Early-types . Red sequence. z 1 to 0

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Isaac Newton Group
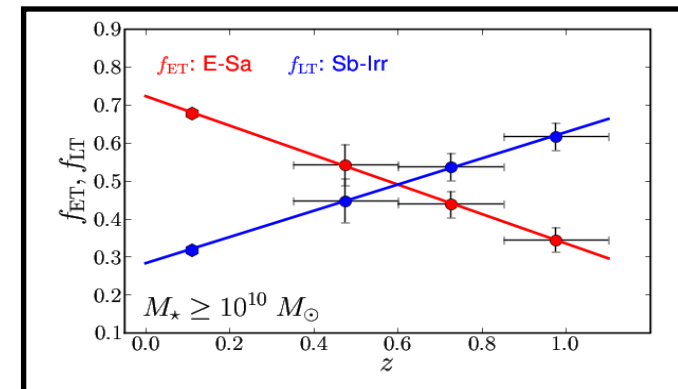
Evolution z 1 - 0

- ### Growth of Red Sequence (L* Phi* up x2)
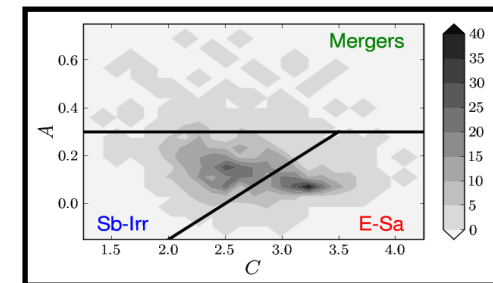 Bell et al 2004; Faber et al 2007

- ### Higher fraction of early types

- ### Size growth (~x4)
  Trujillo et al 2007

- ### Less asymmetric

- ### Mass growth (?)

Processes z 1 to 0

- Fading ('passive evolution')

- Major mergers

- Minor mergers

- Truncation of star formation
    - Internal / external drivers

- Internal dynamical processes
    - Dynamical heating; radial mixing

Diagnostics

1. Populations
   - Stellar population ages, metallicities, alpha-enhancements

2. Morphologies
   - Asymmetries – interaction diagnostics

3. Structure
   - Surface brightness profiles, spheroid vs disk
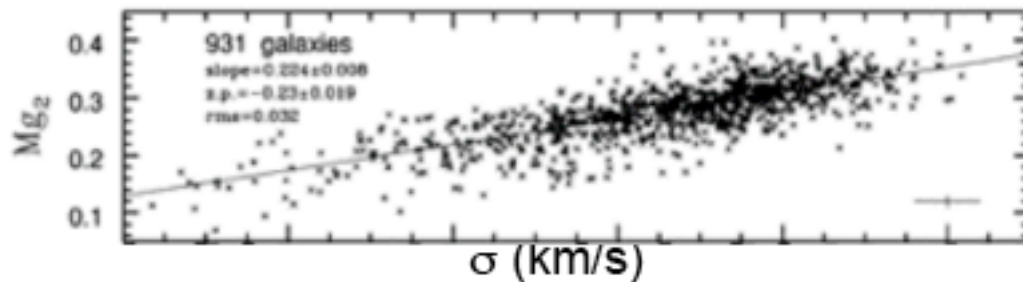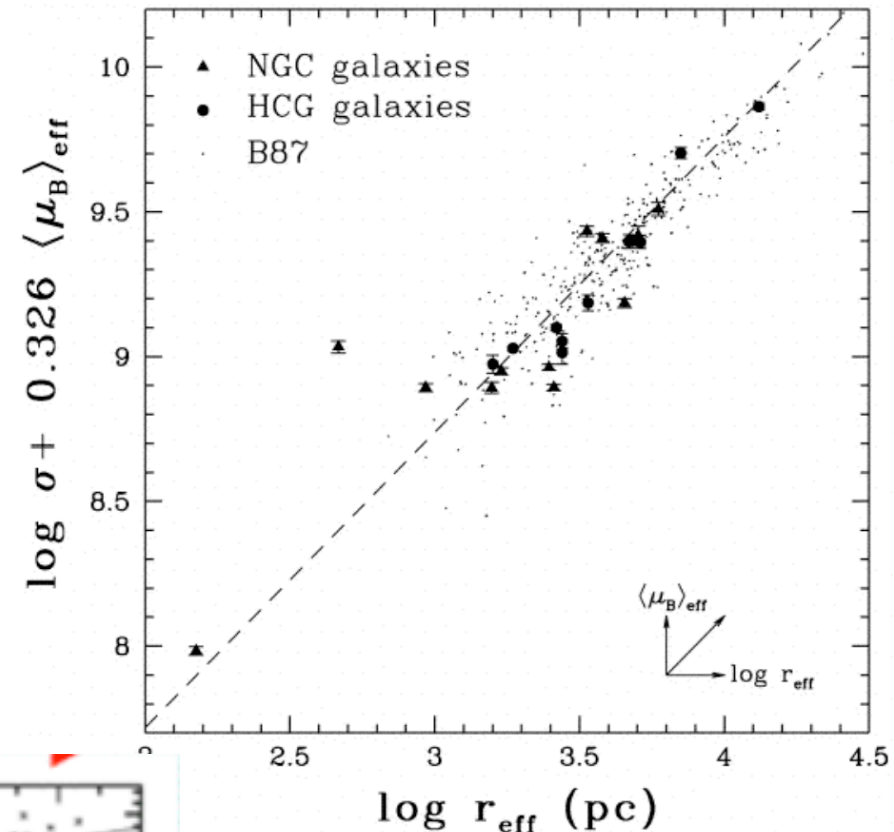
4. Dynamics
   - Fundamental Plane; Faber Jackson

Fundamental Plane

- Tight relation, at z=0
- Three variables linked to mass, size, M/L
- Related to Virial theorem

$$\frac{GM_{\mathrm{dyn}}}{<r>} = k_E \; \frac{<v^2>}{2}$$

- Deviations due to populations? Non-homology?

Faber-Jackson L-σ relation

- Viewing FP not edge-on

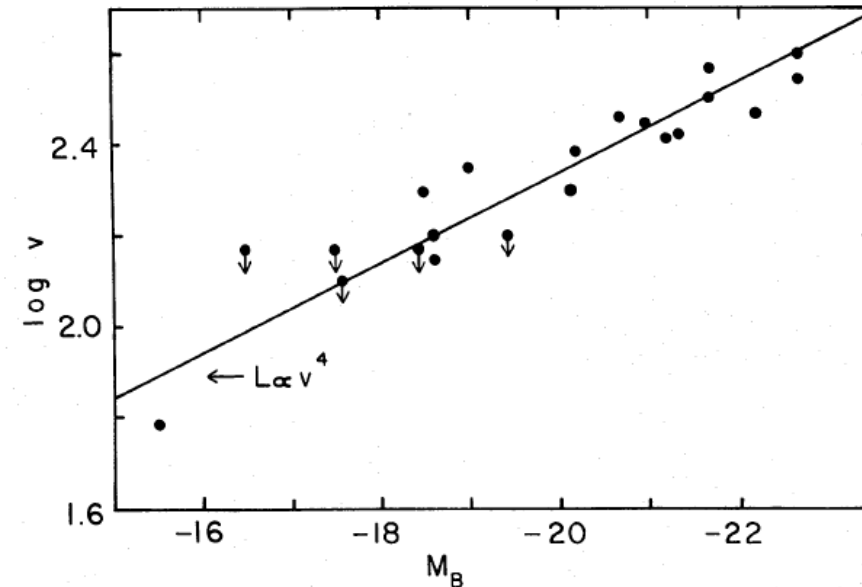- Implies galaxies do not populate entire FP, but just a band

FIG. 16.—Line-of-sight velocity dispersions versus absolute magnitude from Table 1. The point with smallest velocity corresponds to M32, for which the velocity dispersion (60 km s^{-1}) was taken from Richstone and Sargent (1972).

FP, FJ are tight relations

- Interpreted as meaning that z=0 E's are homogeneous, old galaxies that formed in a brief period over 10^{10} yr ago

Renzini et al, many papers

- In conflict with hierarchical models

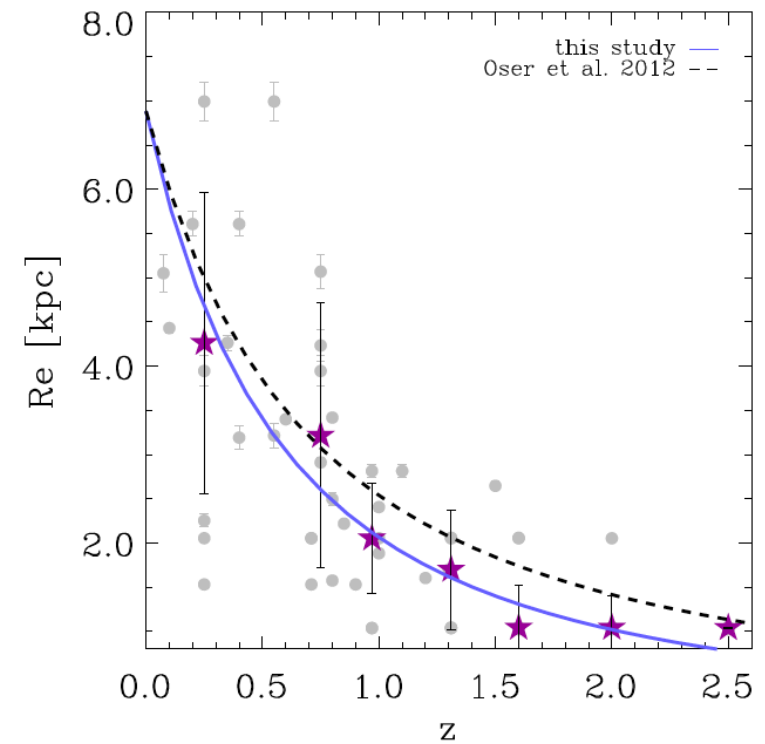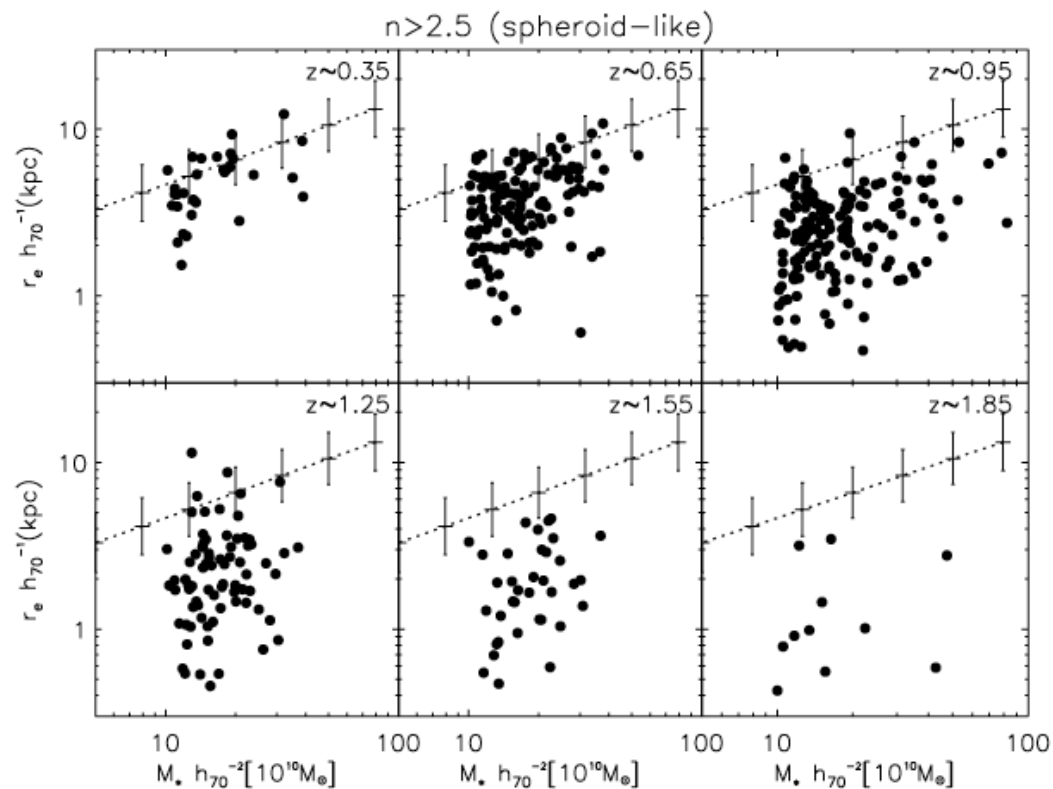 - Perhaps in agreement with results from LF evolution?

Make the puzzle more complex

- Size evolution: upsizing z=2-1-0 (eg Trujillo et al 2007)

- We believe it's minor mergers

  Naab et al 2009

  Tapia et al 2013

- Size evolution means drift on FP

More difícil todavía

- $M_* > M_{dyn}$: an impossible result

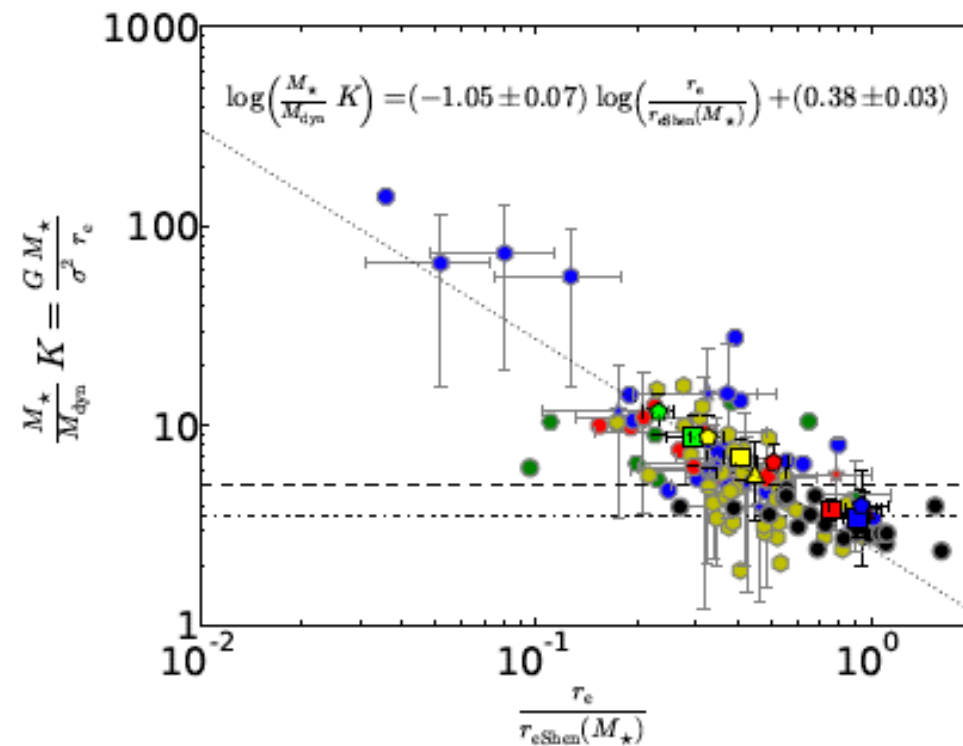$$M_{\mathrm{dyn}} \equiv k_r k_v \, r_e \sigma^2 / G$$

$$z = 0: \quad M_{\mathrm{dyn}} \cong 5 \, r_e \sigma^2 / G$$

- Which is wrong? Probably both
  - Assumptions in population modeling
  - Assumptions in M_{dyn}:
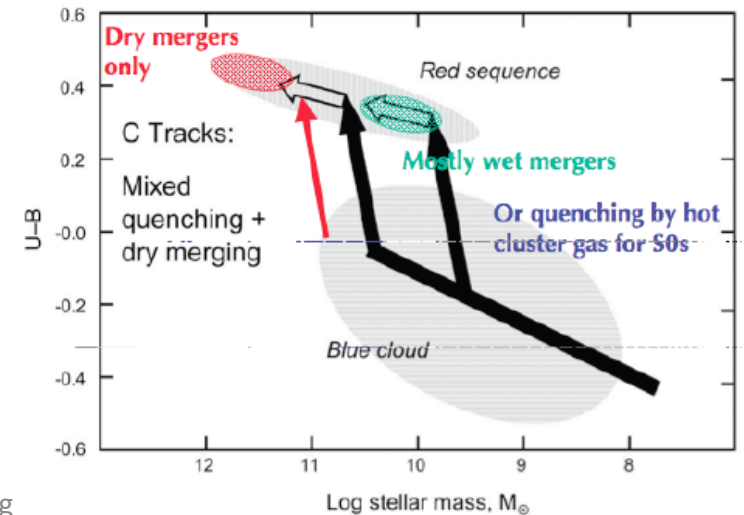   - Virial equilibrium; homology

Peralta's work

- Dynamical masses for sample over range of redshift and compactness

- Infer scaling of M_{dyn} with $R_e\sigma^2$

$$\log\left(\frac{M_\star}{M_{dyn}} K\right) = (-1.05 \pm 0.07)\log\left(\frac{r_e}{r_{eShen}(M_\star)}\right) + (0.38 \pm 0.03)$$

$$\frac{M_\star}{M_{dyn}} K = \frac{G M_\star}{\sigma^2 r_e}$$

Way forward

- Determine FP, FJ relations for sample of early types spanning
  - Size
  - Redshift
  - Color
- In a mass-limited sample 0<z<1
  - From SHARDS

Proposed observations

- Velocity dispersions

- OSIRIS MOS down to I~23 or 24?
  - WHT/AF2 down to I~19-20

- Long-term request to CAT, start 2014B

Upgraded WHT/AF2 performance

- Test observations, dwarf in Hercules cluster
- r=18.9
- 3Å/pix, resolution 8Å
- Exposure 1 hr
- → Mean SNR per pixel = 22 (preliminary reduction)

1910108_M092   Median   SNR22   ACQ_TEST   gnovel468