Dynamical Scaling Relations for all Galaxy Types

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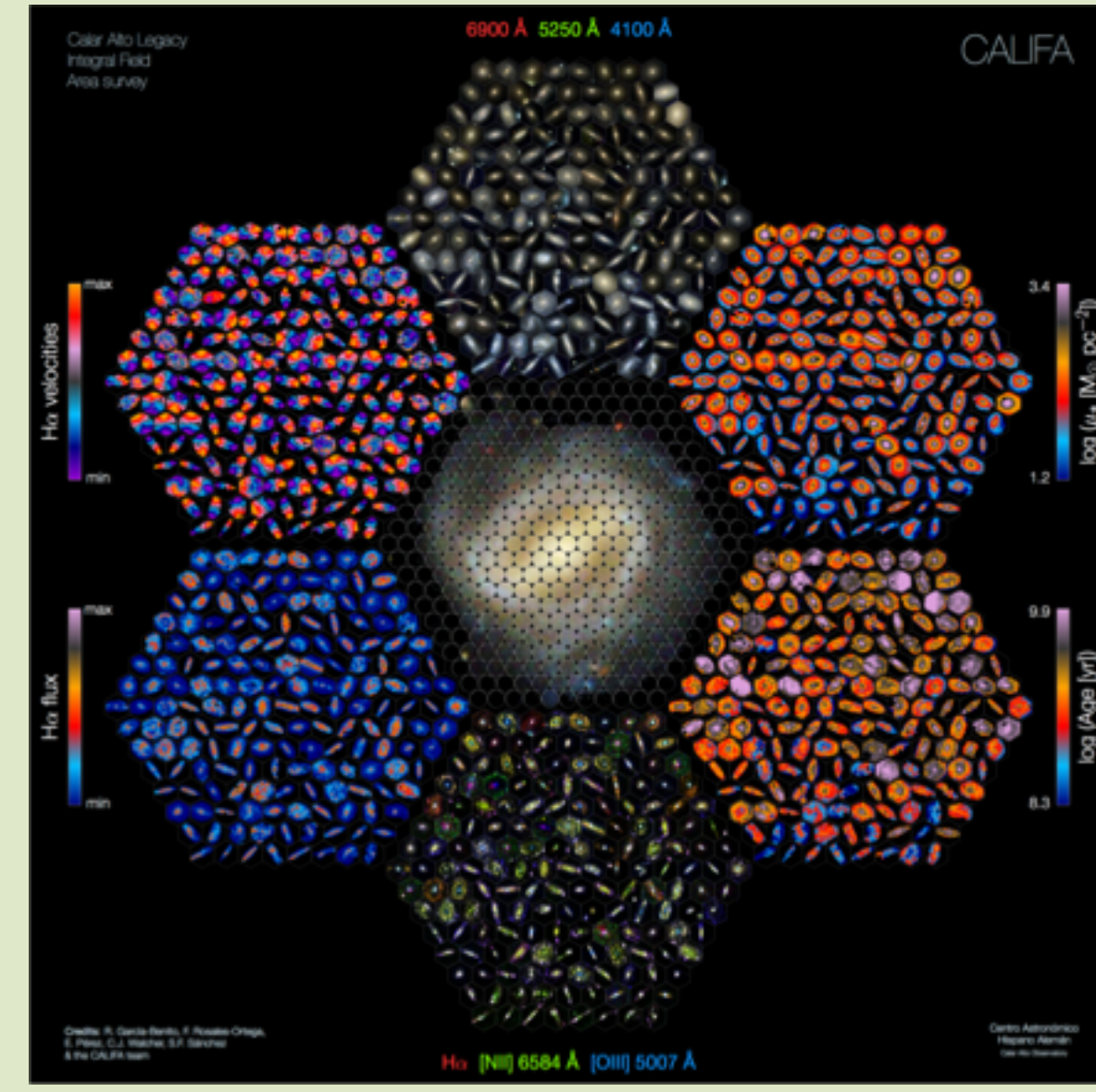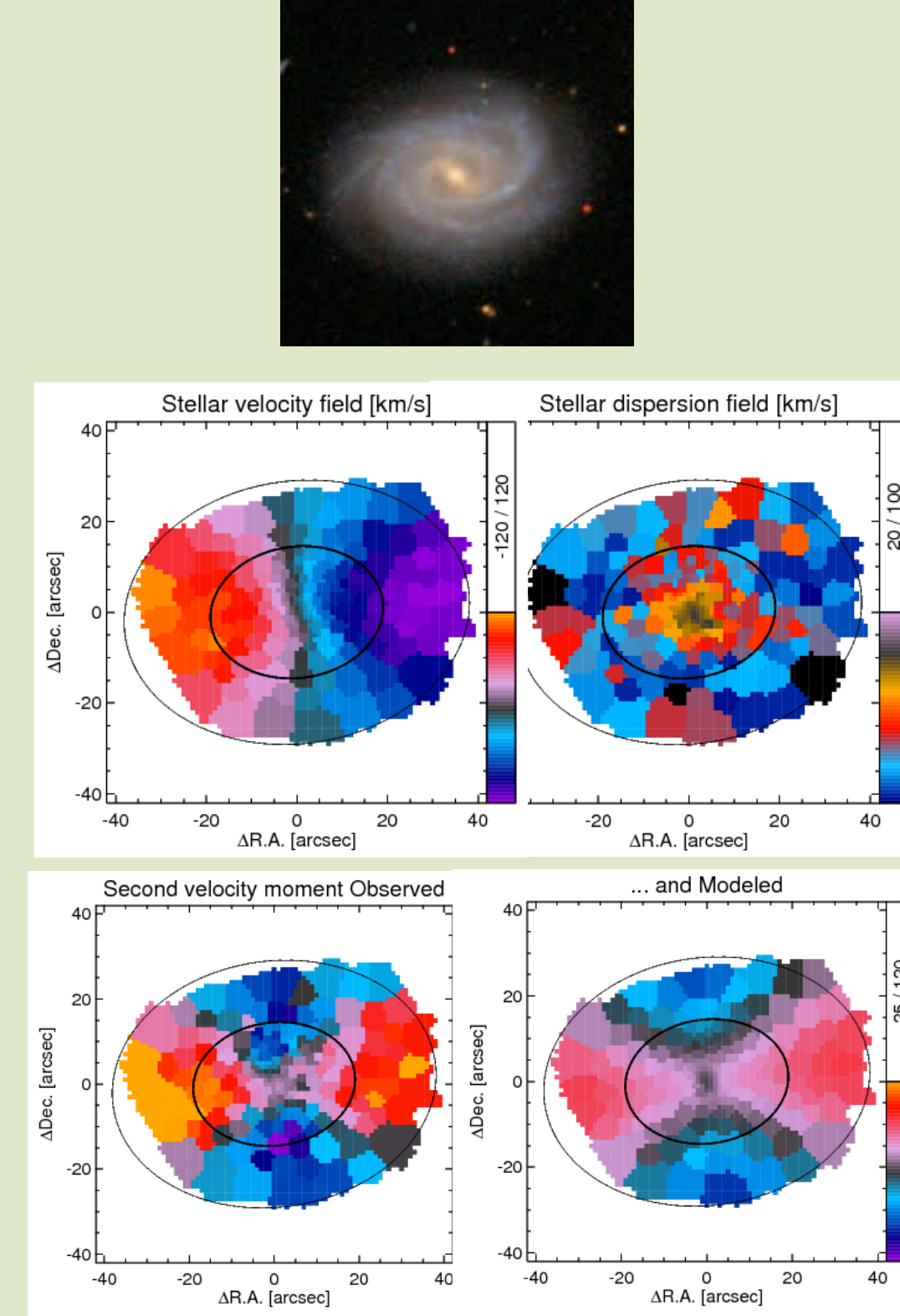
CALIFA IFU Survey

- **Calar Alto Legacy Integral Field Area** survey
- **3D spectroscopy** with PPAK/PMAS
  at 3.5m telescope Calar Alto Obs.: CAHA
- PI: S. Sanchez (UNAM), PS: C.J. Walcher (AIP)
- **667+ galaxies** in local Universe (*0.005 < z < 0.03*)
- **All Hubble galaxy types**
- Selected by apparent size
- **Fair representative mother sample** from SDSS
- **Volume corrections & Cosmic variance corrections**
- 3 Public Data Releases
- Many data products including
  - Stellar Populations,
  - Star Formation rates & SF histories,
  - gas abundances, ionization sources,
  - stellar structure, stellar masses

Parameter Derivation

NGC4210

Dynamical Masses:
JAM: Axisymmetric Jeans Anisotropic Multi-Gaussian Expansion Models (Cappellari 2008) (s. Lyubenova+2016)
Agrees well with Schwarzschild models (s. Leung+2018)

Stellar Masses:
SED fitting method of Walcher+2008 using optical growth-curve magnitudes (s. Walcher+2014)

Star Formation Rates:
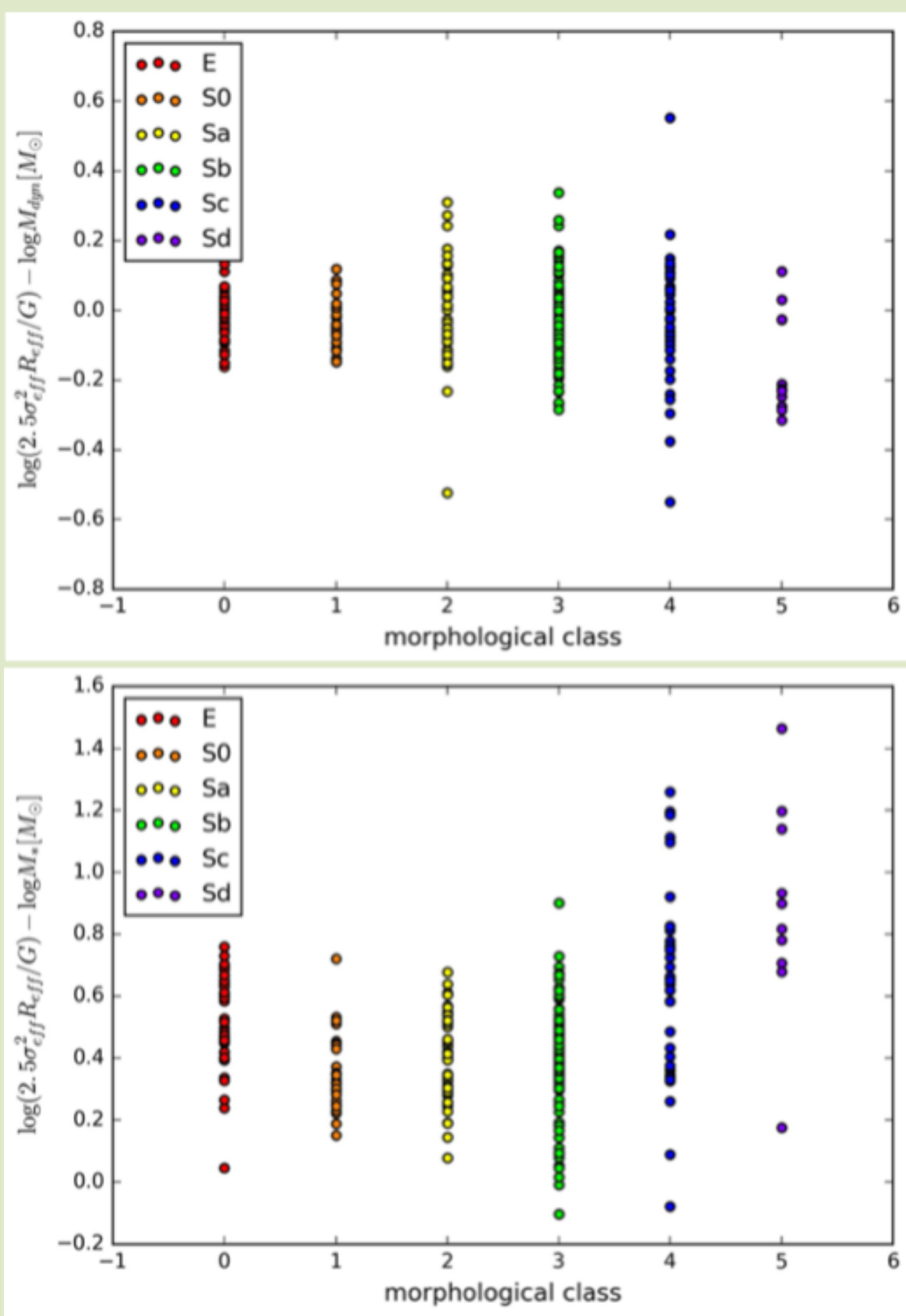Based on extinction-corrected Hα (Kennicutt 1998)

Stellar Metallicities:
STARLIGHT stellar population modelling (s. Cid Fernandes+2014)

Virial Theorem:

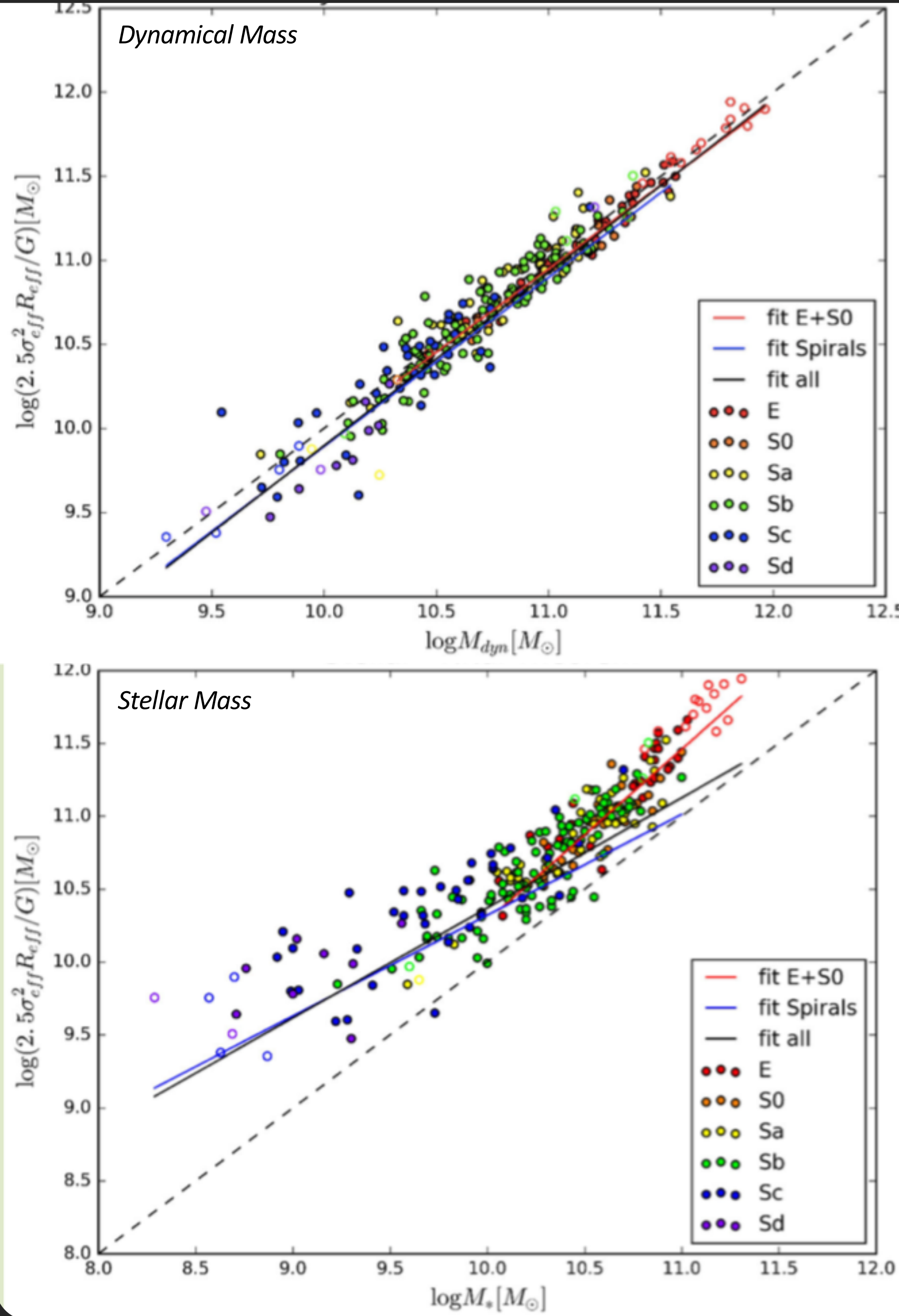$$2\,K + W = 0 \qquad K = \frac{1}{2}M_{tot}\langle v^2\rangle \qquad W = -\frac{G\,M_{tot}^2}{R_g}$$

$$M_{tot} = \frac{\langle v^2\rangle R_g}{G} \qquad M_{tot} = 2.5\,\frac{\langle v^2\rangle R_{eff}}{G} \qquad \langle v^2\rangle = C\sigma^2$$
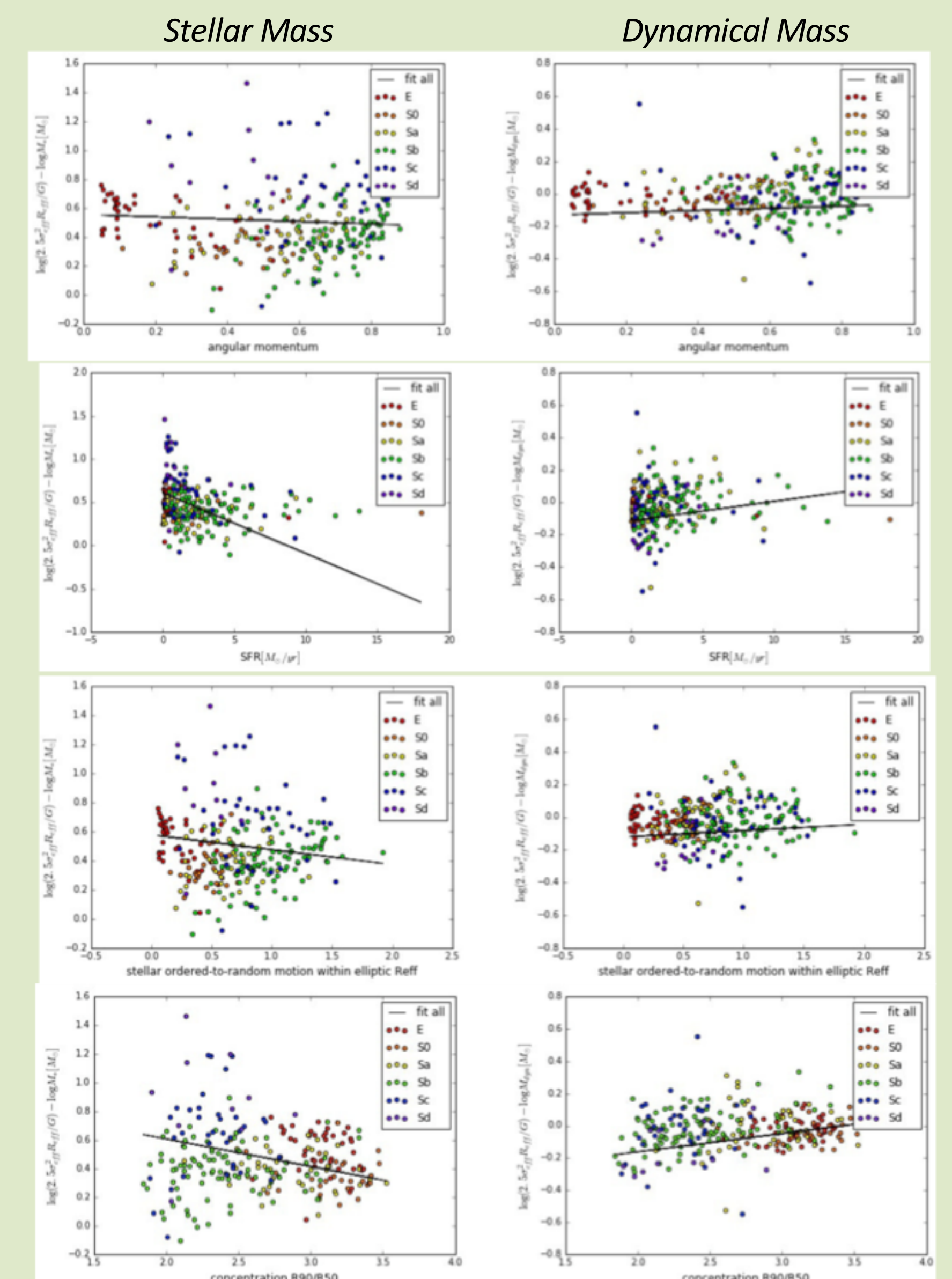
Virial Plane Residuals

- Measured *Dynamical Mass* M_{dyn} follows expectation from Virial Theorem (no tilt like FP for Es, Dressler+1987).
- All morphological types share same fit with <0.2dex 1σ- std deviation from common fit.
- *Stellar Mass* M_* still separates dynamically hot and cold galaxies with different fits.
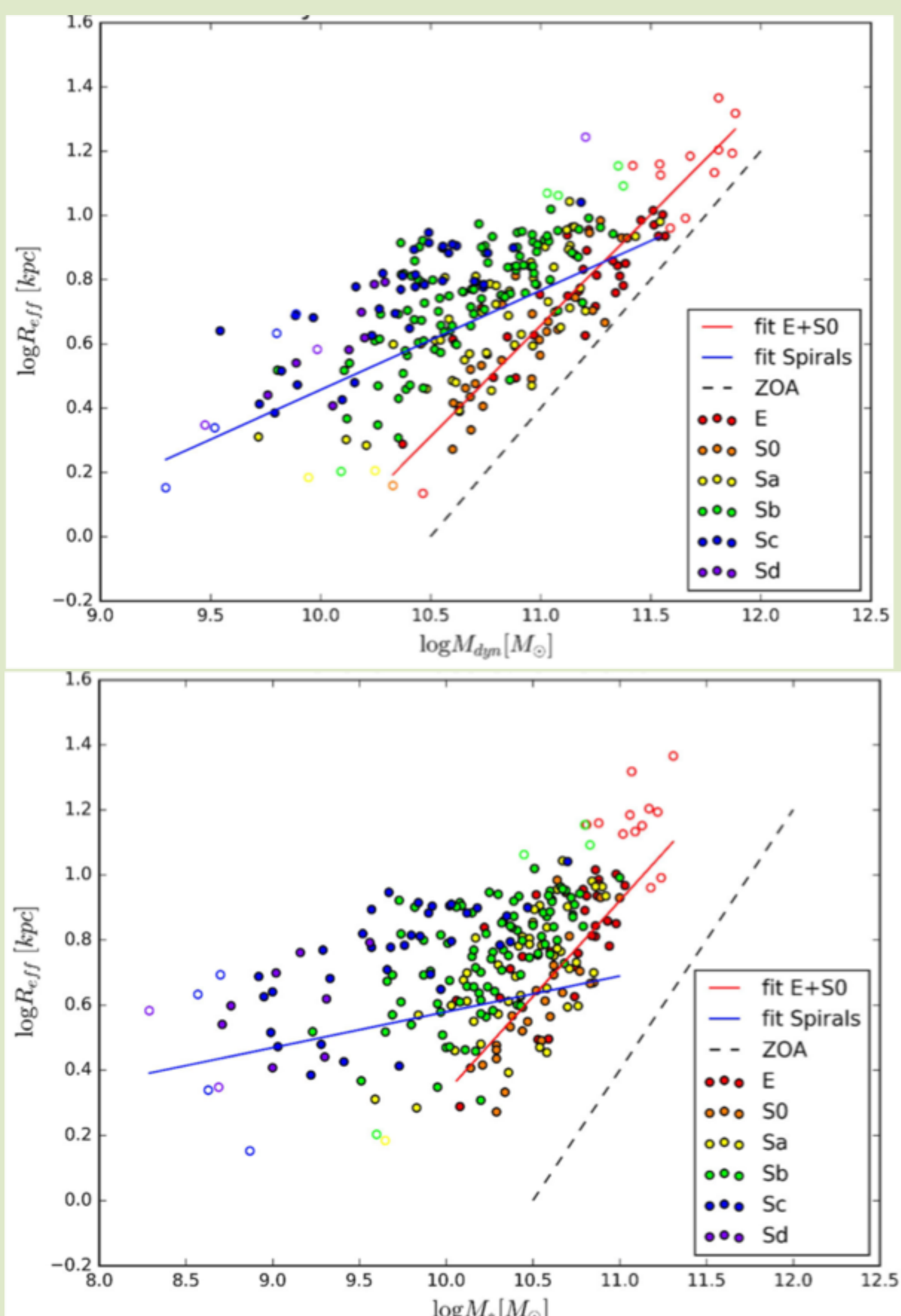
Virial Plane
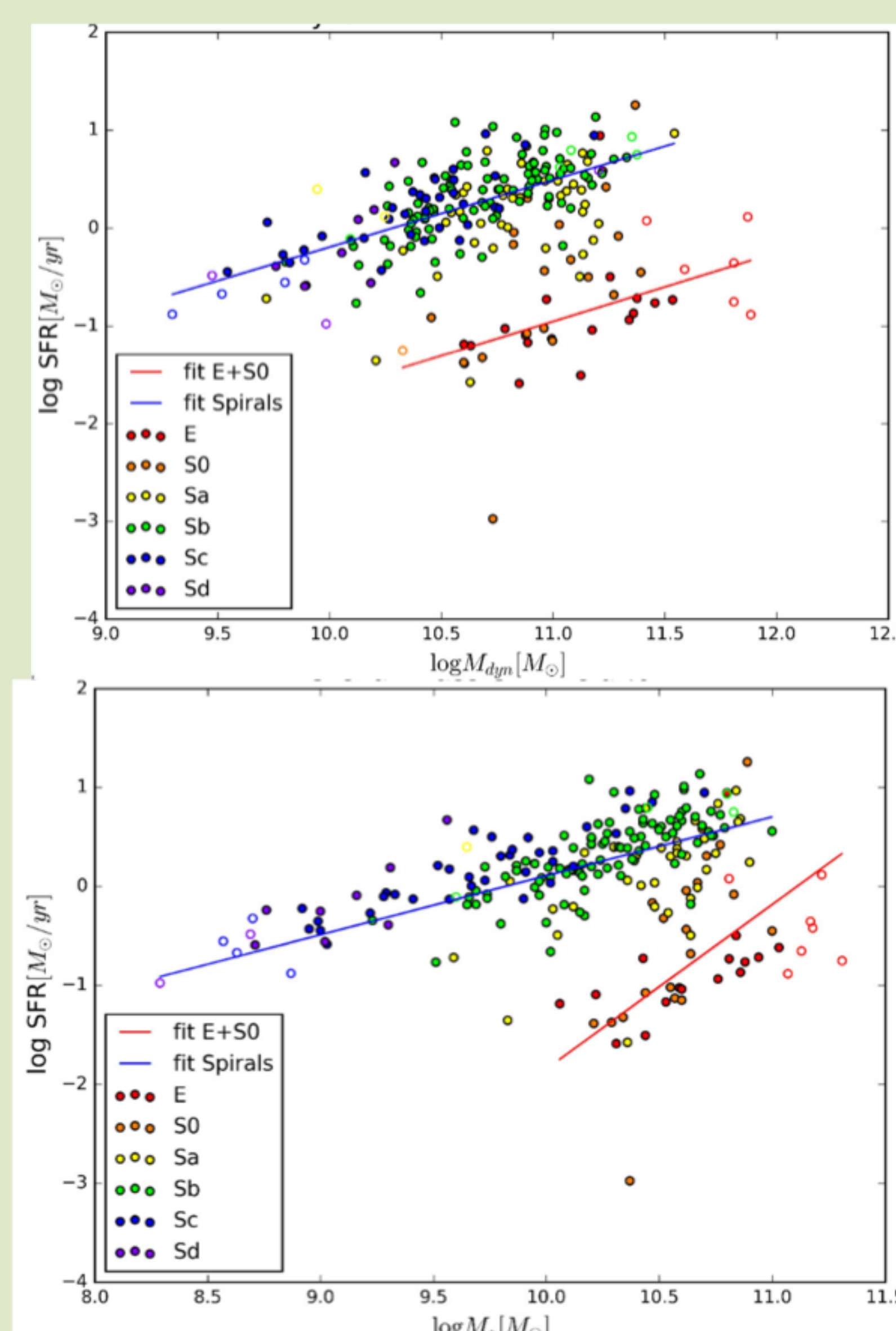

Virial Plane Residuals

Stellar Mass   *Dynamical Mass*

No additional dependence in case of M_{dyn} on λ, SFR, V/σ, B/D!
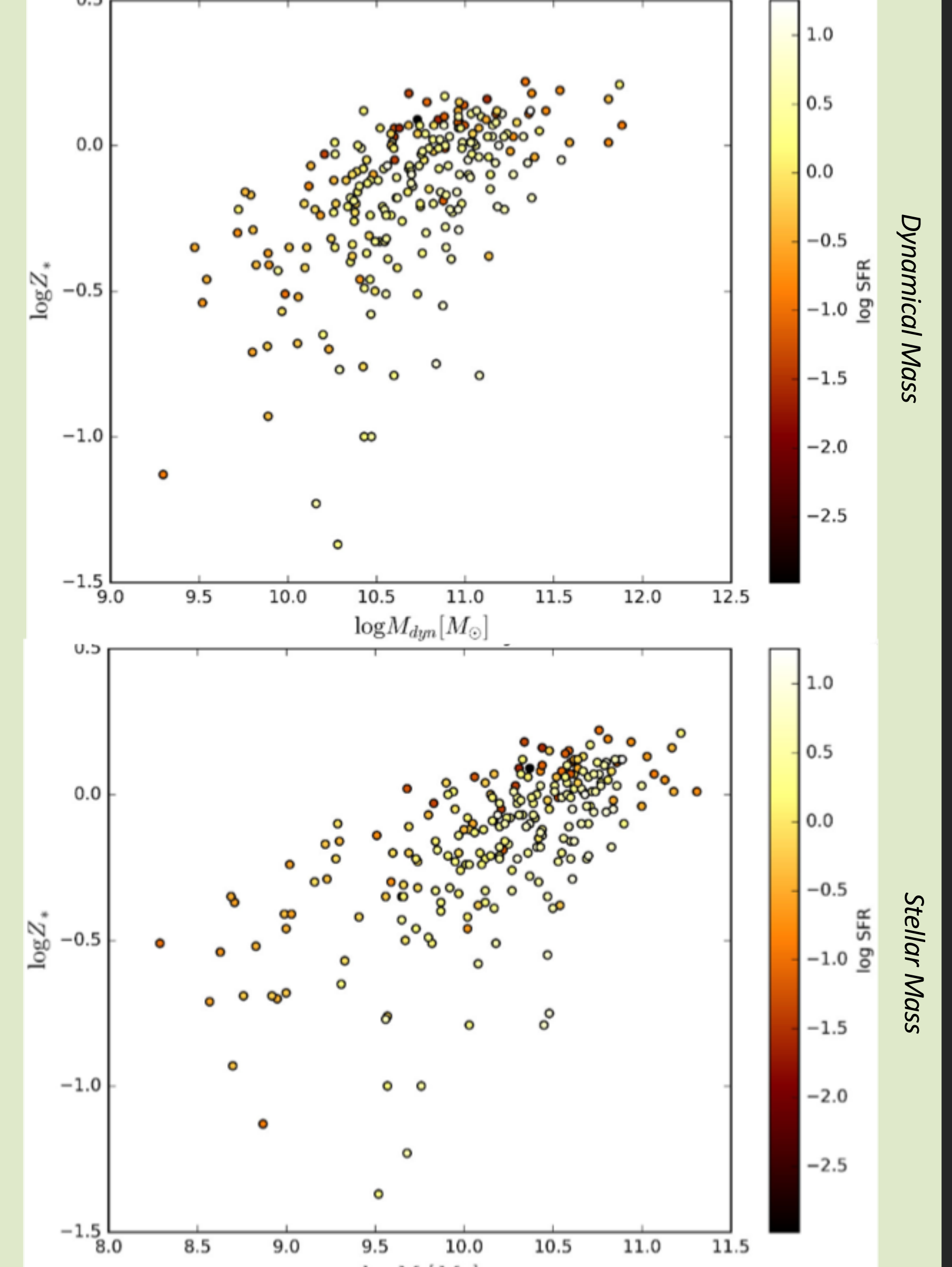
Mass-Size Relation

- Individual fits to types E to Sd become progressively flatter
- *Zone of Avoidance* (Burstein+1997) holds for all types

Mass-SFR Relation

- Galaxies fall into two groups with parallel fits in case of *Dynamical Mass* M_{dyn}

Mass-Stellar Metallicity Relation

- Large spread in distribution with flattening at big masses
- Some additional dependence on Star Formation Rate *SFR*