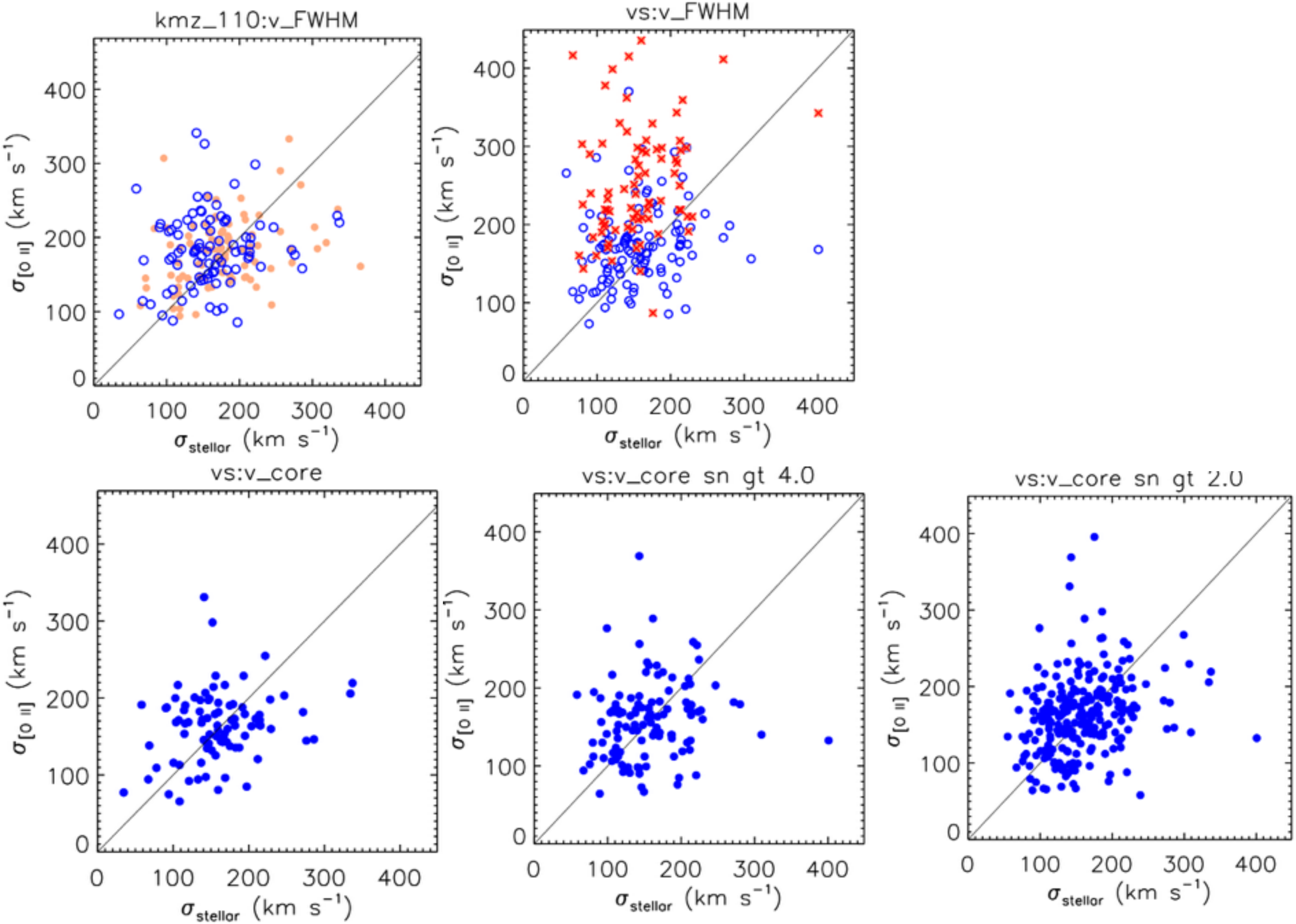


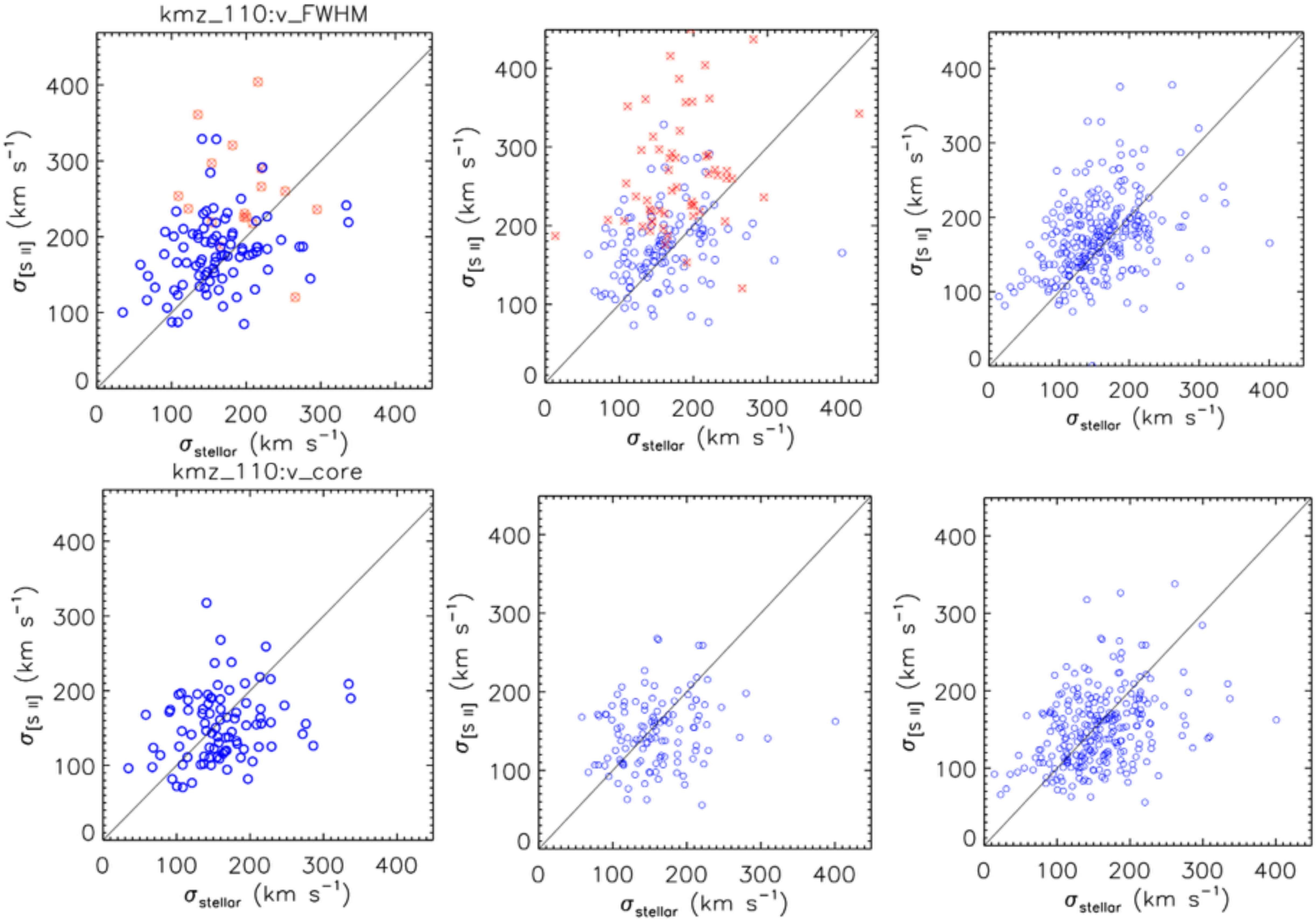
(a)
FWHM[O III]/2.35 (km s-1)
(b)
FWHM[O II]/2.35 (km s-1)
σ* (km s-1)



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



kmz_110:v_FWHM
kmz_110:v_core
$\sigma_{[S\ II]}$ (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%

- 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)