

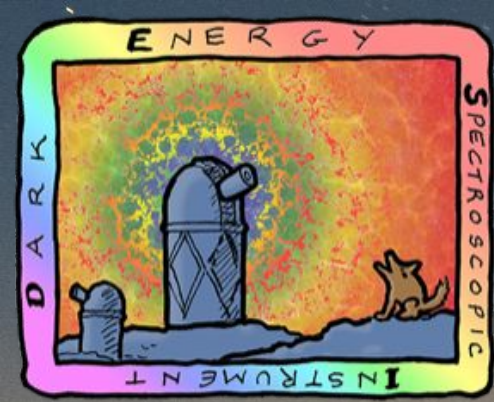
DESI DR1 Fundamental Plane

Caitlin Ross - University of Queensland

In collaboration with Julian Bautista, Kelly Douglass,
Alex Kim, Fei Qin, and many others

DESC PV Workshop 2025





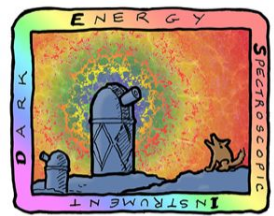
DARK ENERGY SPECTROSCOPIC INSTRUMENT

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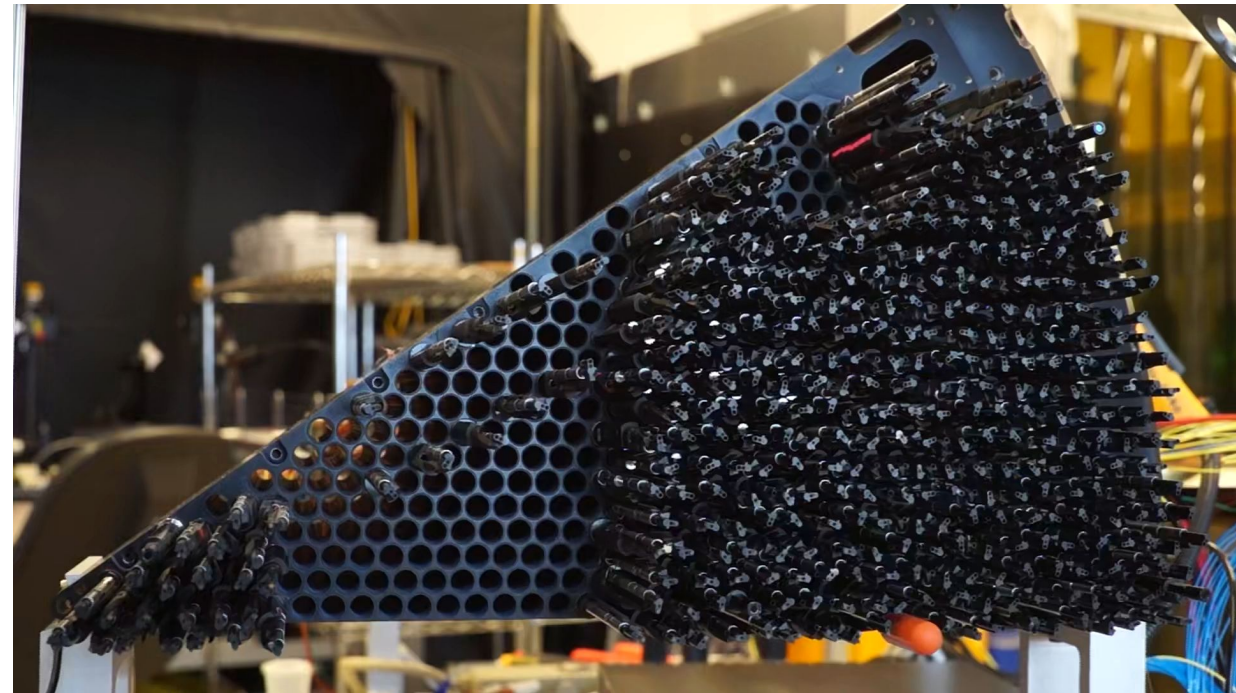
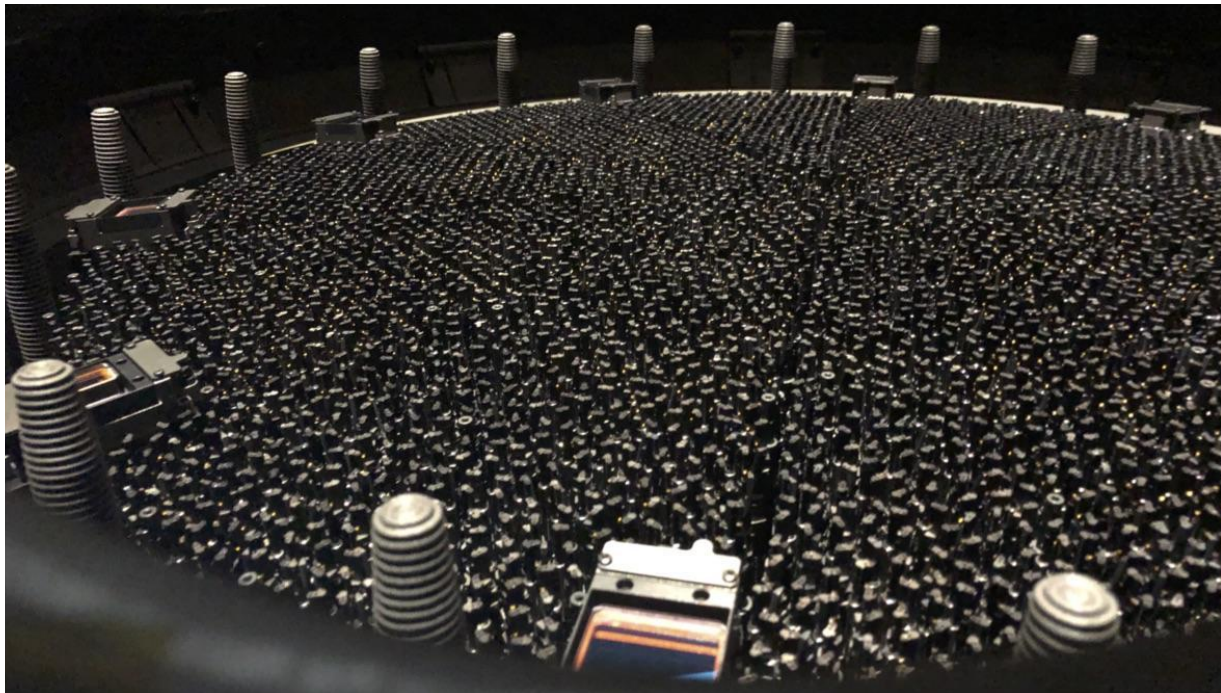


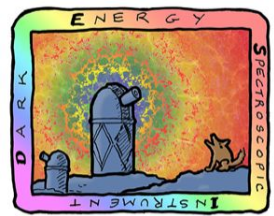
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Dark Energy Spectroscopic Instrument (DESI)

- 5000 fiber spectrograph instrument
- Exposures every ~20min





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Fundamental Plane

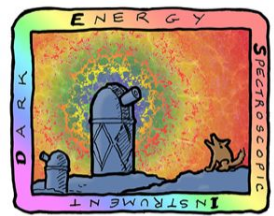
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- Dispersion Supported
- Non star forming

Early-Type Galaxies!

- Half-light Radius – r
- Surface Brightness – i
- Central Velocity Dispersion – s



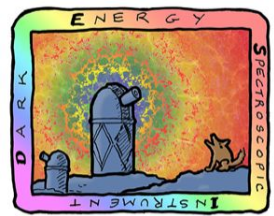
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Selection Criteria

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Selection Criteria	# Remaining
SPECTYPE = GALAXY	16 406 896
ZWARN = 0 and DELTACHI2 > 30	13 977 157
FLUX>0 and NOBS > 0	13 923 084
$0.0033 < z < 0.1$	860 590
de Vaucouleurs profile or Sérsic profile with $n_s > 2.5$	179 372
$g-r, r-z$ colour cuts	133 371
Axial ratio $b/a > 0.3$	127 446
Magnitude in range $10.0 < m_r < 18.0$	110 796
Velocity dispersion in range $50.0 < \sigma_{vdisp} < 420$	108 487
Single measurement per galaxy	97 995
No FP outliers	96 469

- Quality Control
- Isolation of Early-Type Galaxies
- Sigma Clipping (Calibration only)
- Best measurement of galaxy

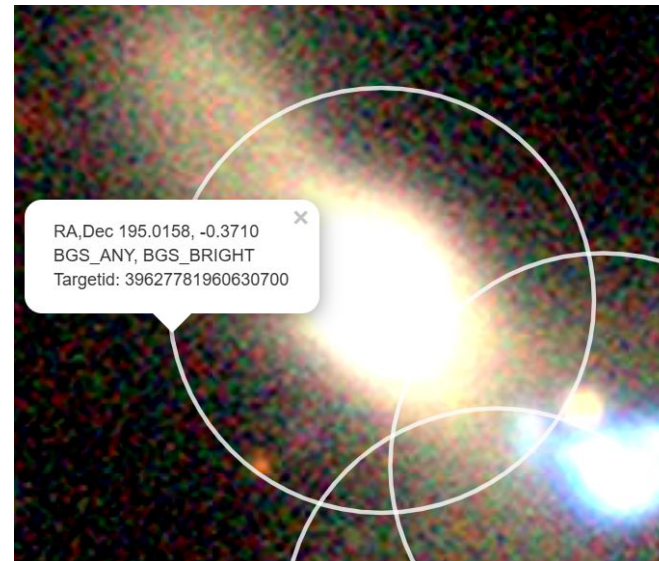
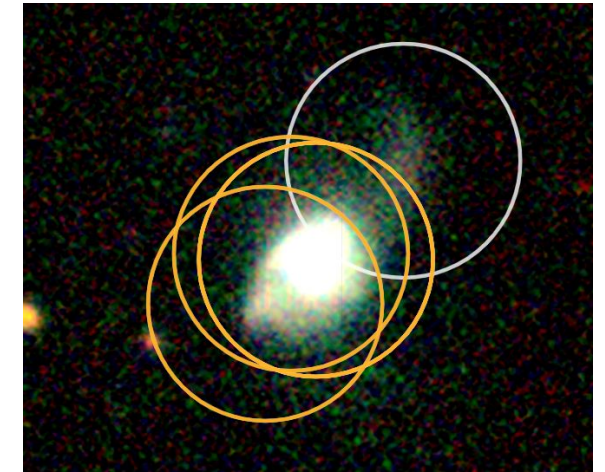
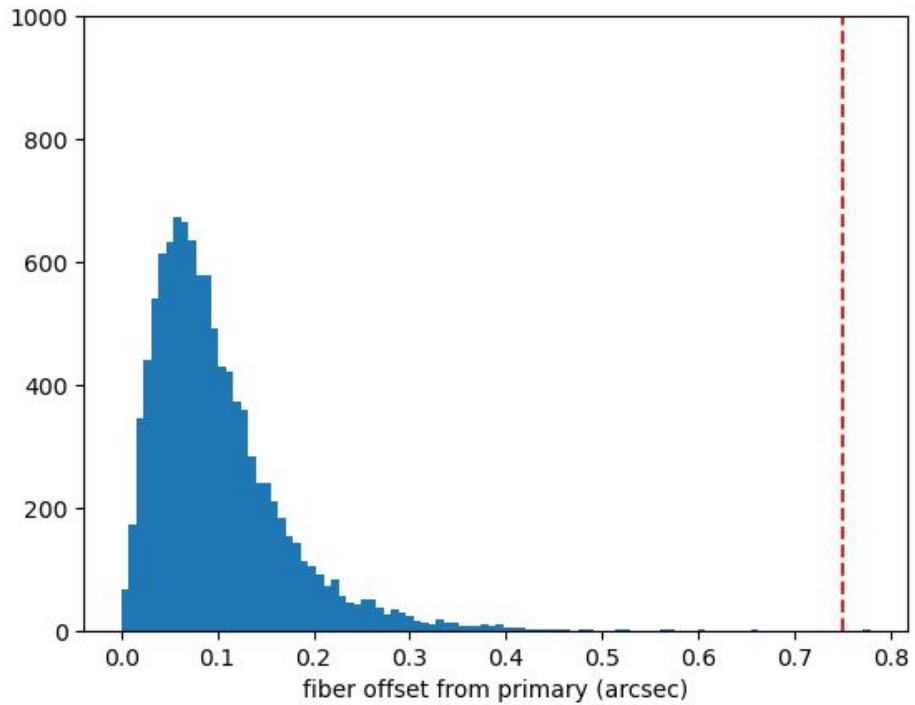


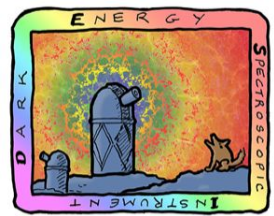
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Repeat Observations

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primary: where $\frac{\delta\sigma_{vdisp,i}}{\sigma_{vdisp,i}} = \min_i \frac{\delta\sigma_{vdisp}}{\sigma_{vdisp}}$



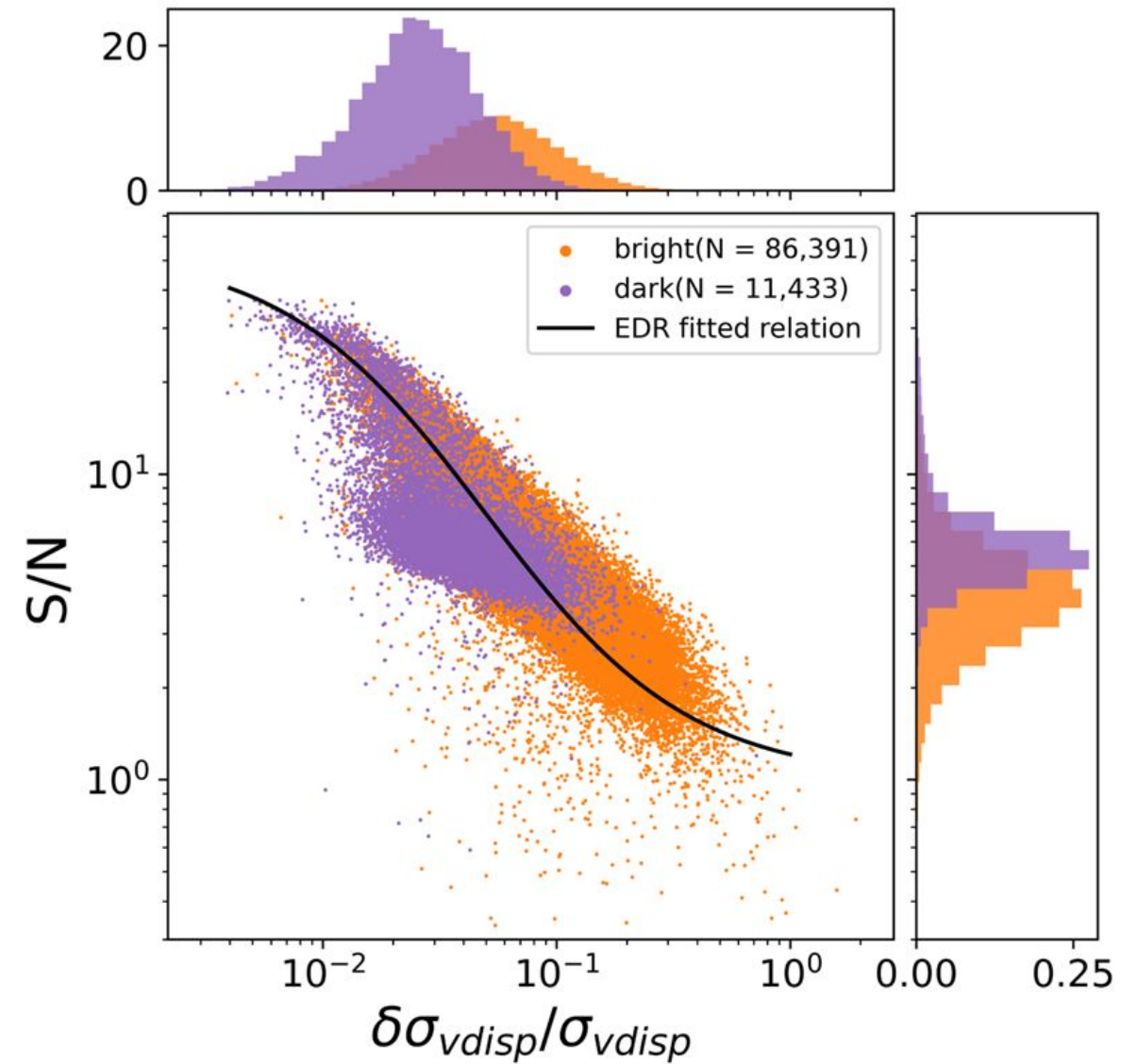
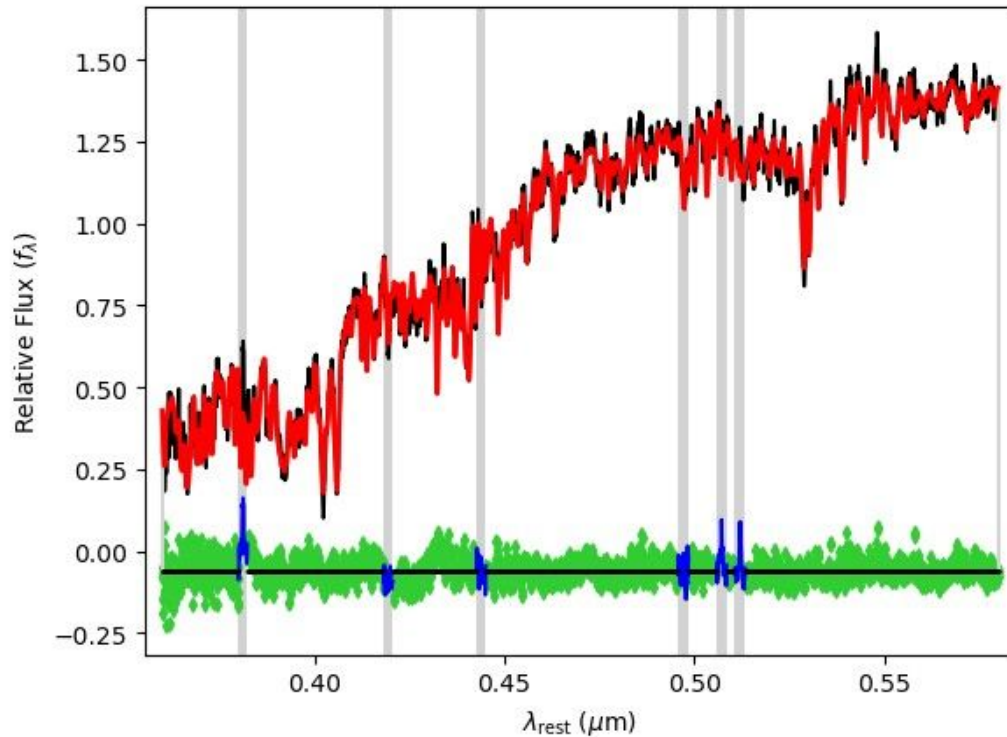


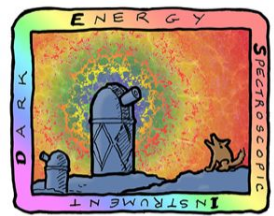
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Velocity Dispersions

Indo-U.S. Coudé Feed Spectral Library



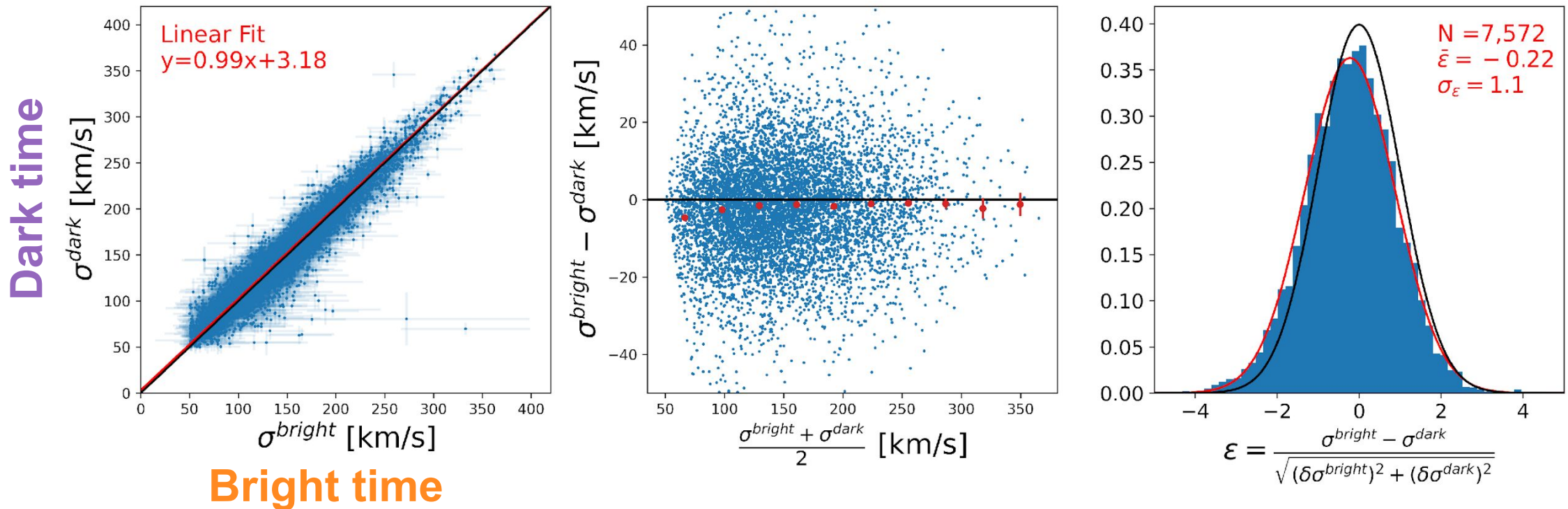


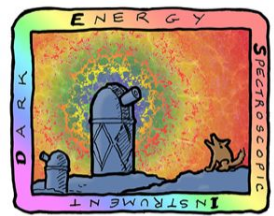
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Velocity Dispersions

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- **Dark time** observations have **+2.3km/s** higher velocity dispersions than their **bright time** counterparts





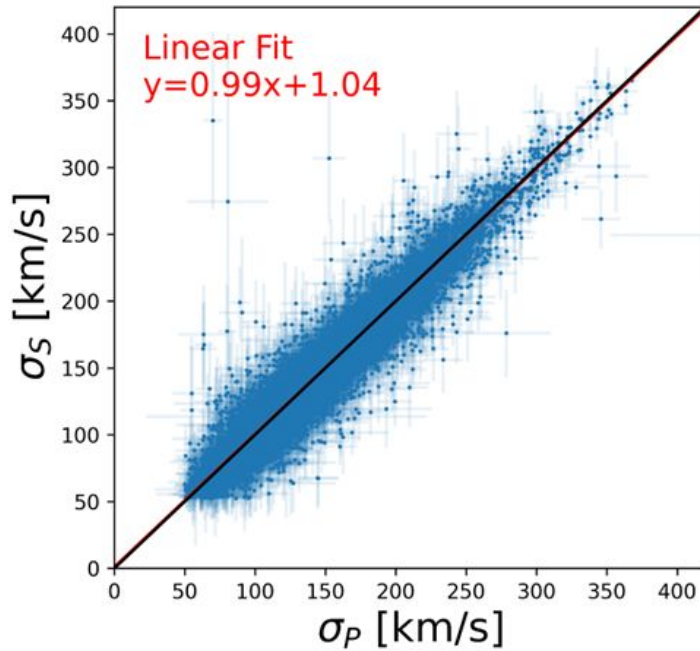
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Velocity Dispersions

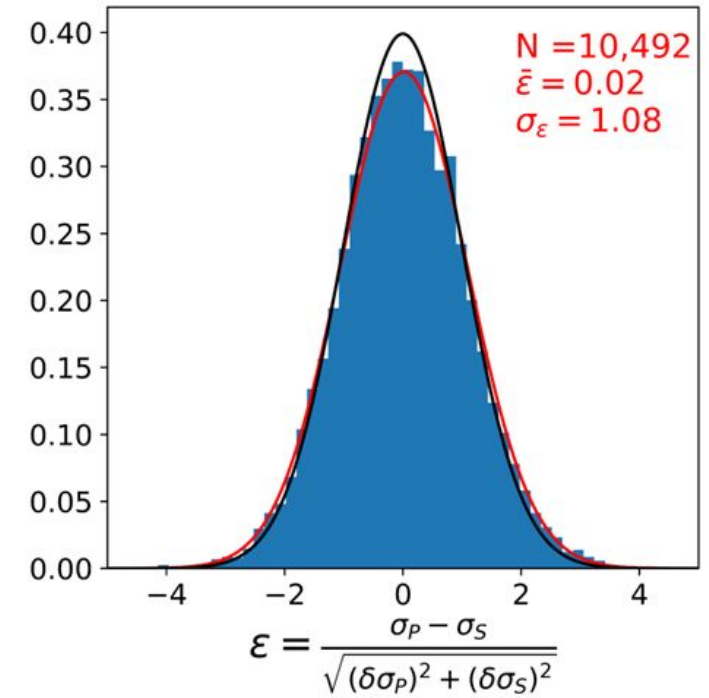
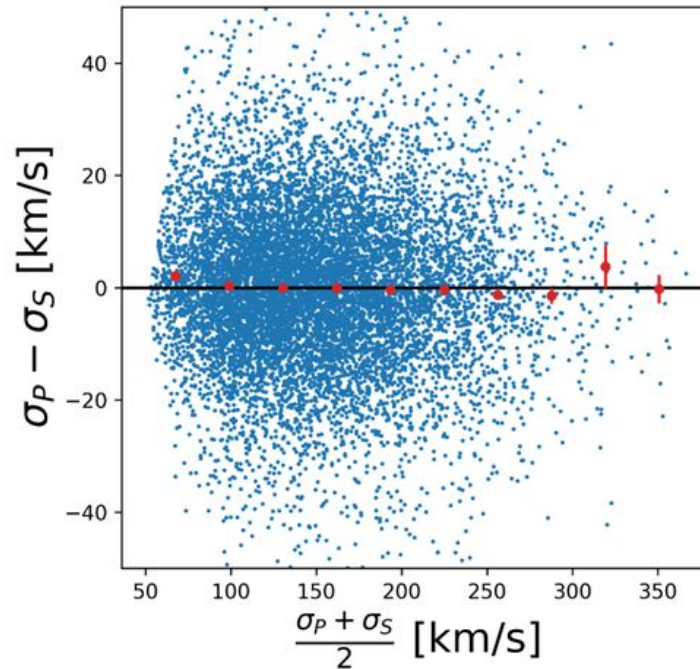
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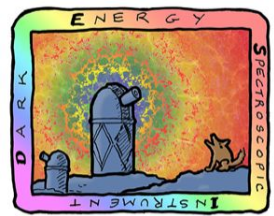
- Increased errors by **factor of 1.13** (from pPXF output) to account for scatter in repeat observations

Secondary



Primary



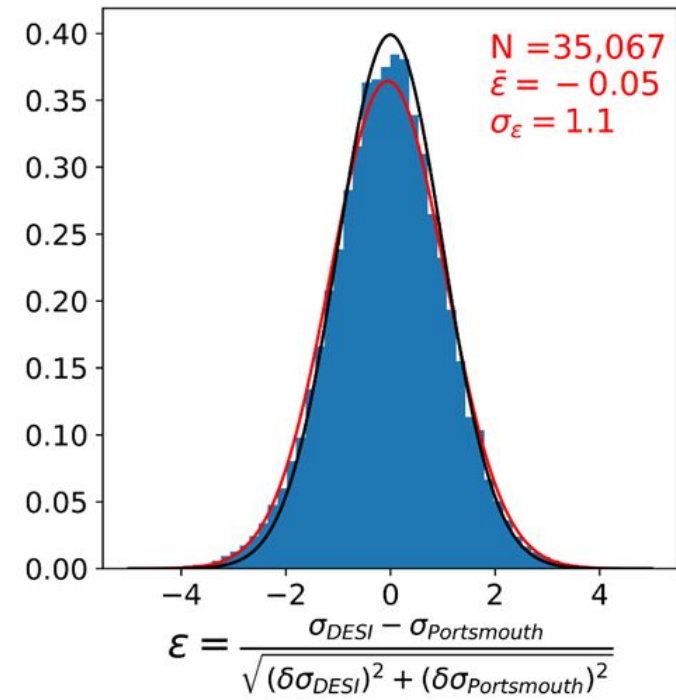
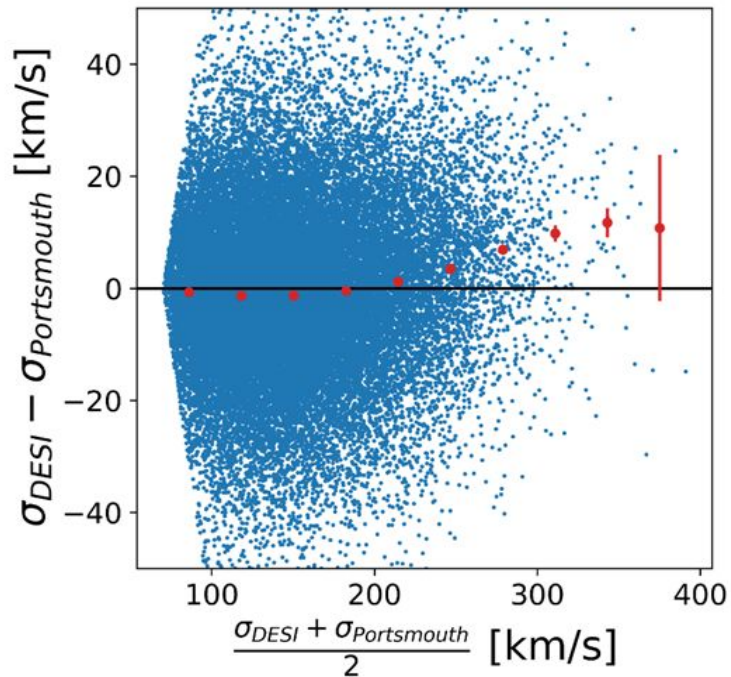
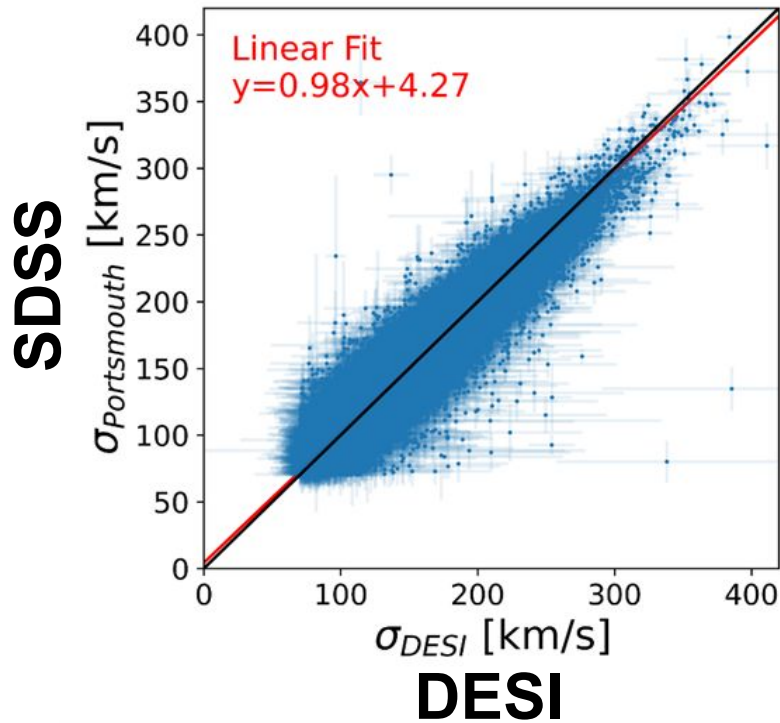


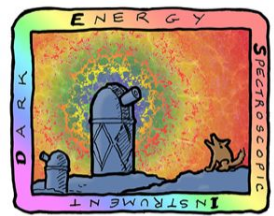
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Velocity Dispersions

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- In good agreement with SDSS (0.05σ offset)

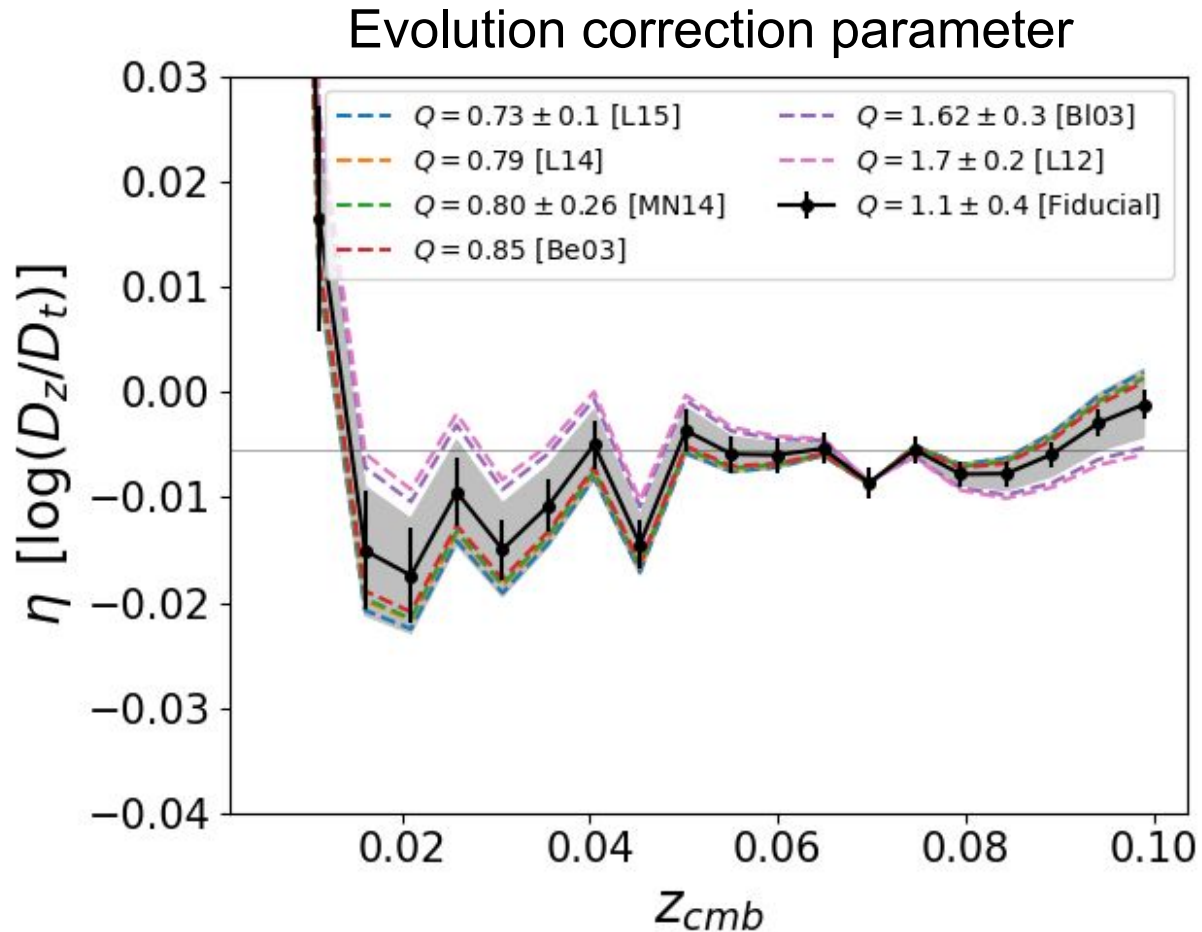




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FP Fit Systematics

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Corrects for evolution of
intrinsic galaxy brightness with
redshift

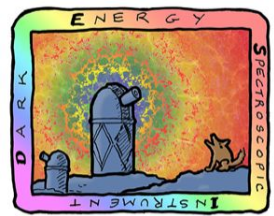
Galaxy magnitude

$$i = 0.4(M_{\odot}^r - m_r) + k_r - Qz_{cmb}$$

+ 4 log(1 + z_{helio})

- log($2\pi\theta_e^2$) + 2 log(64800/ π)

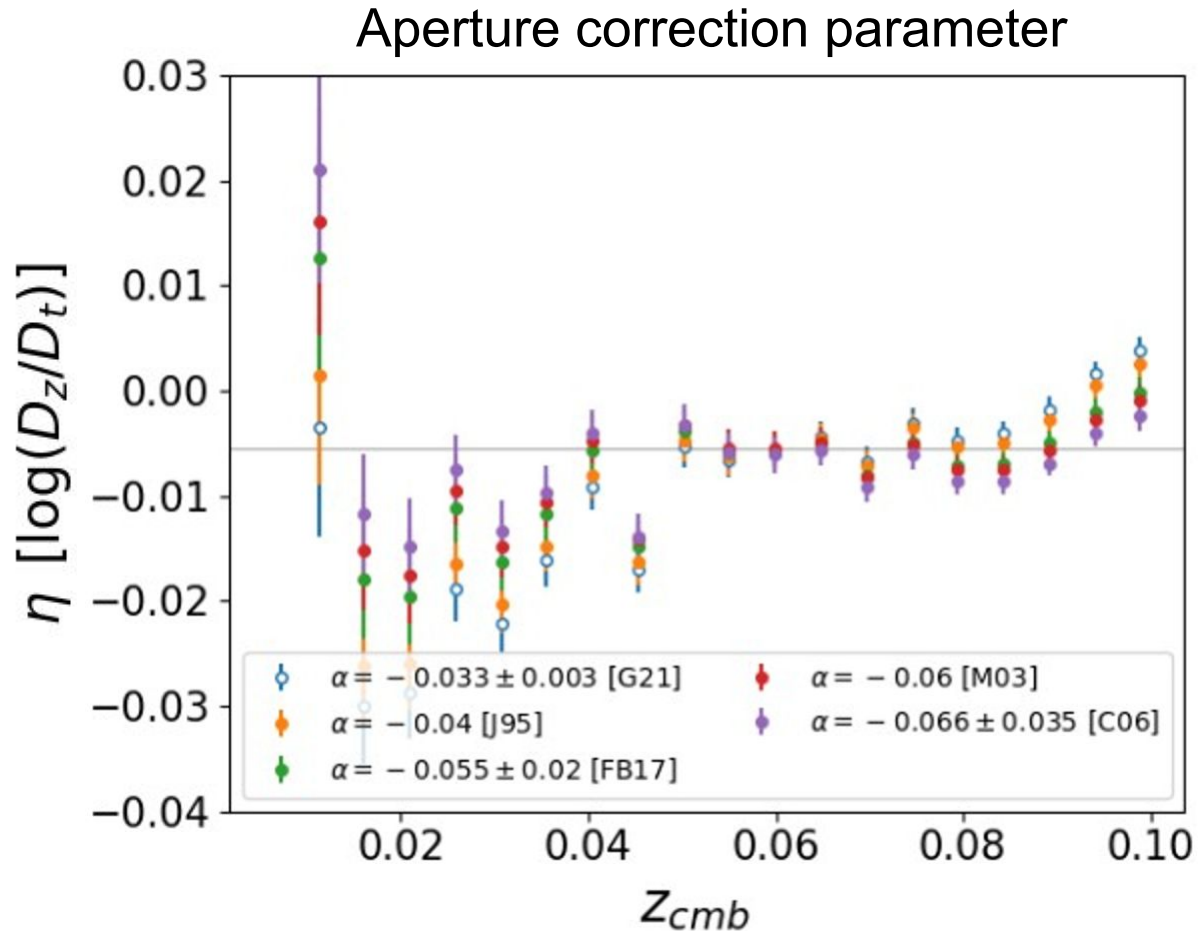
Convert to Surface Brightness



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FP Fit Systematics

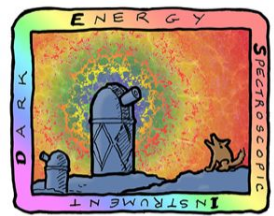
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Velocity dispersion

$$s = \log(\sigma_{vdisp})$$
$$+ \alpha_{ap} [\log(\theta_e) - \log(8\theta_{ap})]$$

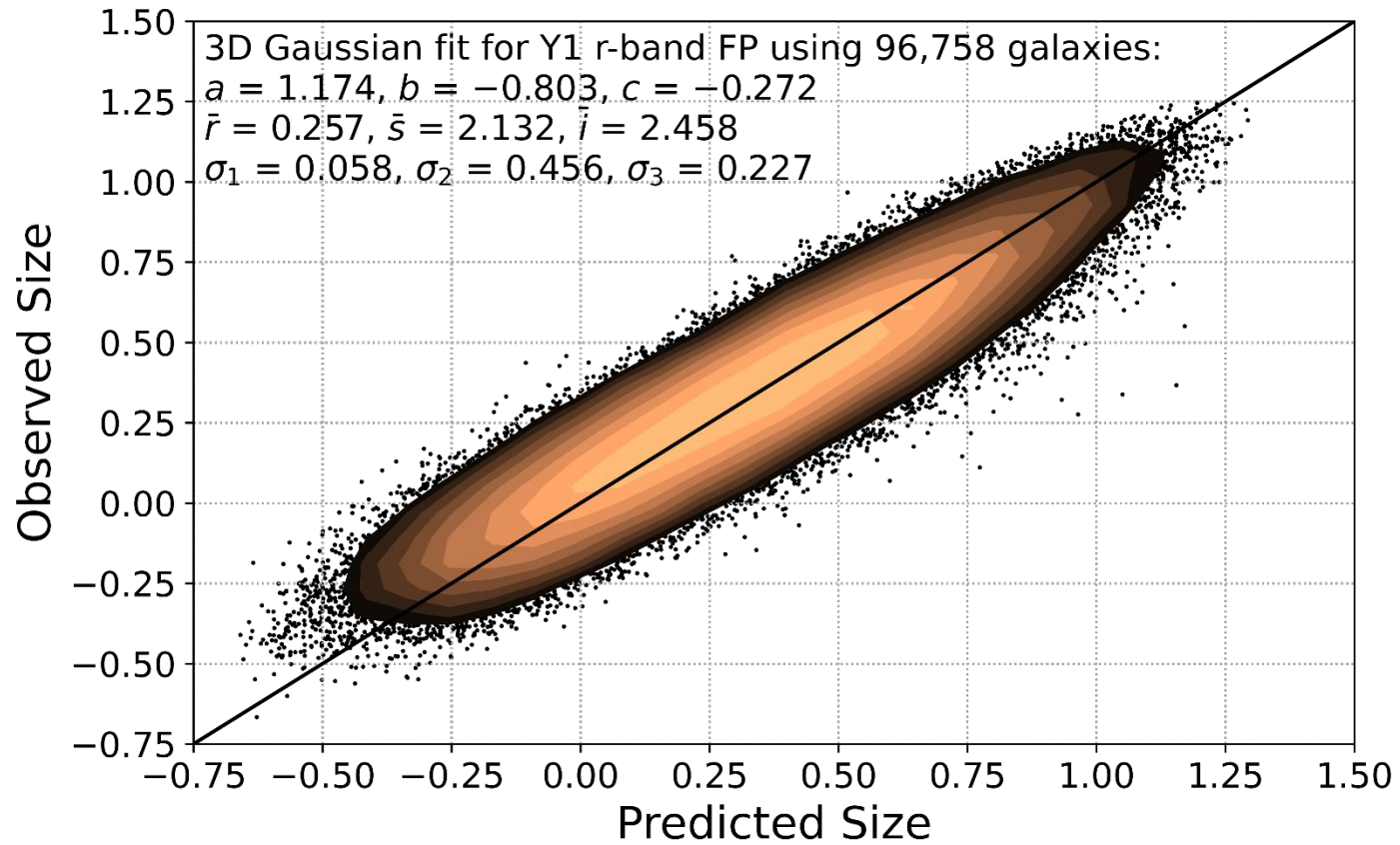
Corrects for fixed size spectral fiber

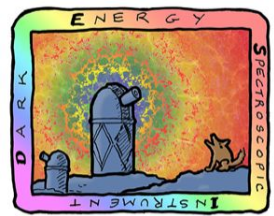


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DR1 Fundamental Plane

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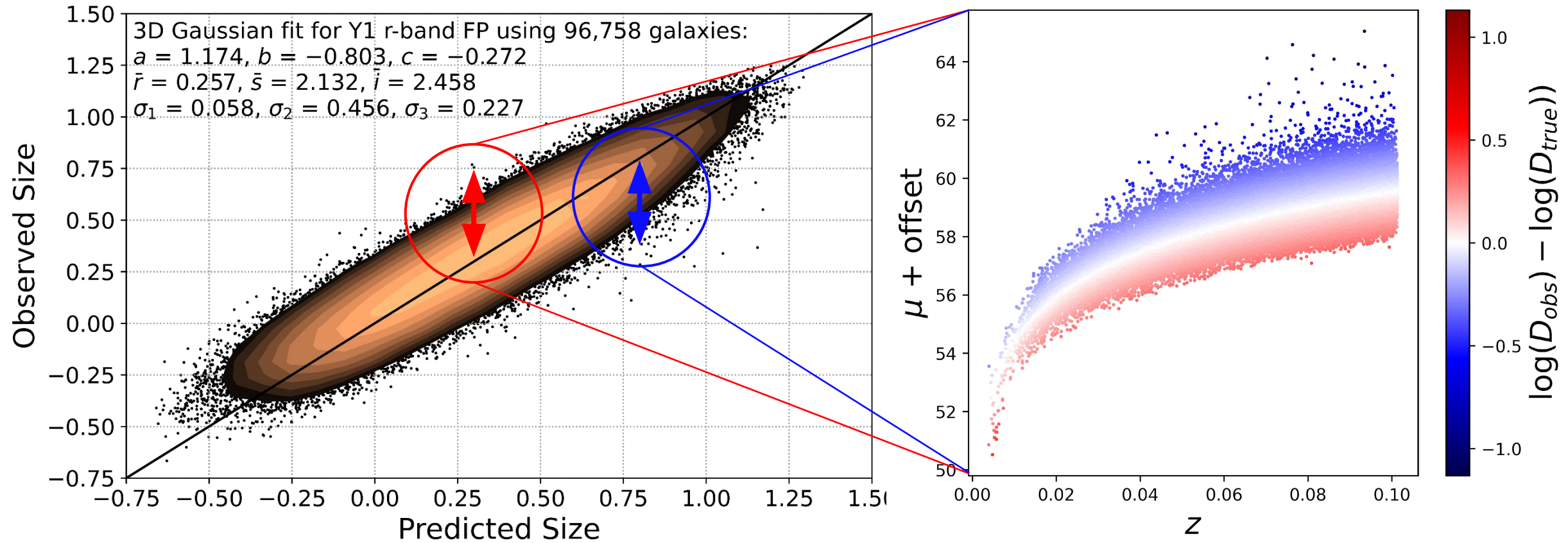


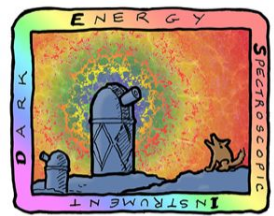


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DR1 Fundamental Plane

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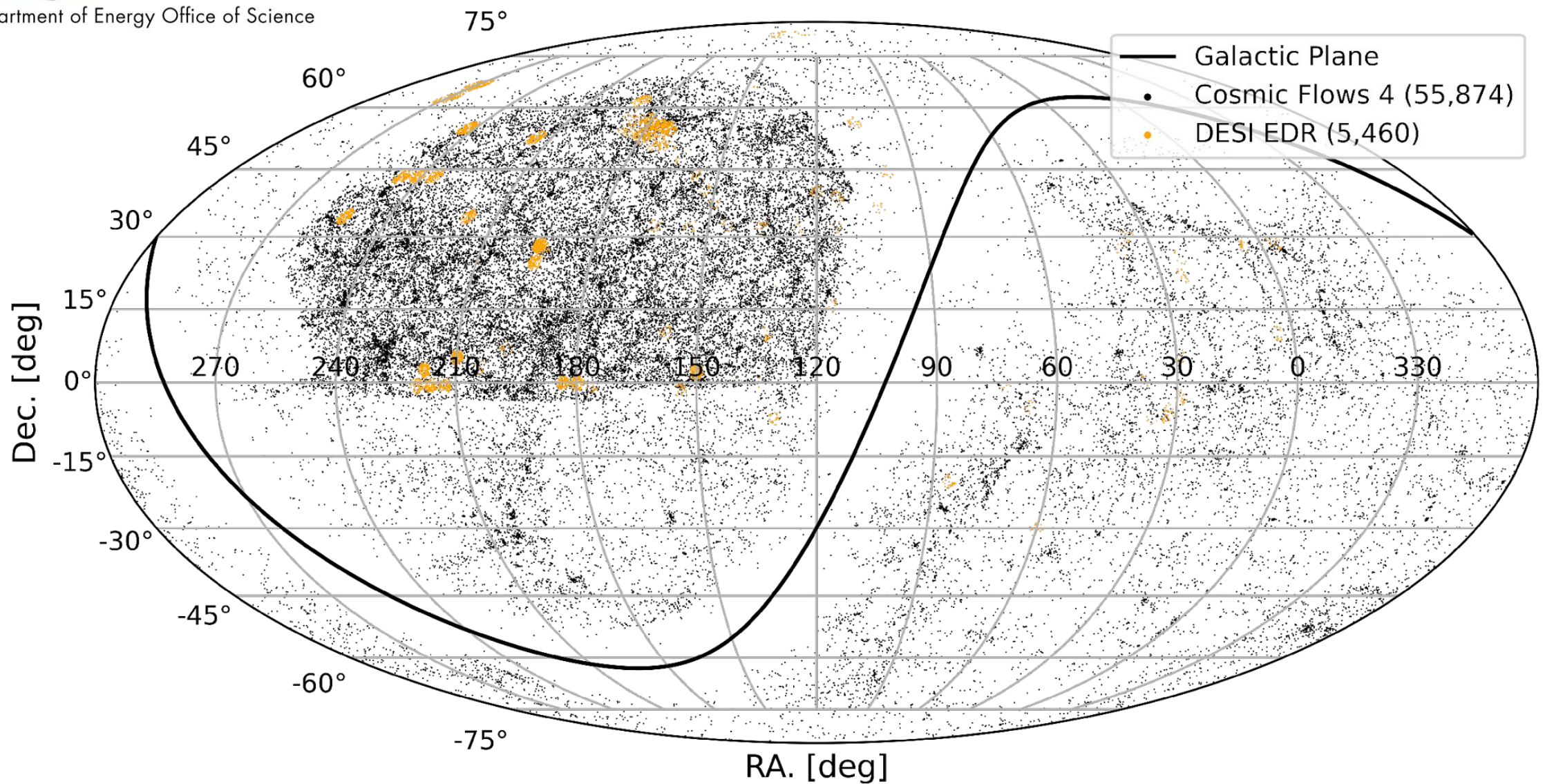


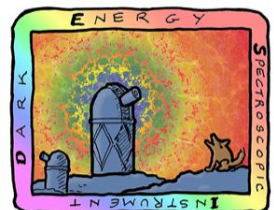


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Existing Measurements

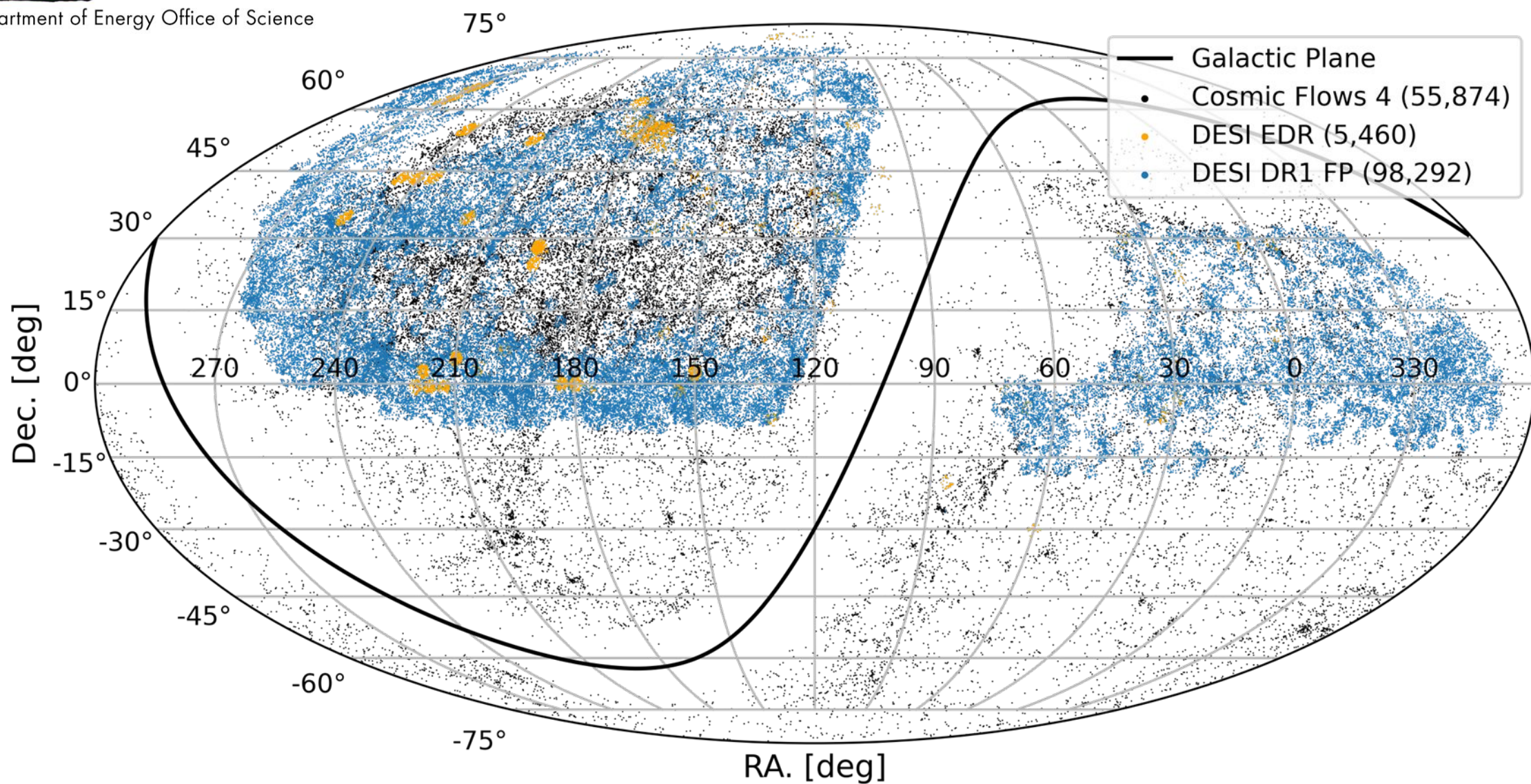


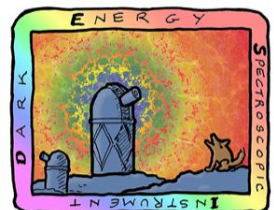


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DESI FP Sample

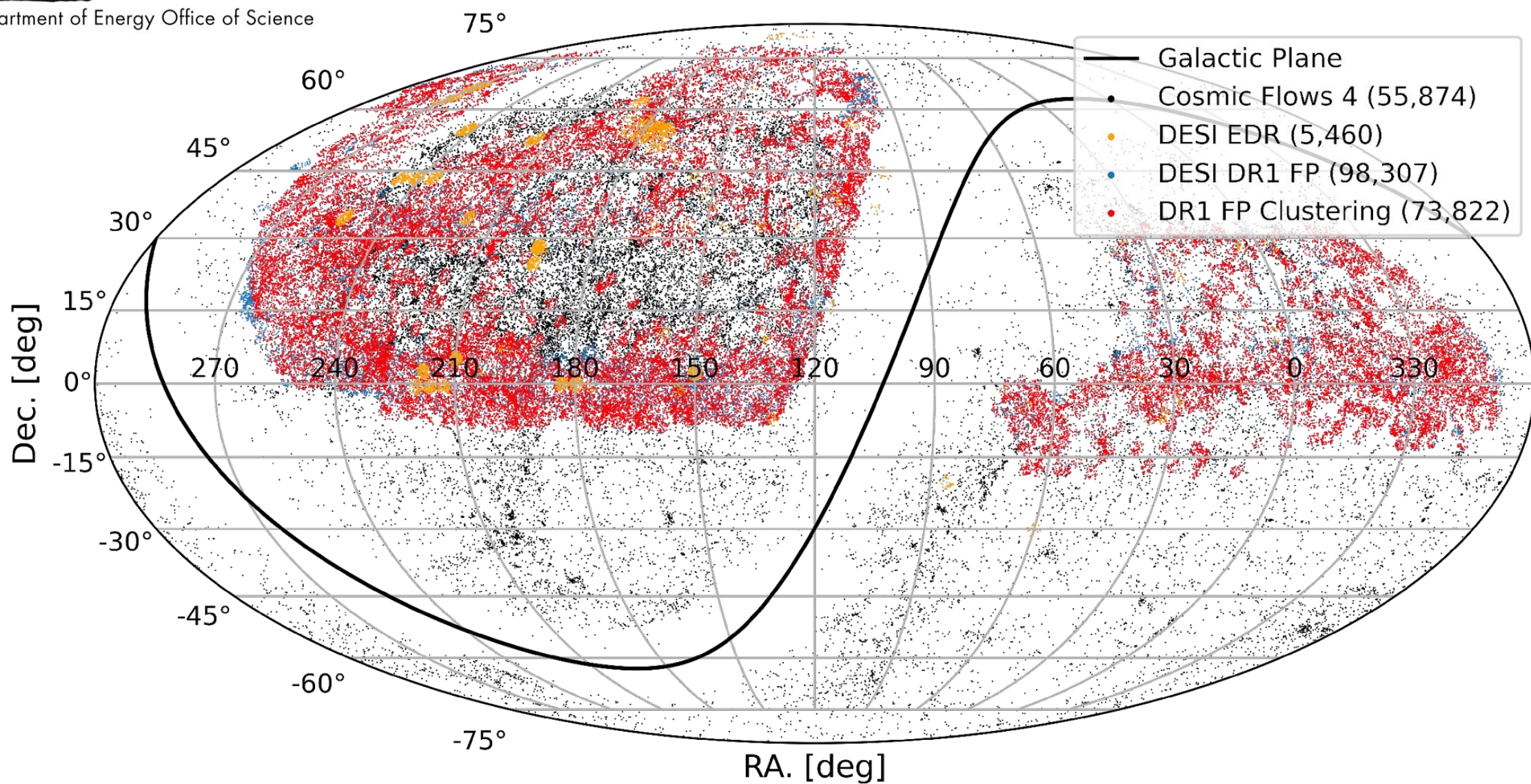


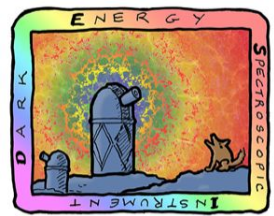


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DESI FP Sample





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Summary

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DR1 Fundamental Plane sample:

- PVs for 97 995 Early-type Galaxies
- ~74 000 of which lie within the BGS footprint and are being used for H_0 and σ_8 measurements
- Part of the DESI DR1 PV paper suite (Hopeful December arXiv release)

To come in DR2:

- More in depth velocity dispersion systematics analysis
- Investigate methods to reduce spiral contamination