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Title	Central Velocity Dispersions of the GAMA Spectroscopic Database and Synergies with KiDS
Authors	D'AGO, GIUSEPPE, Napolitano, R. N., TORTORA, CRESCENZO, SPINIELLO, CHIARA, LA BARBERA, Francesco
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Central velocity dispersions of the GAMA spectroscopic database and synergies with KiDS

G. D'Ago - INAF-OACN

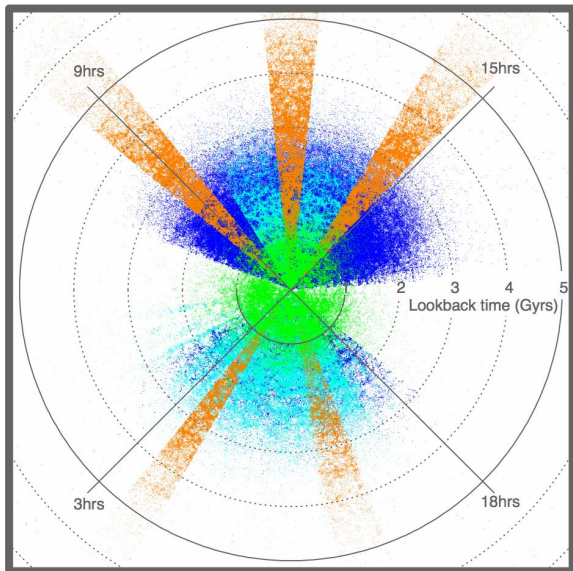
In collaboration with: N.R. Napolitano, C. Tortora, C. Spiniello, F. La Barbera



- ~ 270k spectra for galaxies < 19.8 mag collected at the Anglo-Australian Telescope (AAT)
- ~ 345k with SDSS, 2dFGRS, MGC
- ~ 286 deg² covered
- Spectra have been taken with the AAOmega MOS (580V + 385R)
- Averaged resolution: $R \sim 1300$
- λ range: **3727.49 Å - 8857.49 Å**
- Averaged SNR: $\sim 8/\text{pixel}$



Central velocity dispersions of the GAMA spectroscopic database



GAMA | 2dFGRS | SDSS DR9 | 6dFGS

Region	RA range	Dec range	Main survey limit
G02	30.2 - 38.8	-10.25 - -3.72	$r < 19.8$
G09	129.0 - 141.0	-2 - +3	$r < 19.8$
G12	174.0 - 186.0	-3 - +2	$r < 19.8$
G15	211.5 - 223.5	-2 - +3	$r < 19.8$
G23	339.0 - 351.0	-35 - -30	$i < 19.2$

KiDS!

Large-scale structure and galaxy evolution:

- growth rate of structure
- halo mass function
- star formation efficiency in groups
- stellar masses
- measure the recent galaxy merger rate ...

GOALS

Unrivalled combination of:

- Covered area
- Spectroscopic depth
- Spatial resolution
- Wavelength coverage (21-band)

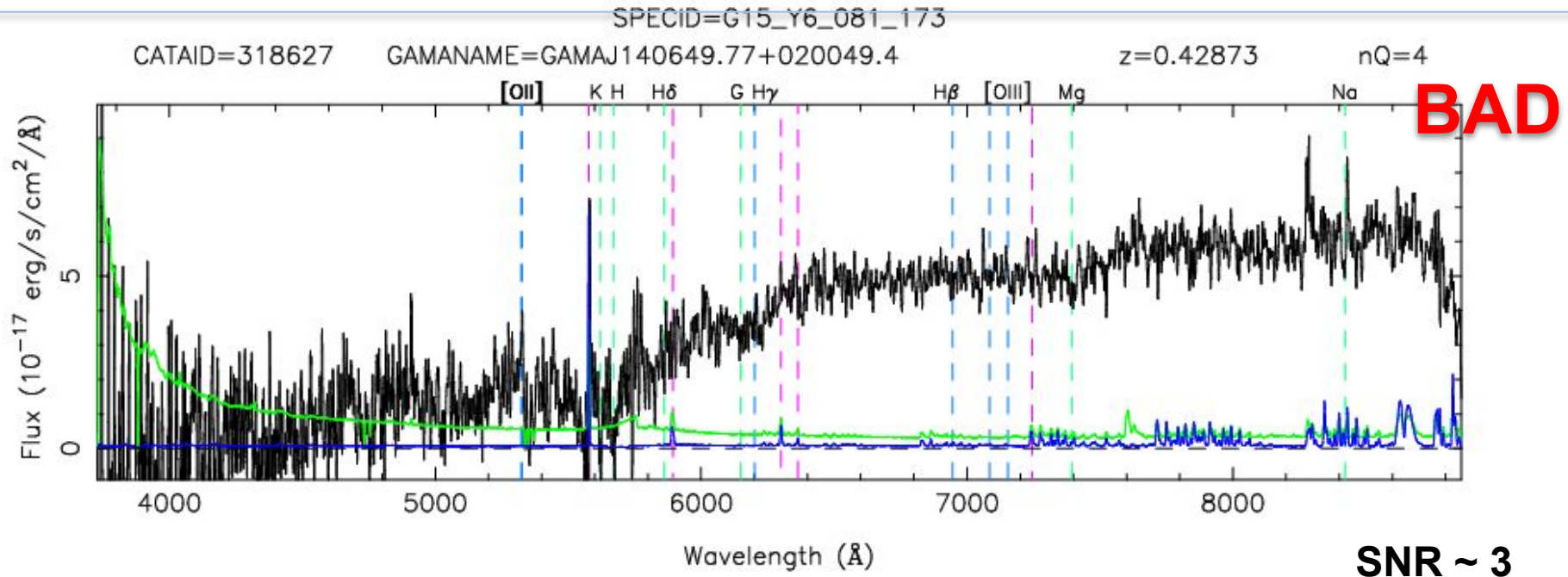
PROs

We already have redshifts for the whole database. **Velocity dispersion measurements are still missing!**

- key role in understanding the evolution of galaxies
- scaling relations
- dark matter fraction ...

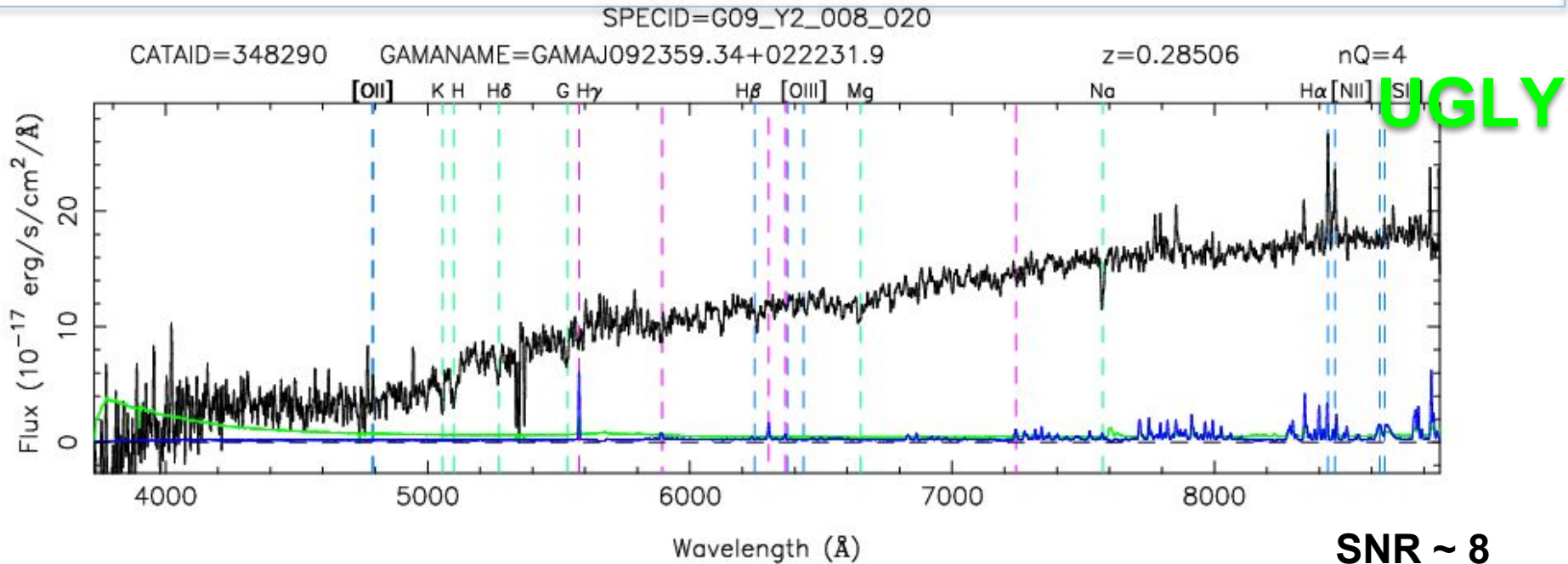
PPXF (Cappellari, 2017) is the state-of-the-art for measuring the internal kinematics of galaxies

- good selection of templates
- good quality spectra (in terms of SNR and features)
- good choice of the initial guess
- optimal pixel-masking
- SNR > 8? (Hopkins et al. 2013)



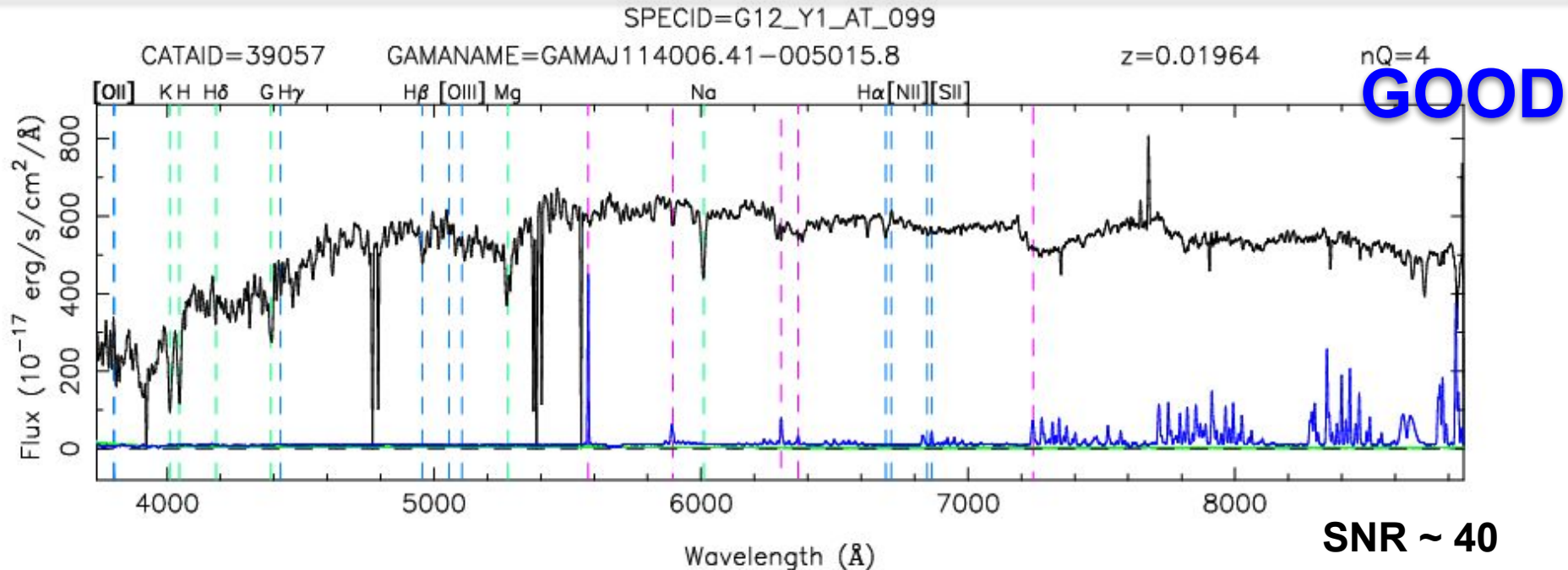
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THE SETUP:

- Selection of **45 MILES SSP** (IMF: un $\Gamma=1.3$, met: $-2.27 - 0.40$, age: $0.03 - 14$ Gyr)
- $\Delta\lambda_1$: 3850-6000 Å, $\Delta\lambda_2$: 4500-6800 Å
- **Call-K, Call-H, Hdelta, G-band, Mg, Na**
- **$0.003 < z < 0.9$** (reliability redshift range)
- conservatively masking typical gaseous lines
- very low cut on SNR (let's try to exploit the most of the spectra, by selecting $\text{SNR} > 3$)
- $nQ > 2$
- **COMMENTS_FLAG==0** (it means no bad spliced or fringed spectra)

GAMA provides with reliable redshift estimates, making things really easy...

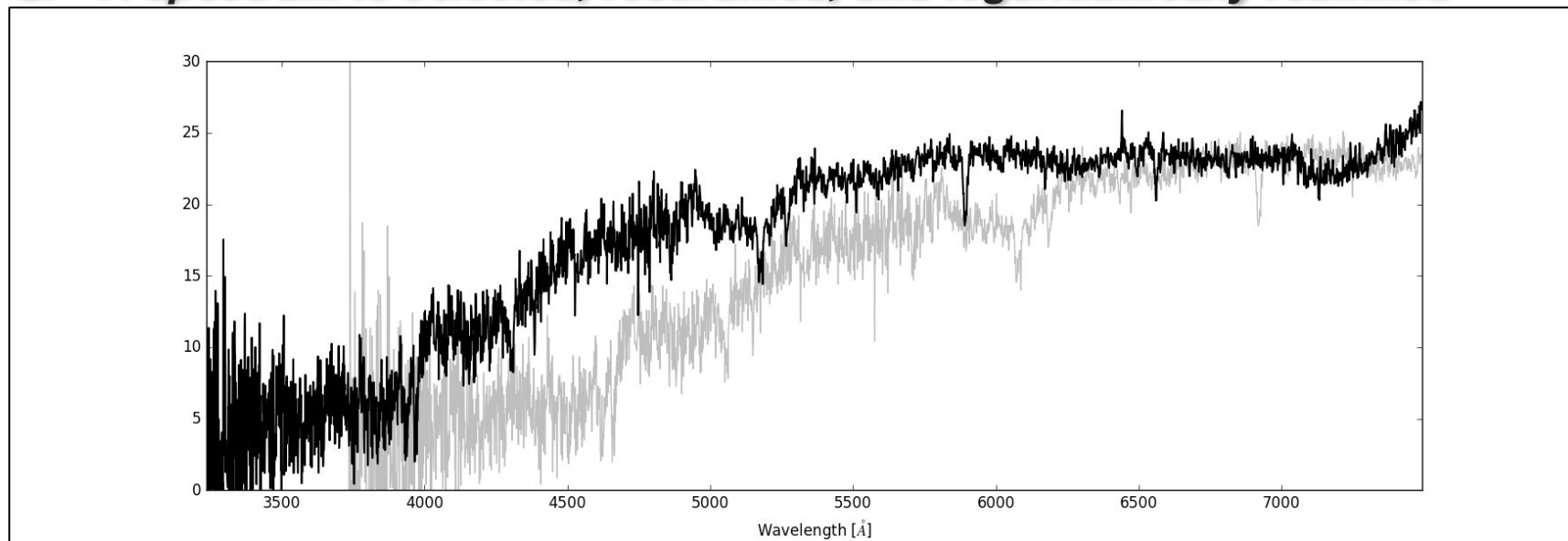
...we exploit a BOOTSTRAP pipeline in order to extract velocity dispersions!

Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

- 1. Templates are loaded just once for the whole pipeline run**
- 2. A spectrum is selected, restframed, and logarithmically rebinned*
- 3. Spectrum is trimmed according to redshift*
- 4. Templates are logarithmically rebinned to the instrumental velocity scale, and are convolved with the instrumental FWHM -> building up the template matrix*
- 5. Typical gaseous lines are conservatively masked*
- 6. PPXF runs in sigma-clipping mode iteratively and every time the noise is adapted in order to find the optimal noise level and a pixel mask*
- 7. BOOTSTRAP: 256 fitting conditions (moments and polynomial degrees) are randomly set and 256 simulated spectra are generated from the original one according to the noise -> 256 fits run in parallel mode*
- 8. Our best velocity dispersion estimate is stored as the mean and standard deviation of the 256 fits*

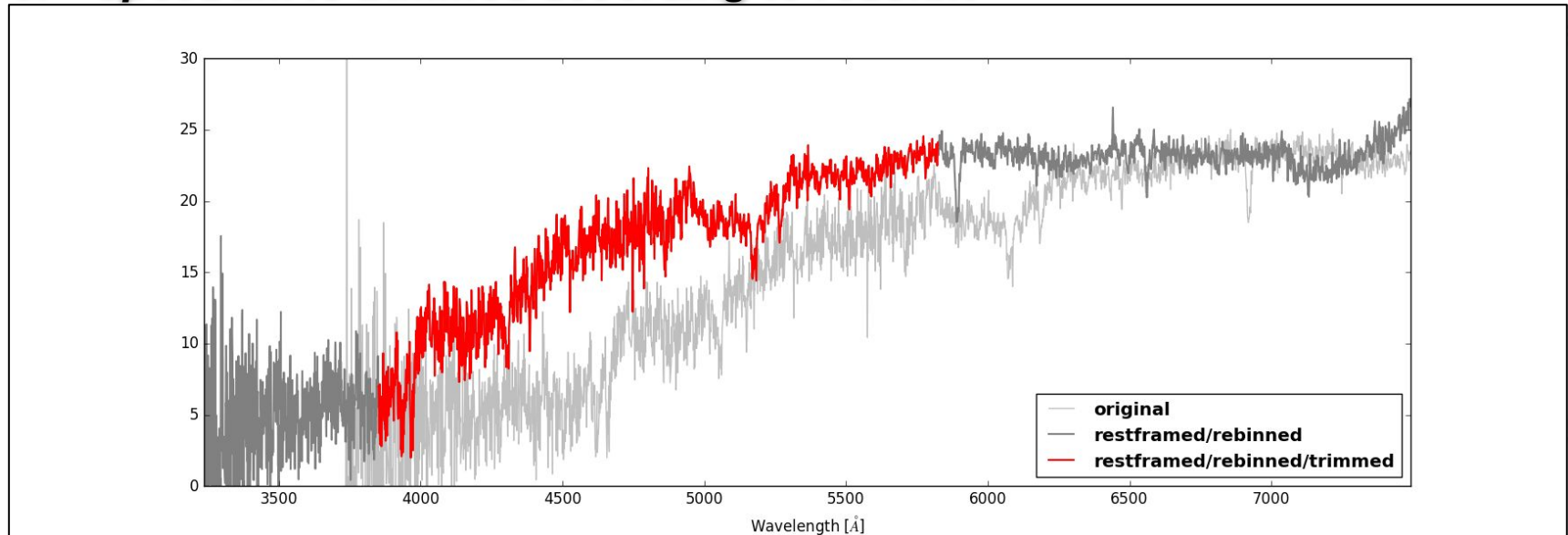
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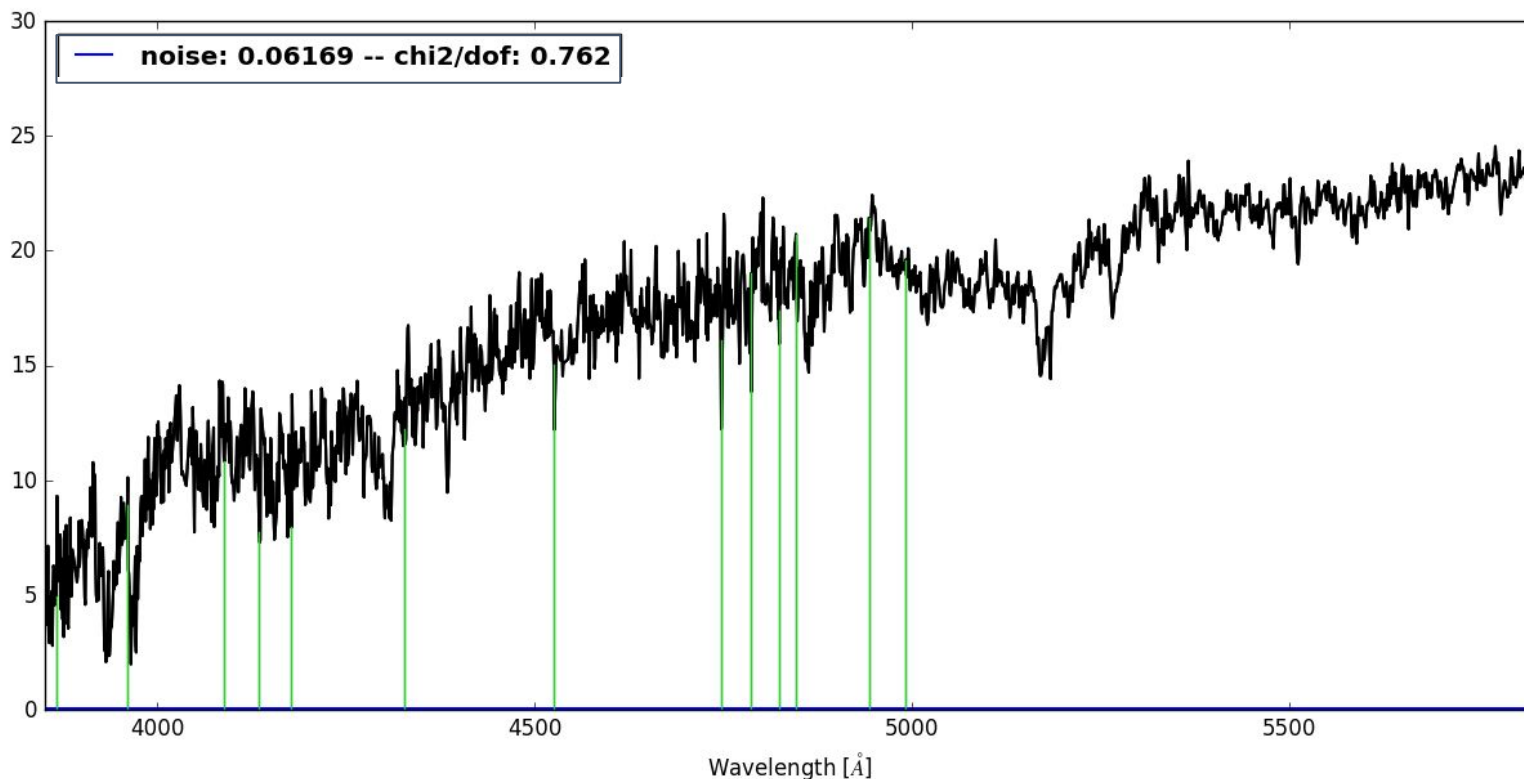
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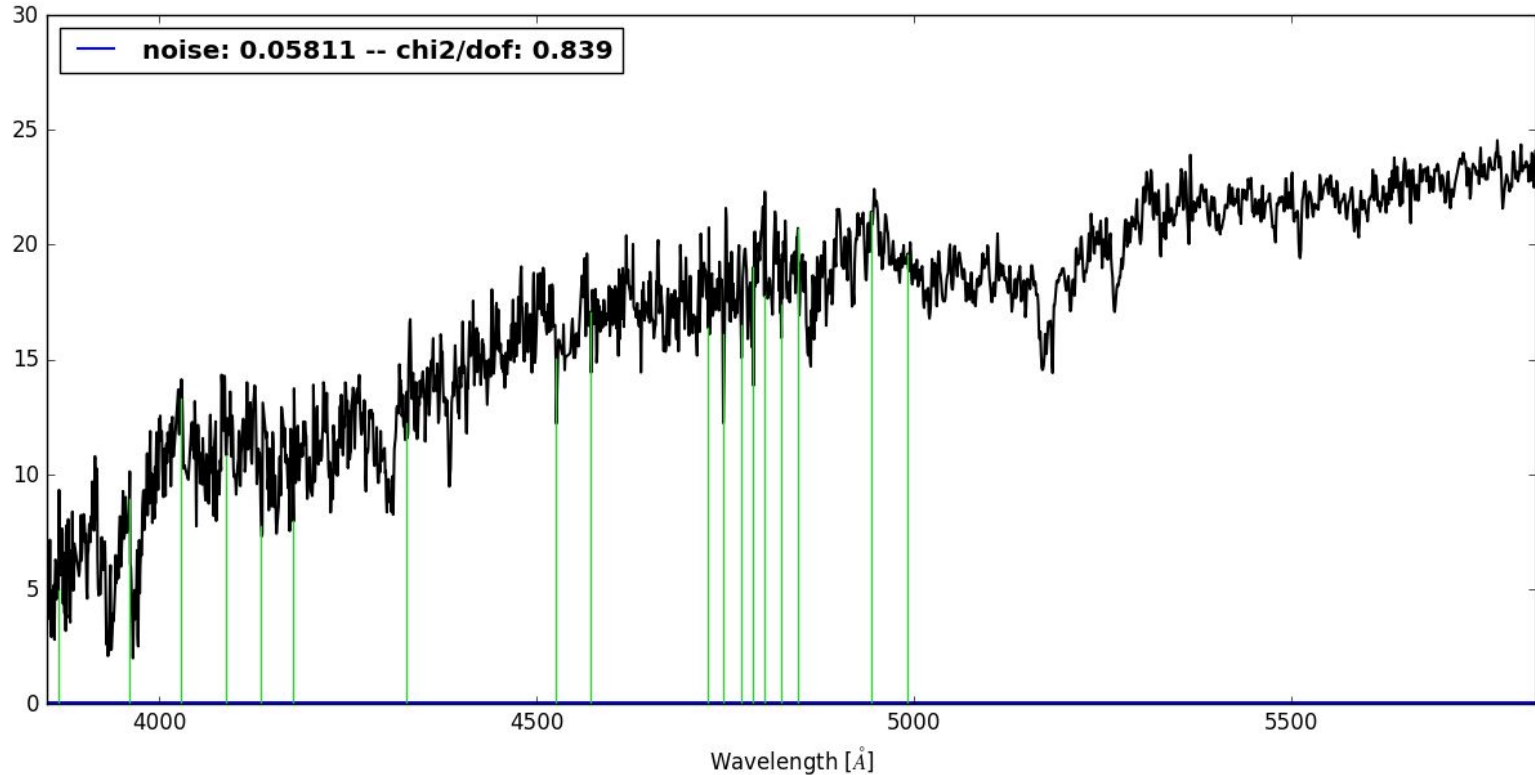
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```
[4 - 5/84626] Start fitting G09_Y2_004_377.fit at z=0.17459 and SNR_gama=16.21
Optimising noise and pixelmask...
chi2/DOF: 0.762
chi2/DOF: 0.839
chi2/DOF: 0.908
chi2/DOF: 0.963
chi2/DOF: 1.034
Fit0 sigma: 181.200712287 +/- 14.7083389759 km/s,   chi2=1.0344
Starting simulations... 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
```

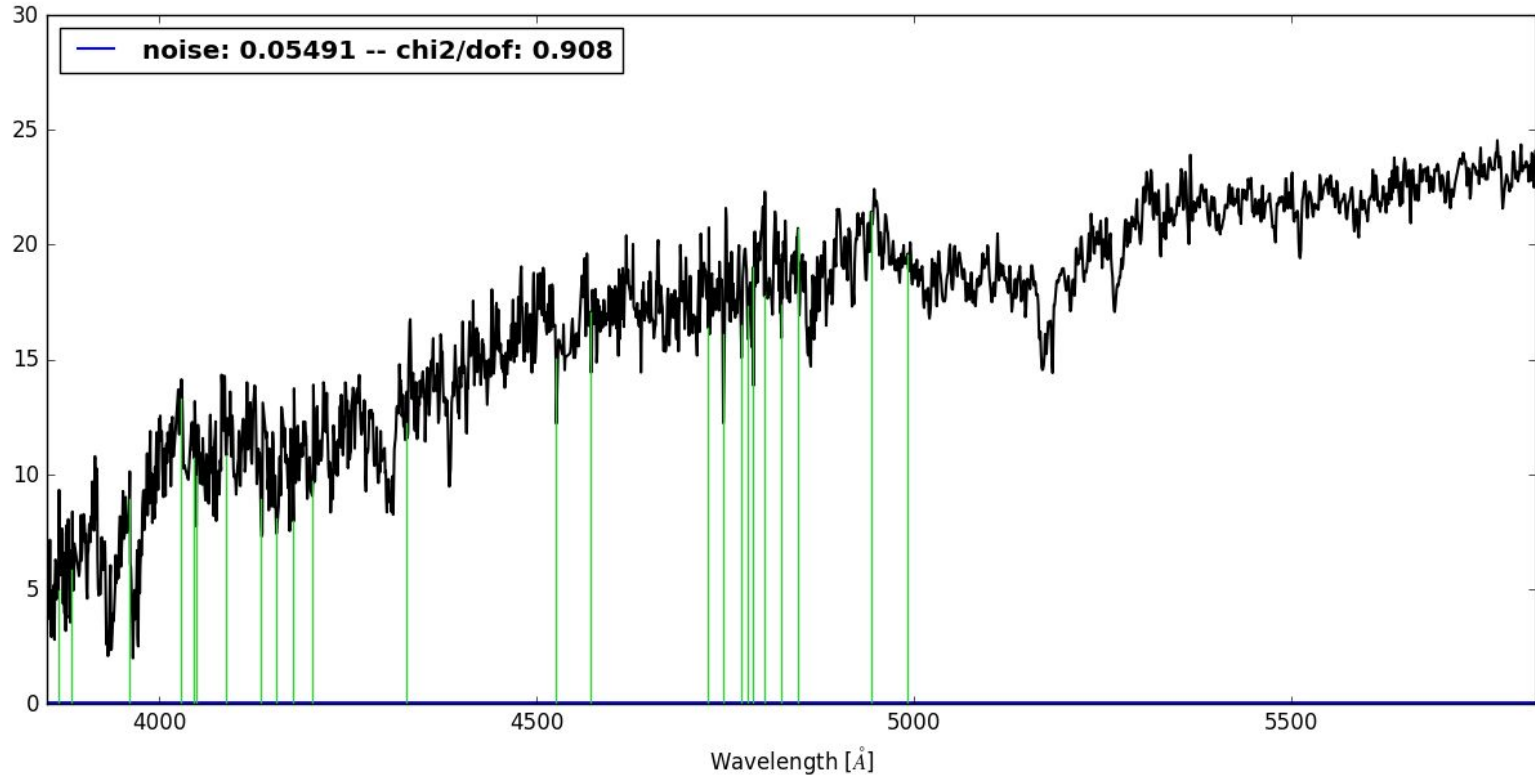
Optimised Modelling of Early-type Galaxy Aperture Kinematics (Ω MEGA-K)



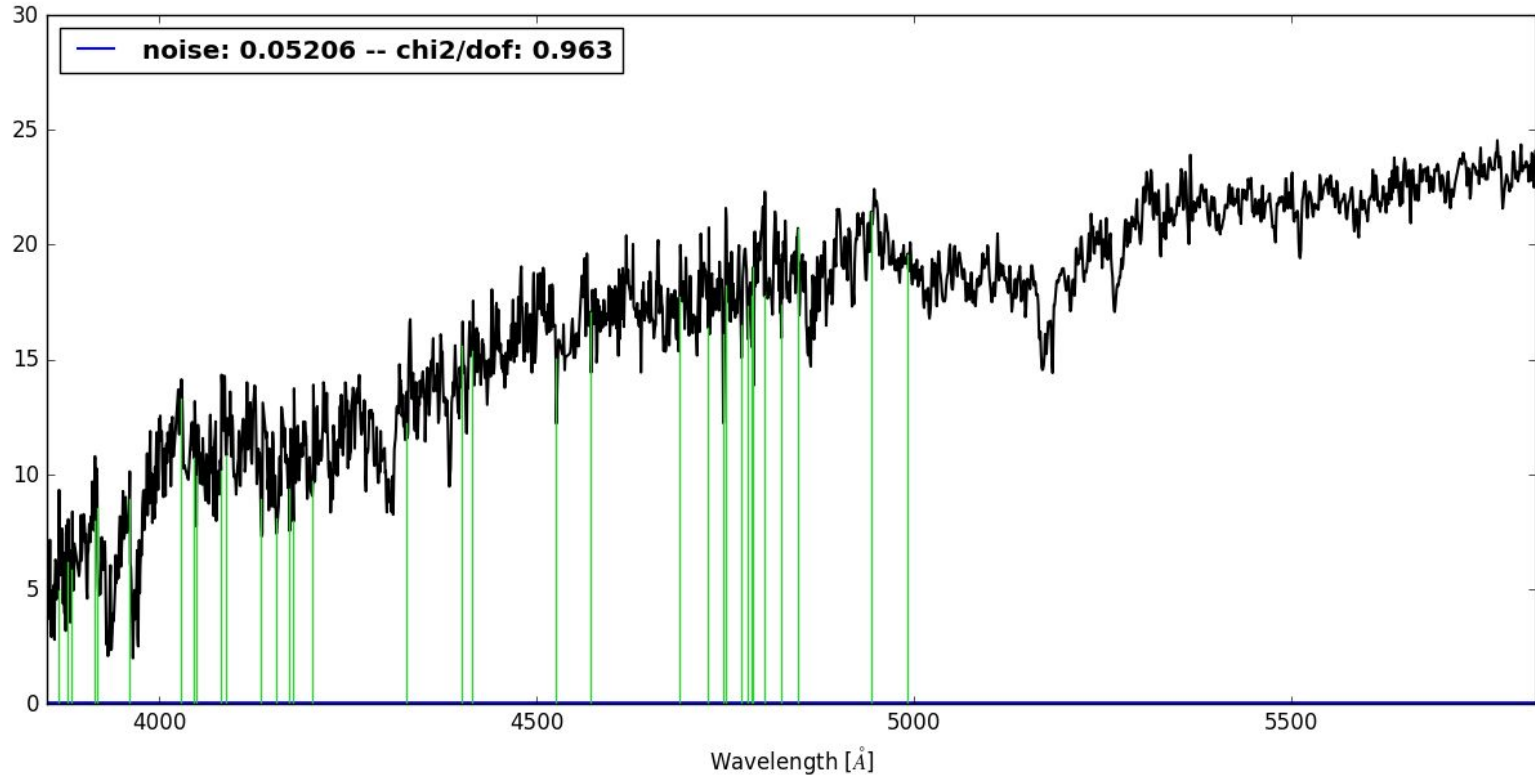
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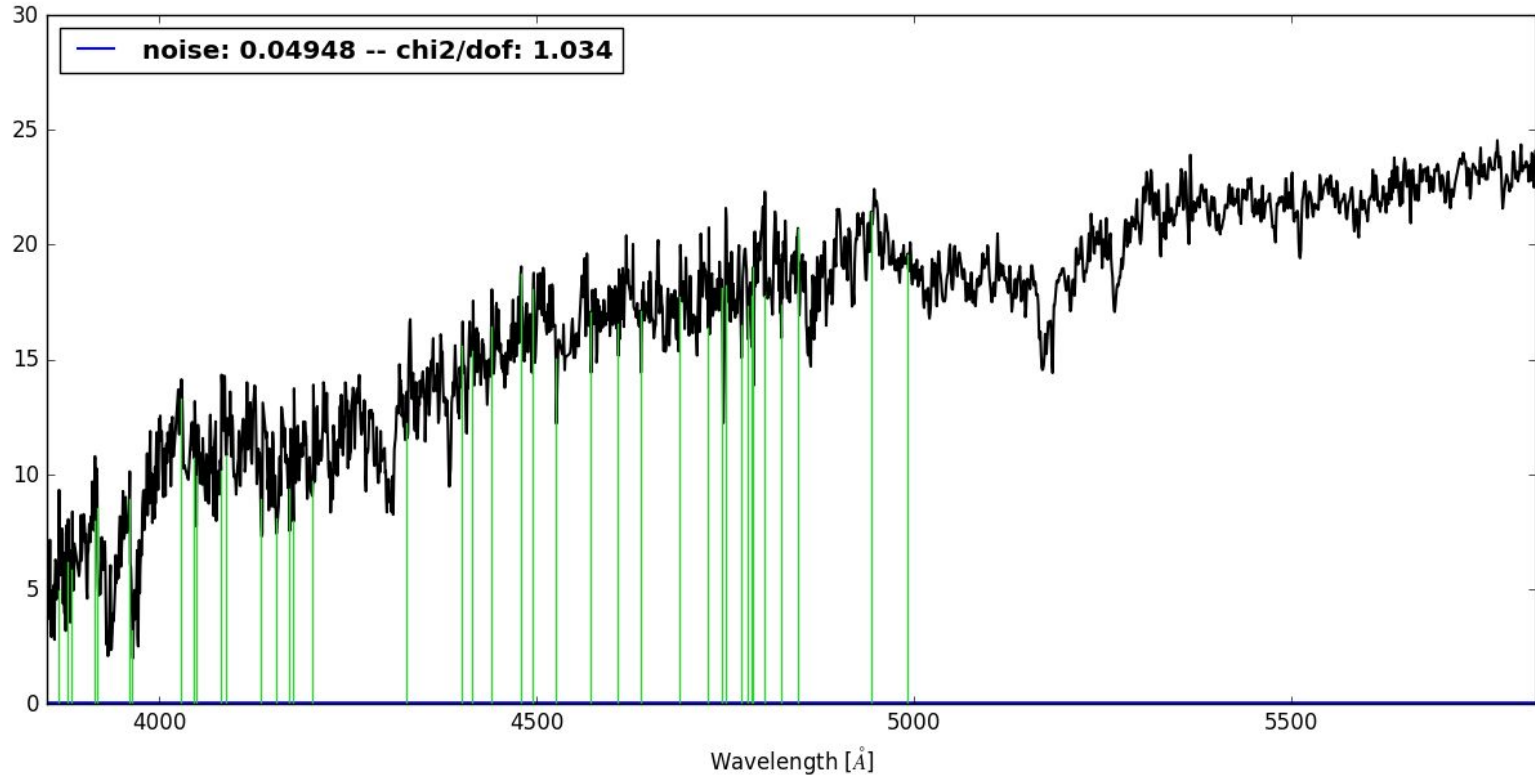
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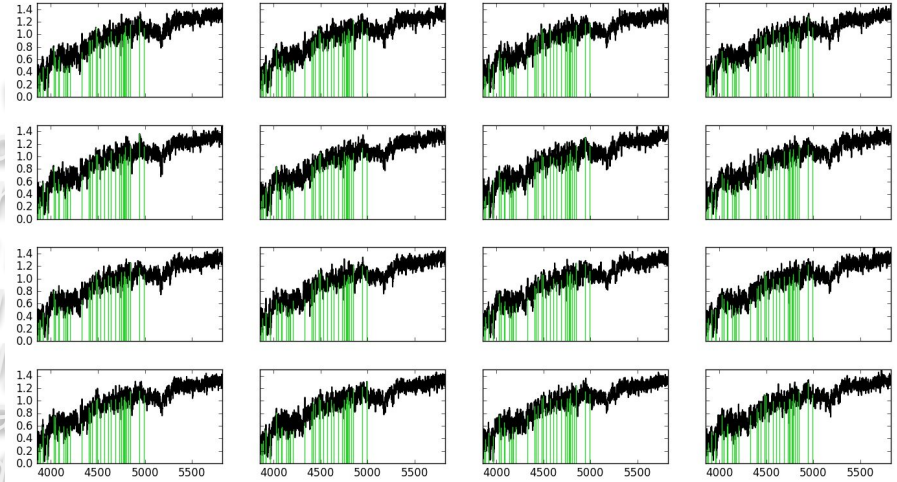


Optimised Modelling of Early-type Galaxy Aperture Kinematics (Ω MEGA-K)



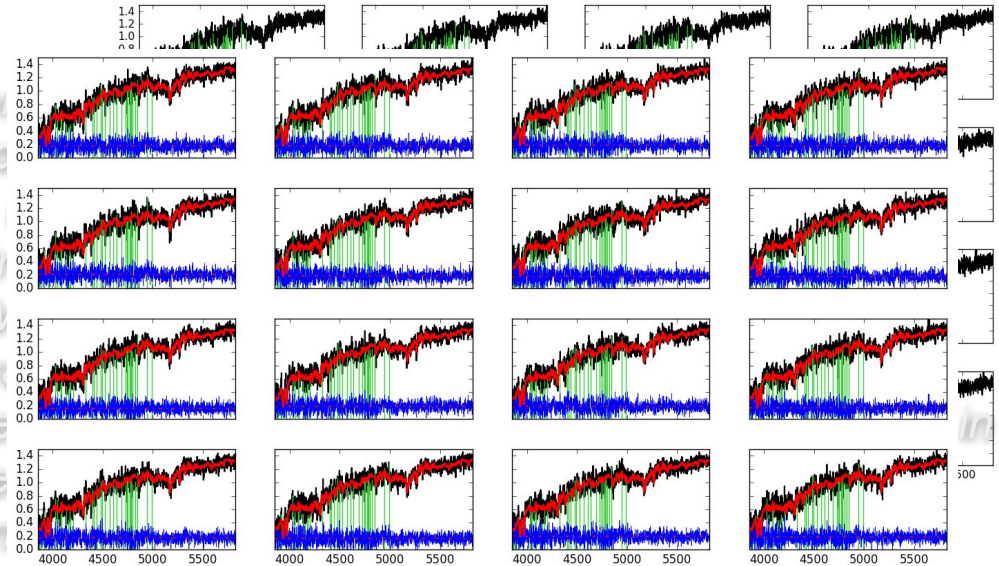
Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

1. Templates are loaded just once for the
2. A spectrum is selected, restramed, and
3. Spectrum is trimmed according to redshift
4. Templates are logarithmically rebinned and convolved with the instrumental FWHM
5. Typical gaseous lines are conservatively
6. PPXF runs in sigma-clipping mode iteratively in order to find the optimal noise level and
7. **BOOTSTRAP: 256 fitting parameters (moments and polynomial degrees) are randomly set and 256 simulated spectra are generated from the original one according to the noise -> 256 fits run in parallel mode**
8. Our best velocity dispersion estimate is stored as the mean and standard deviation of the 256 fits



Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

1. Templates are loaded just once for the whole sample
2. A spectrum is selected, restframed and normalised
3. Spectrum is trimmed according to the signal-to-noise ratio
4. Templates are logarithmically rebinned and convolved with the instrumental FWHM
5. Typical gaseous lines are conservatively masked
6. PPXF runs in sigma-clipping mode to find the optimal noise level
7. BOOTSTRAP: 256 fitting conditions are randomly set and 256 simulations are run according to the noise level
8. Our best velocity dispersion estimate is stored as the mean and standard deviation of the 256 fits

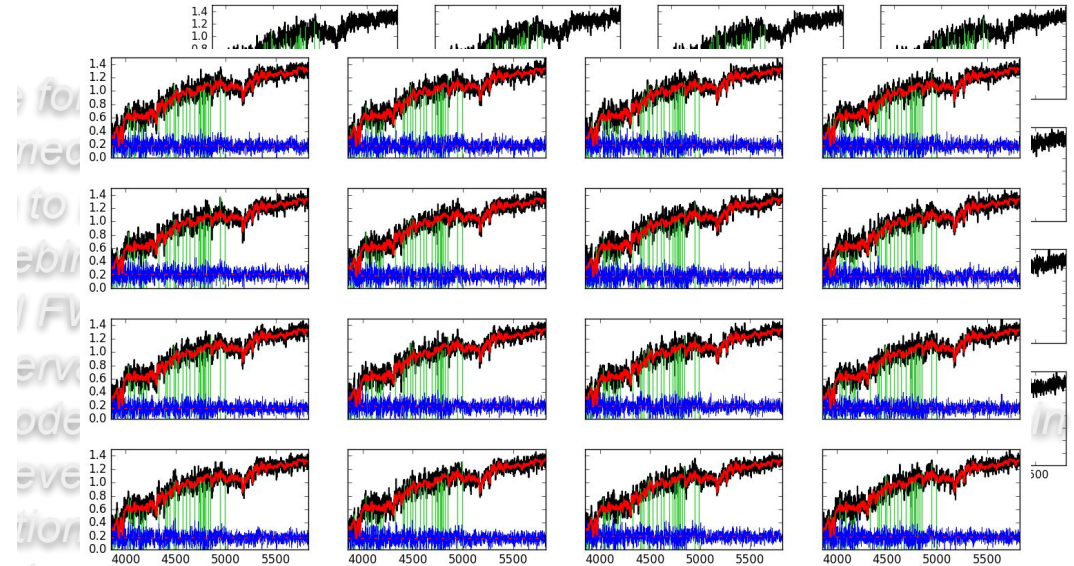
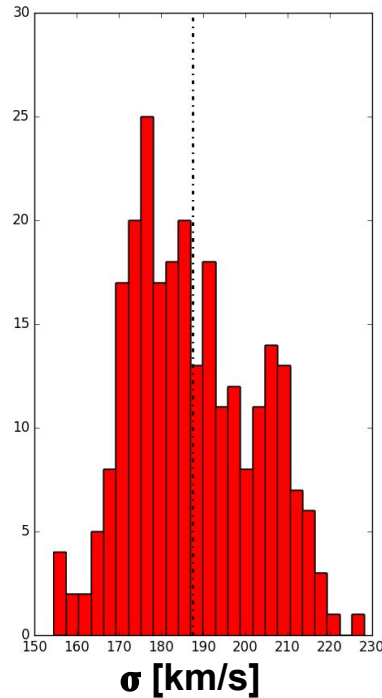


256 fits run in parallel mode!

1 one

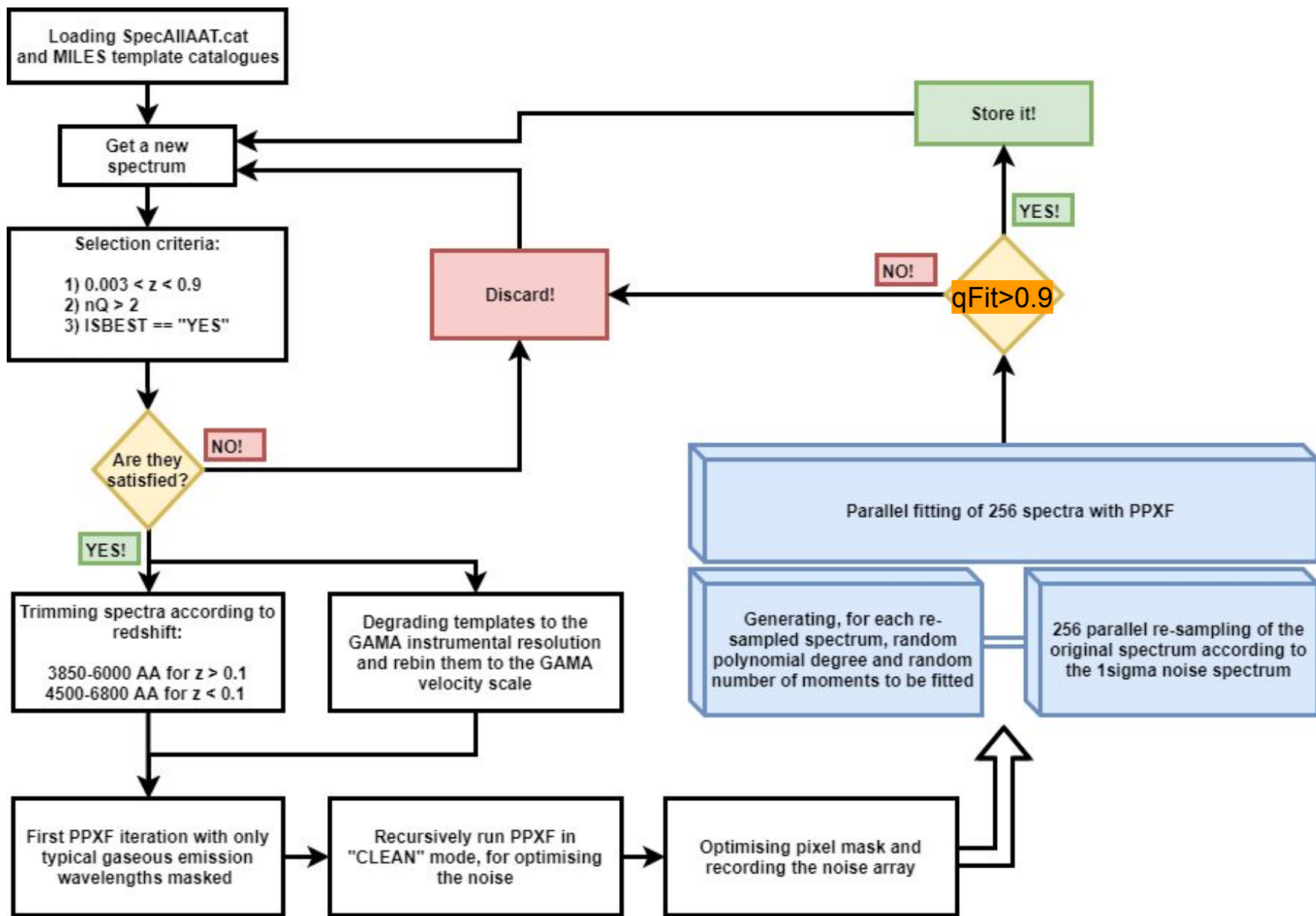
Optimised Modelling of Early-type Galaxy Aperture Kinematics (OMEGA-K)

1. Template
2. A spectrum
3. Spectrum
4. Template
5. convolved
6. Typical gal
7. PPXF run
8. order to fit
9. BOOTST
10. randomly
11. according

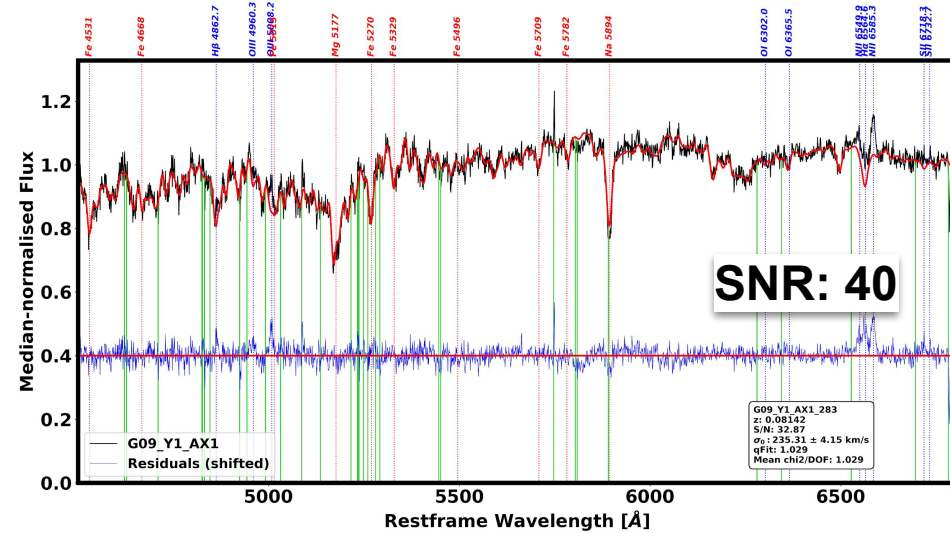
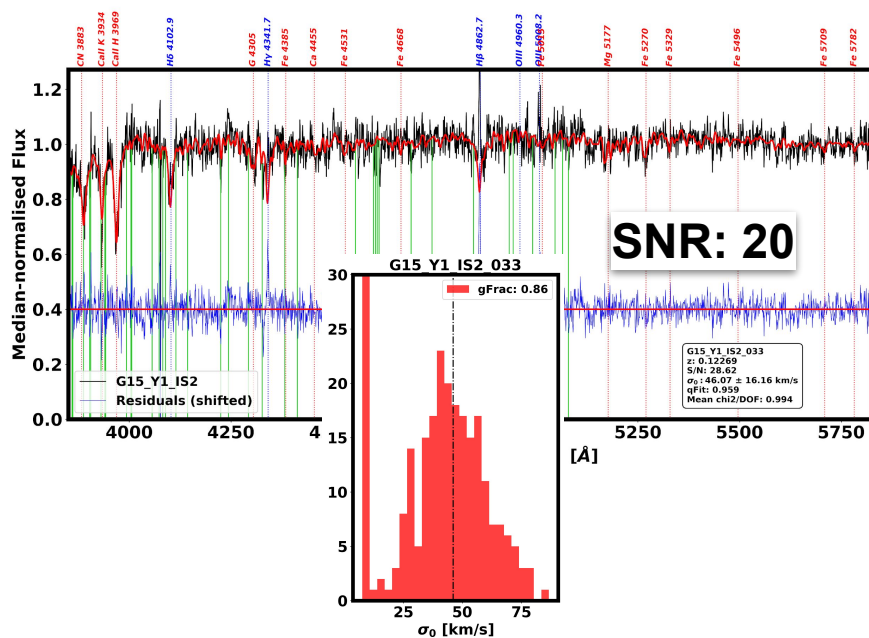
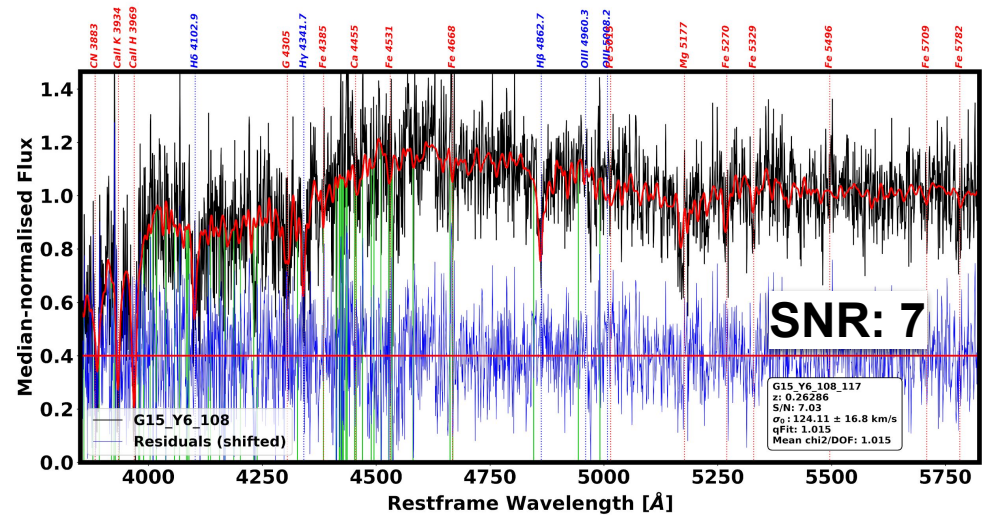
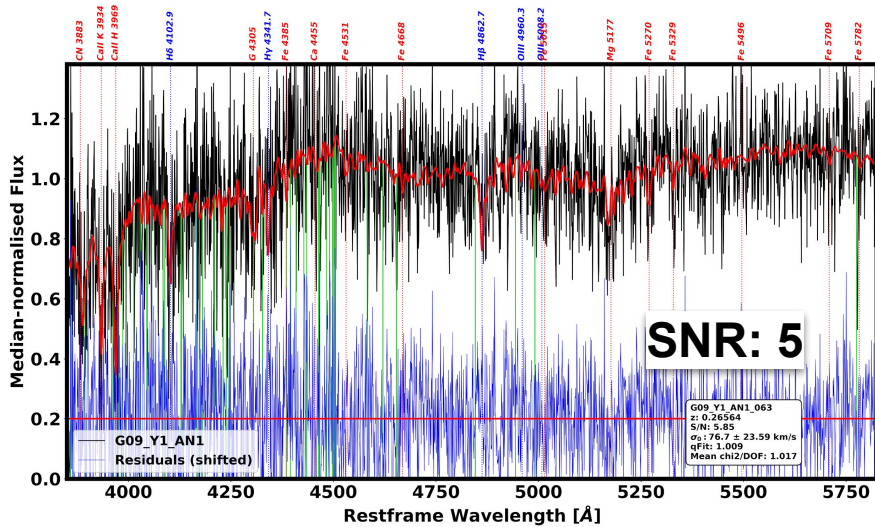


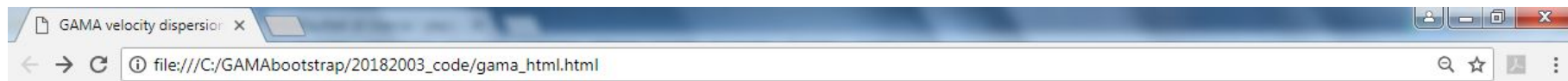
8. **Our best velocity dispersion estimate is stored as the mean and standard deviation of the 256 bestfit velocity dispersions**

Central velocity dispersions of the GAMA spectroscopic database



Central velocity dispersions of the GAMA spectroscopic database

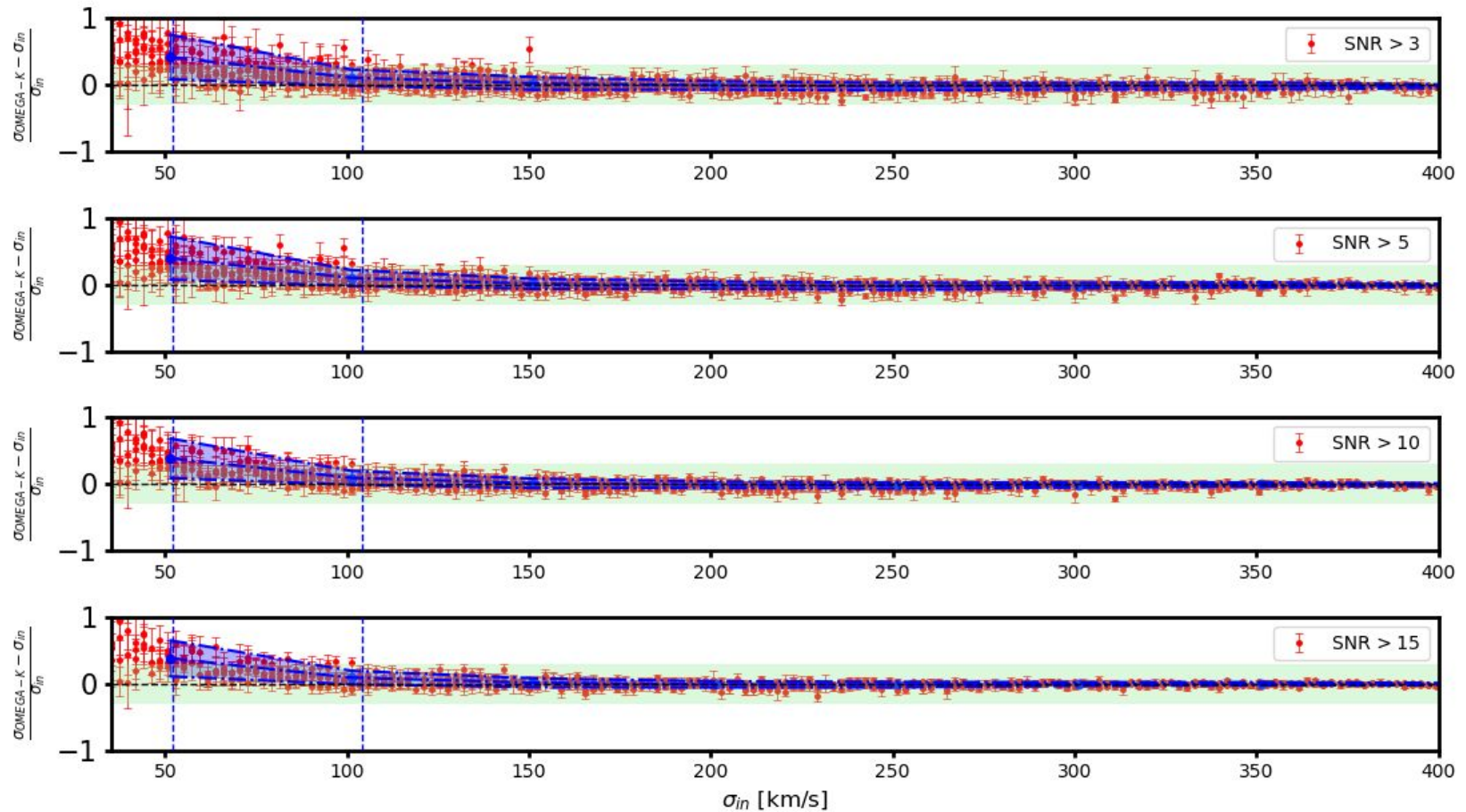




GAMA intDR velocity dispersion measurements with OMEGA-K (G. D'Agò, INAF-OACN)

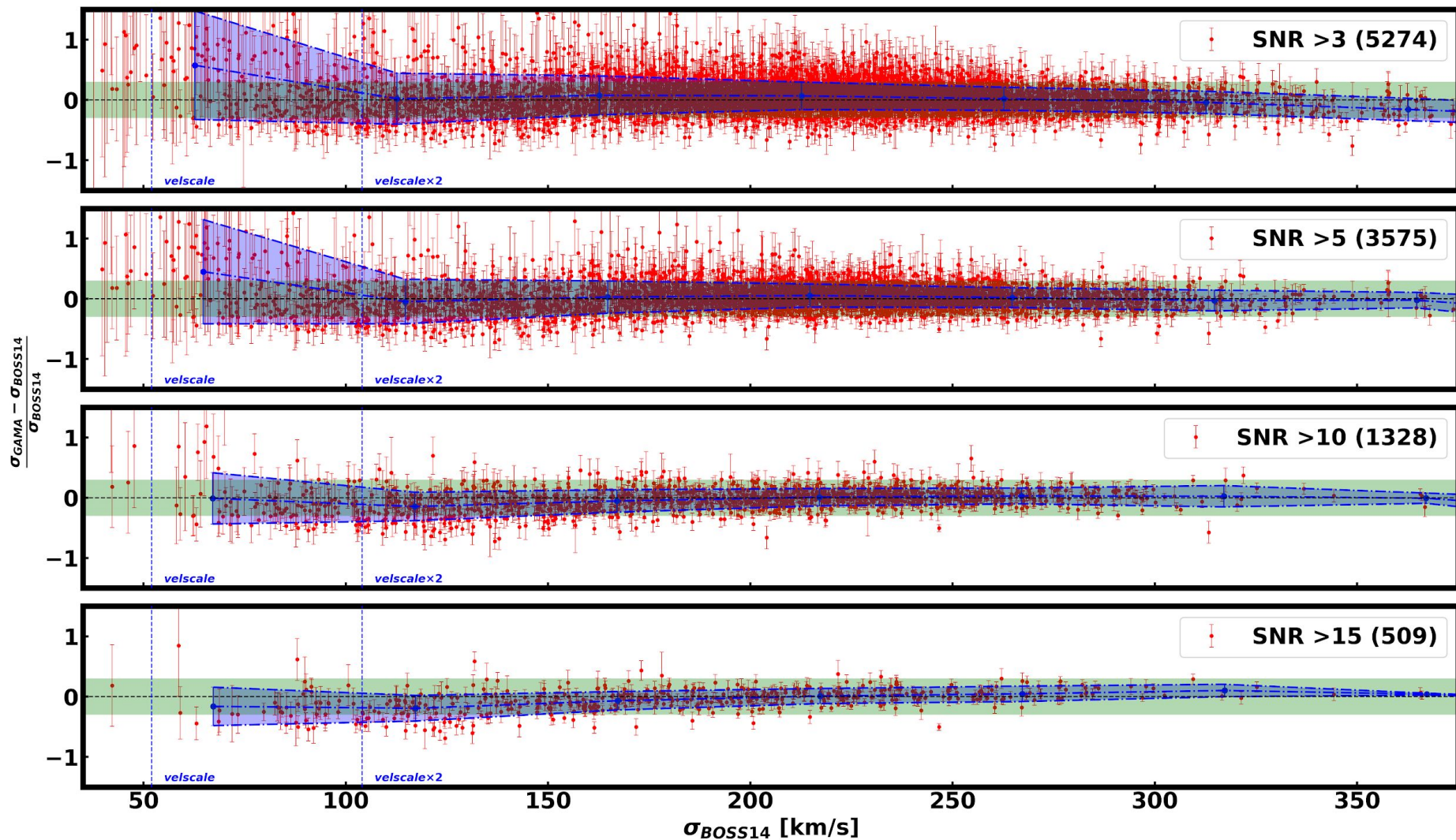
MEAN PLOTFIT	CATAID	SPECID	RA [deg]	DEC [deg]	z	SN	SN_m	SIGMEAN [km/s]	SIGERR [km/s]	gFRAC	Chi2/DOF
	300522	G09_Y1_AN1_043	129.94838	1.02466	0.15967	6.99	13.52	109	15	1.	1.019
	300518	G09_Y1_AN1_044	129.91463	1.06686	0.26512	9.74	5.22	243	8	1.	1.008
	371124	G09_Y1_AN1_046	130.14879	0.85127	0.19742	6.23	15.41	165	15	1.	1.056

Central velocity dispersions of the GAMA spectroscopic database



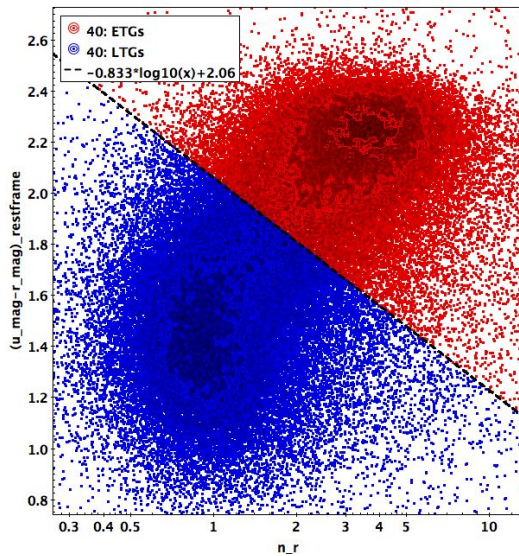
- 4000 GAMA-like simulated spectra ($3 < \text{SNR} < 40$)
- $< 30\%$ median scatter at $2 \times \text{velscale}$
- $< 10\%$ median scatter at higher σ

Central velocity dispersions of the GAMA spectroscopic database



- 7000 matches with SDSS DR14
- < 30% median scatter at 2*velscale (SNR>5)
- few points at higher SNR show good agreement too

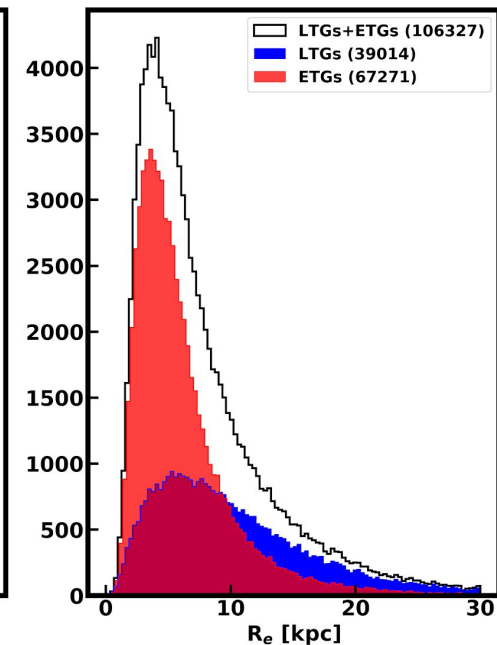
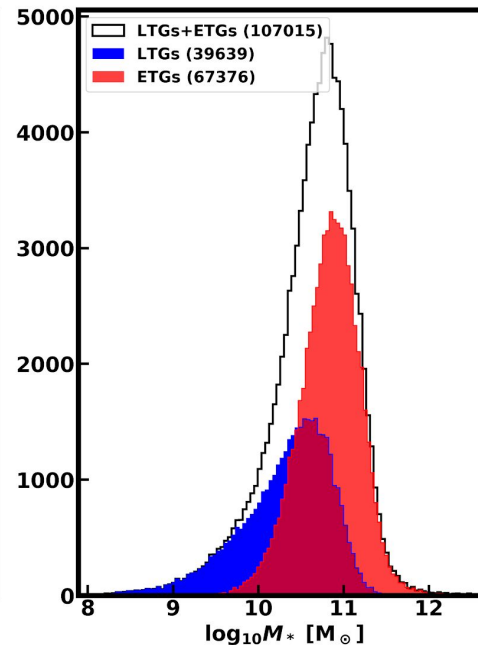
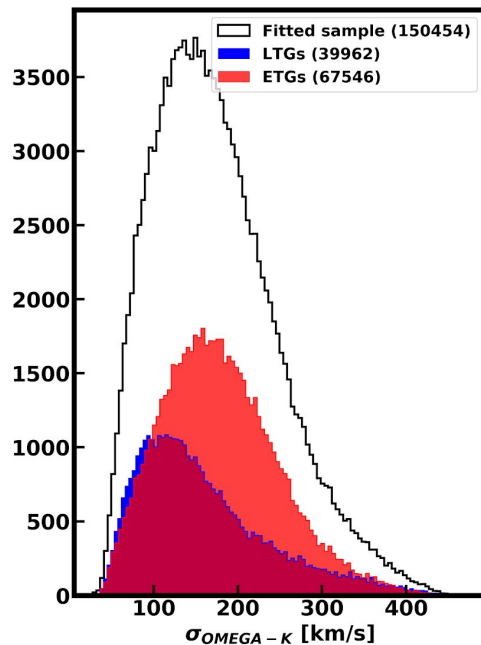
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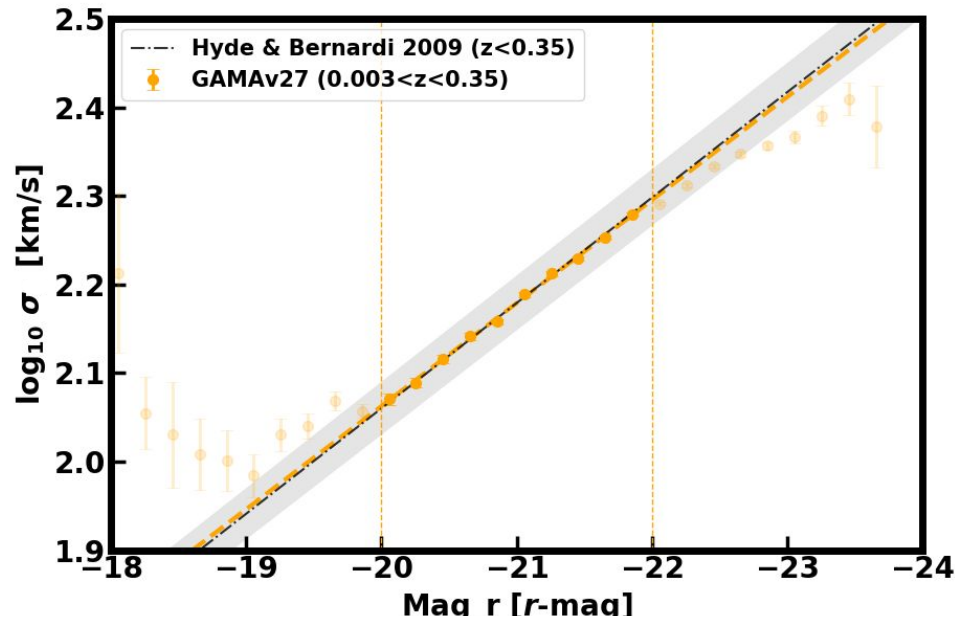
from Kelvin, Lee S. et al. 2012:

- separation between disk-dominated (LTG) and spheroid-dominated (ETG) galaxies
- $u-r$ vs n_r

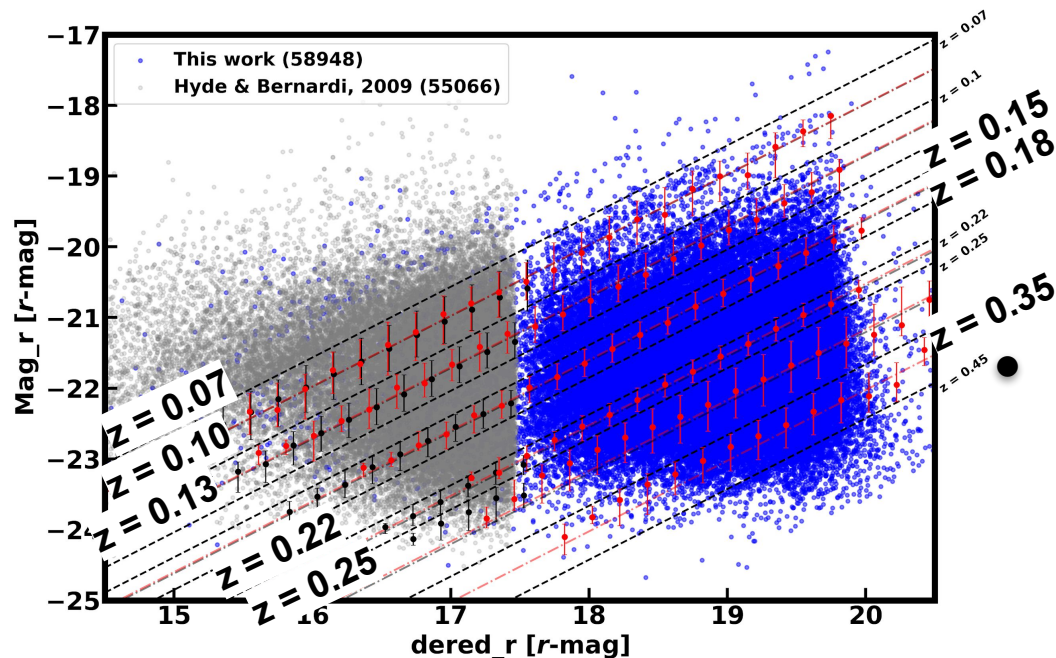
- >150k galaxies
- >100k galaxies with measured structural parameters by GAMA



Central velocity dispersions of the GAMA spectroscopic database



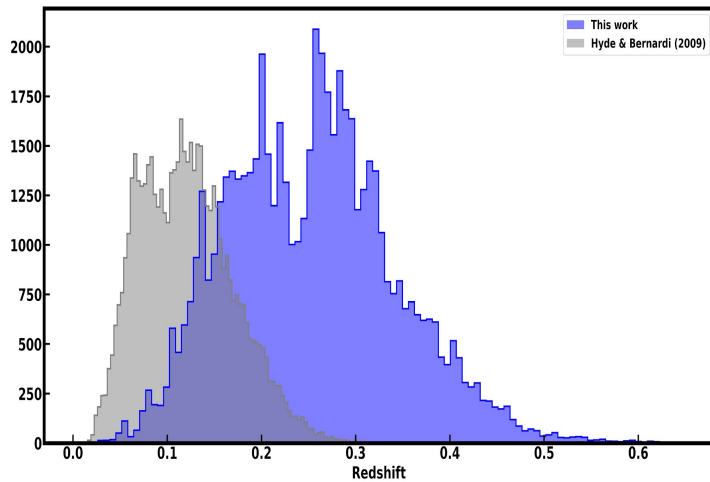
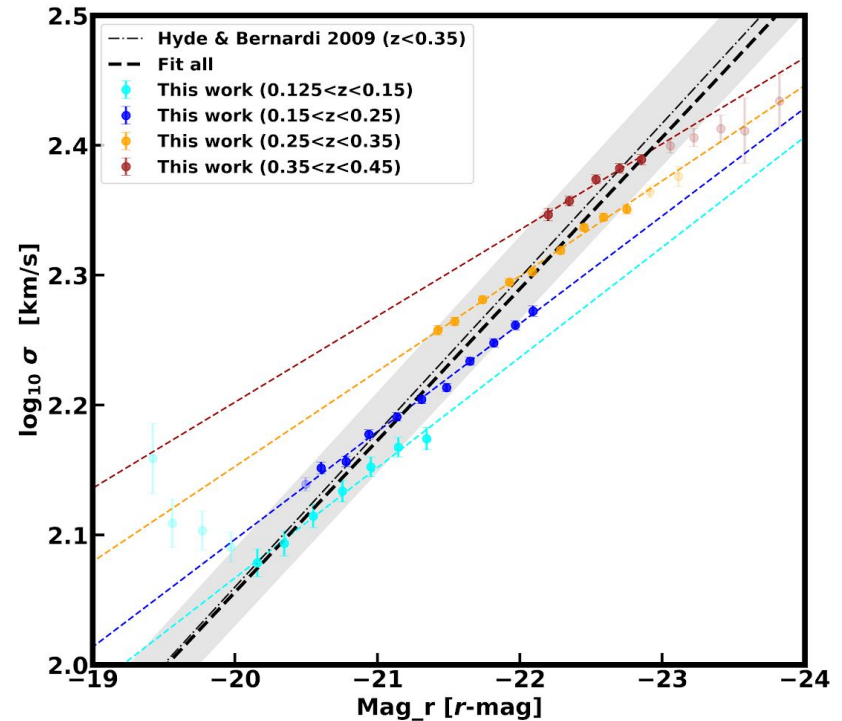
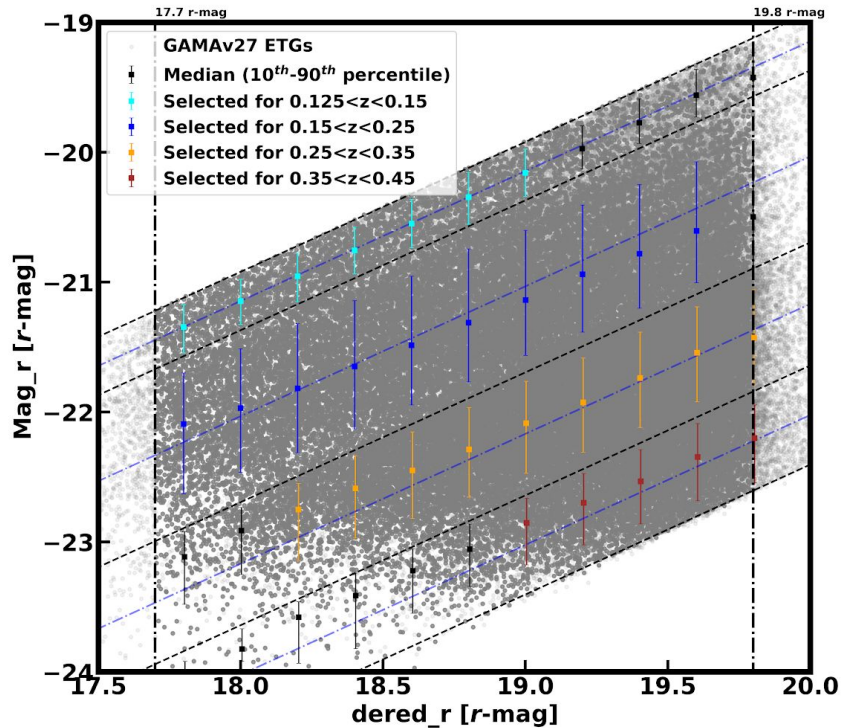
- **Hyde and Bernardi investigated F-J relation in the 0.07 - 0.35 redshift range (fit to the median in 0.2 mag bins)**
- **Our data are well compatible with the literature within magnitude range [-20 mag, -22 mag]**



Hyde and Bernardi sample is more complete to lower redshift (see next slide)

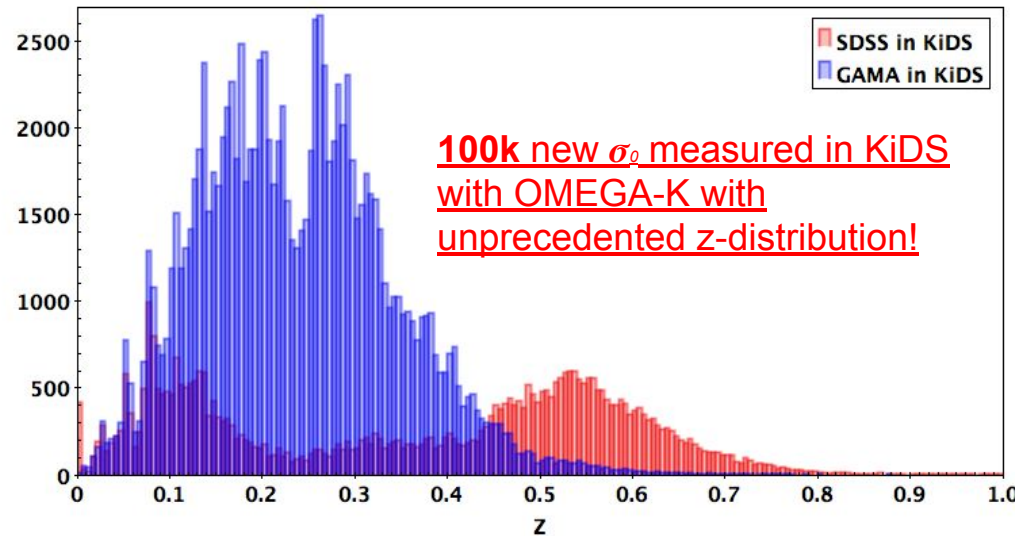
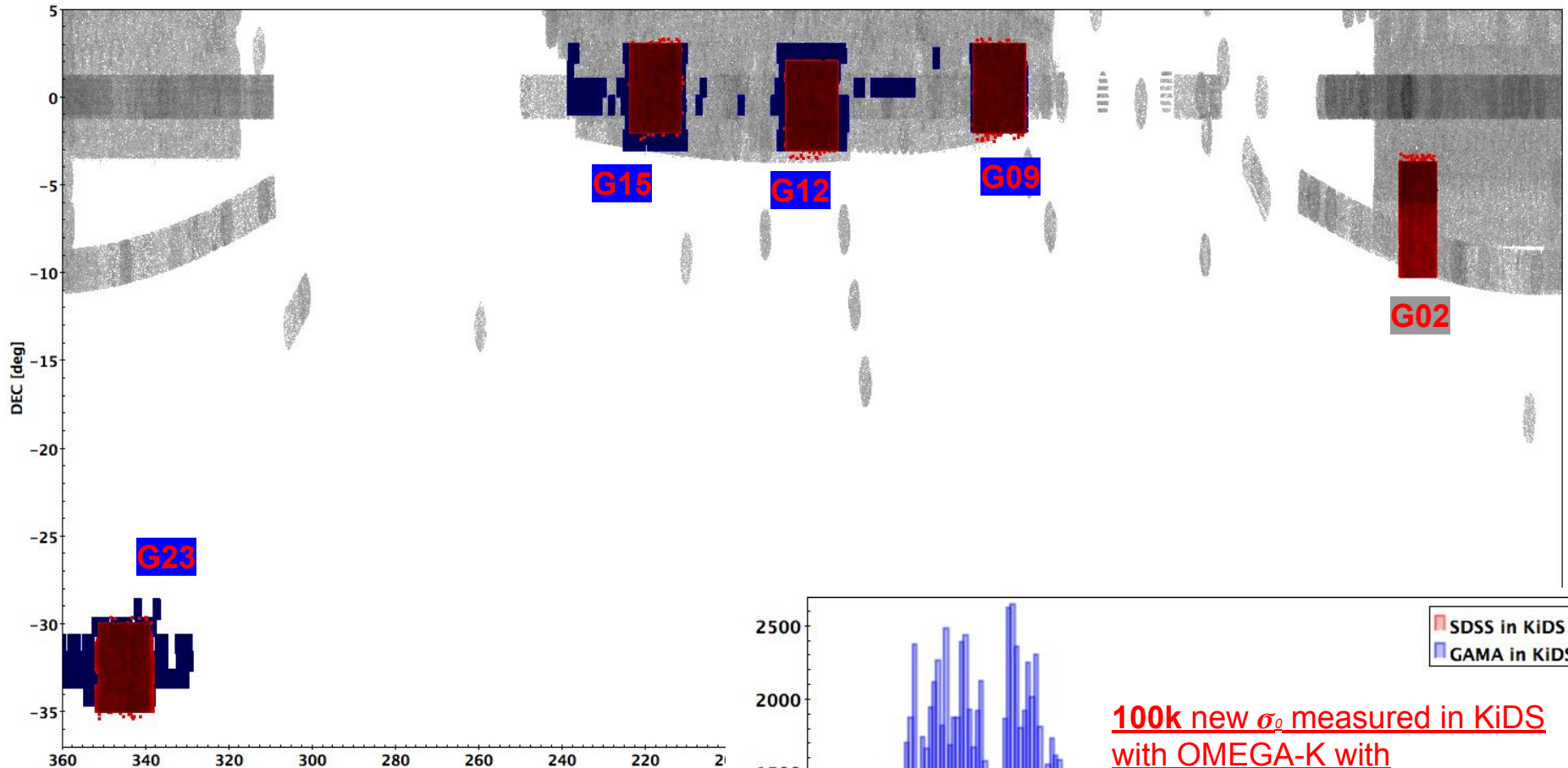
- **We are more complete around $z = 0.35$**

Central velocity dispersions of the GAMA spectroscopic database



- **The spectroscopic depth of our sample allows us to investigate different redshift bins suggesting a possible evolution of the F-J relation**
- **The higher is the redshift, the less steep is the slope of the fit to the datapoints**

Central velocity dispersions of the GAMA spectroscopic database



- 150k galaxies match with KiDS database
- 40k galaxies match with SDSS DR14
- 5k galaxies in common KiDS/SDSS/GAMA



Thank you!