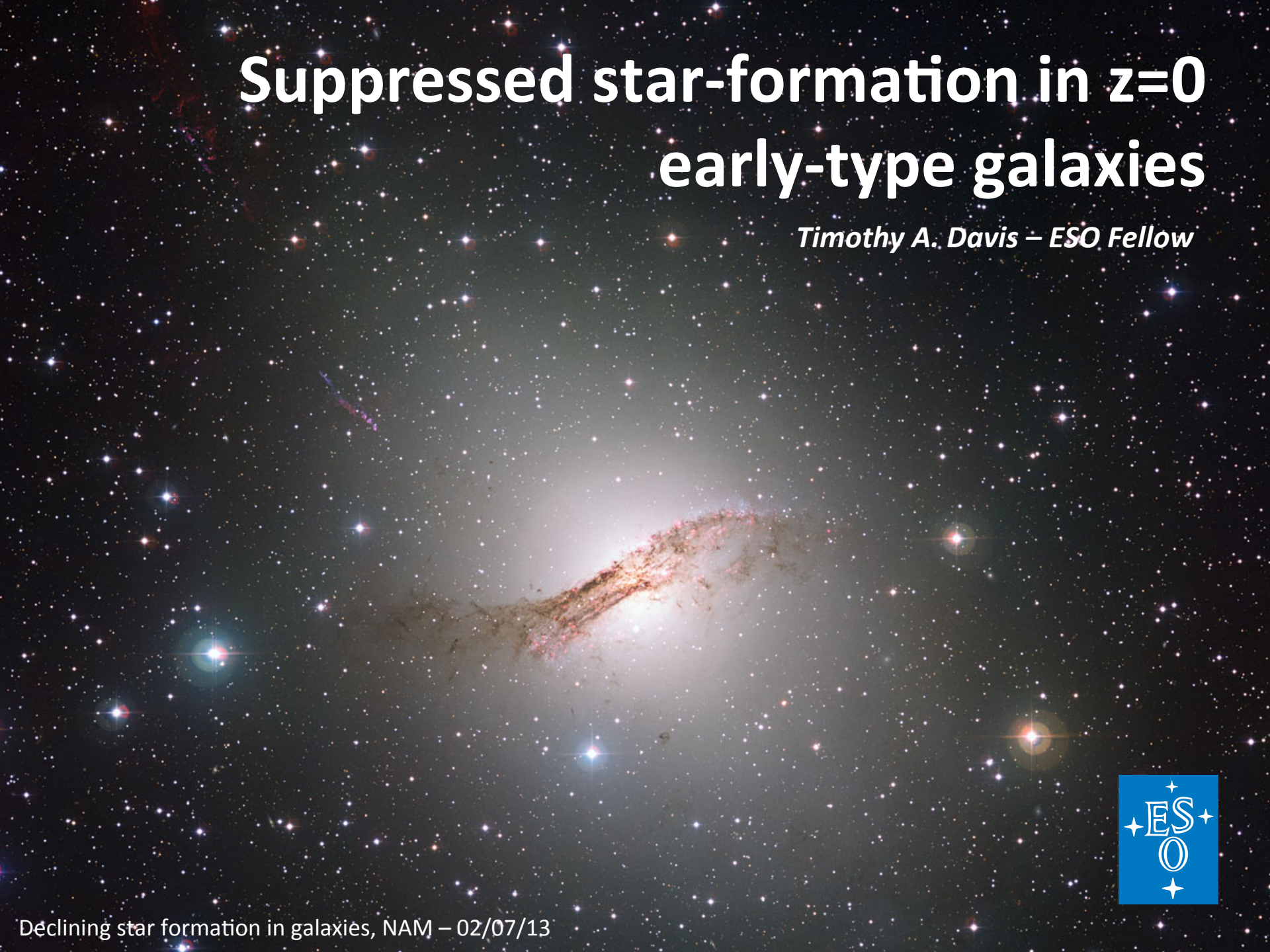
Suppressed star-formation in z=0 early-type galaxies

Timothy A. Davis – ESO Fellow



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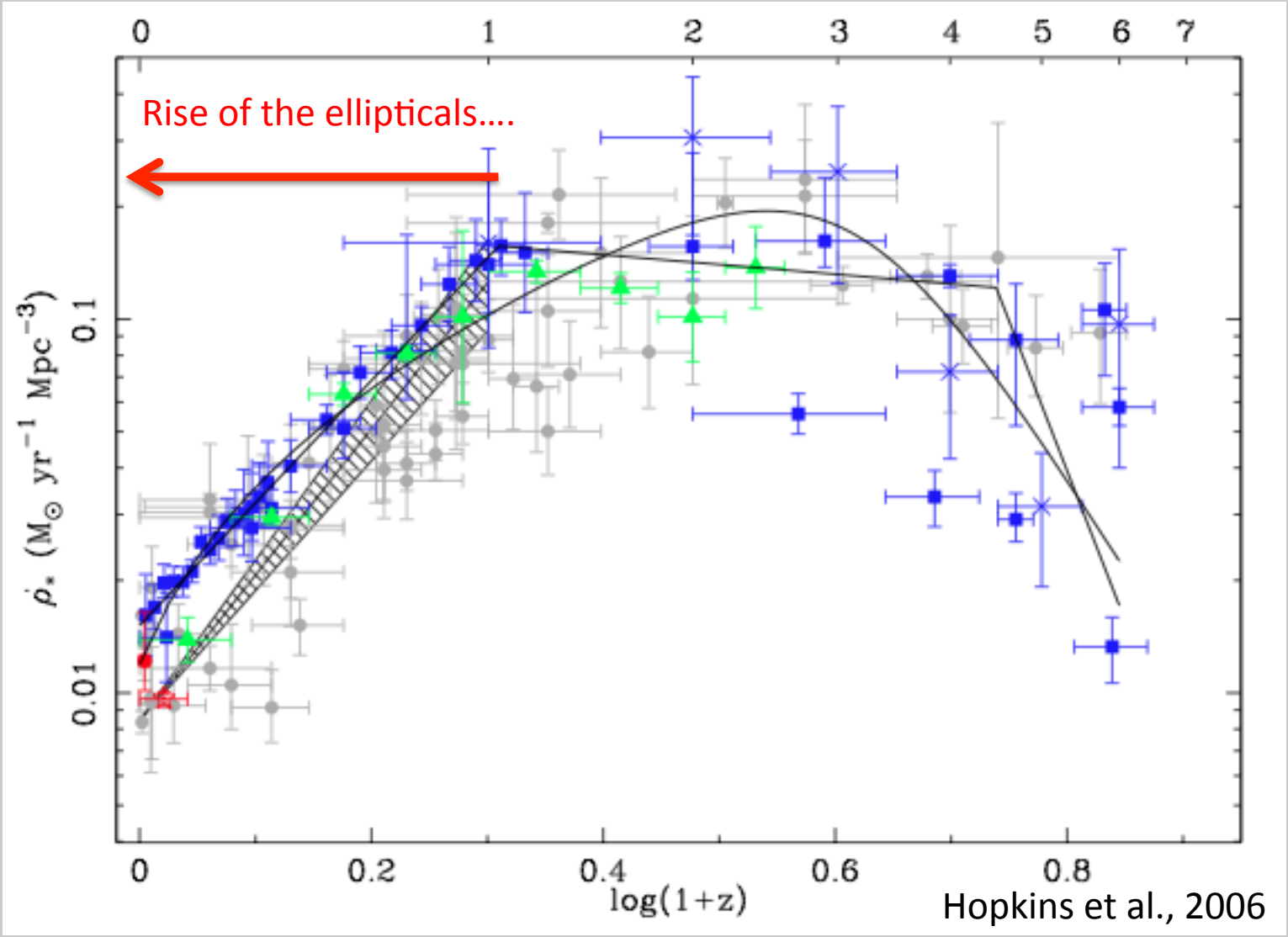

Hopkins et al., 2006

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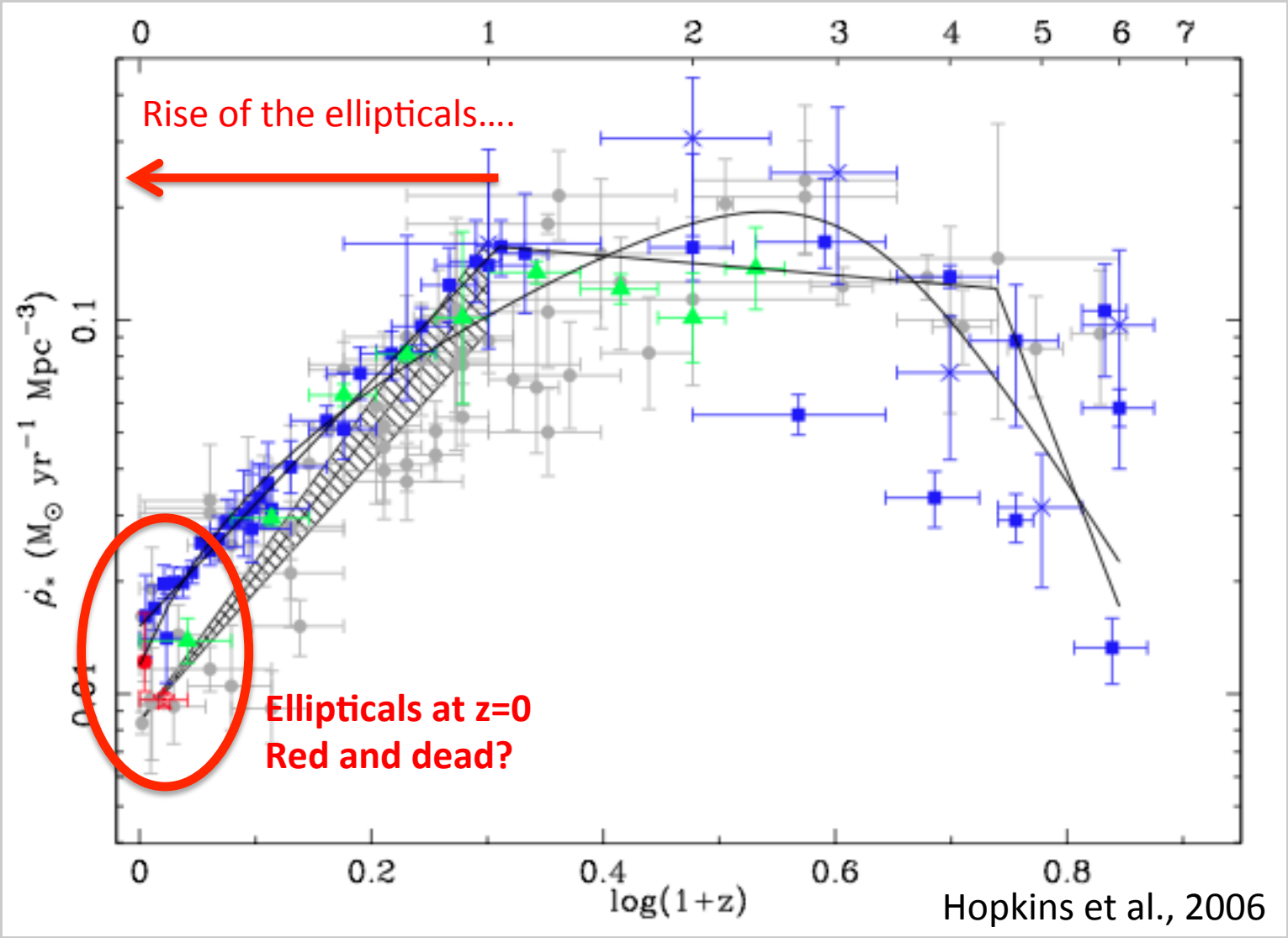
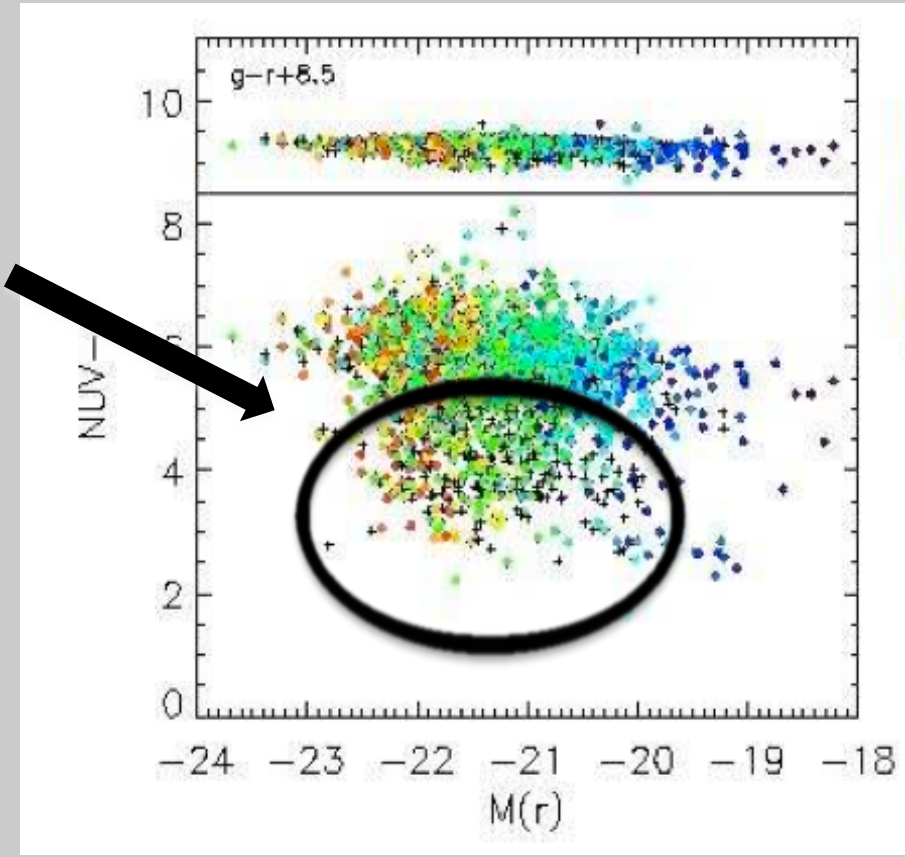


Hopkins et al., 2006

Suppressed star-formation in z=0 early-type galaxies

Local early-type galaxies are not just "red and dead"

- Some 30% have blue UV colours implying residual star-formation
  (e.g. Kaviraj et al. 2007)



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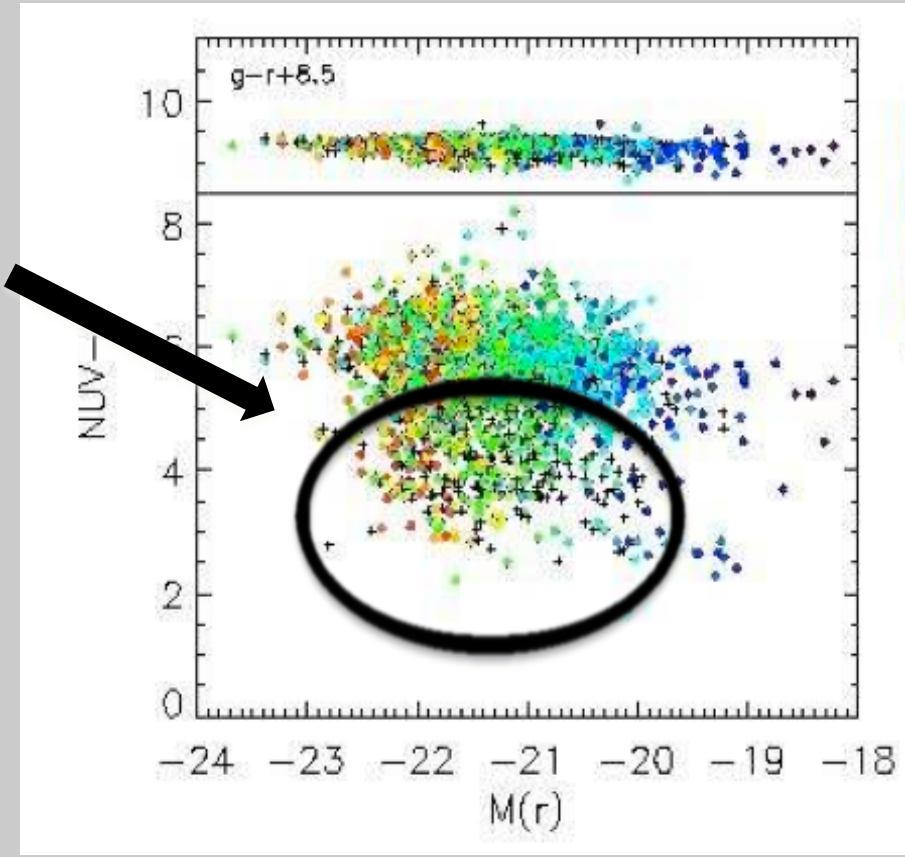

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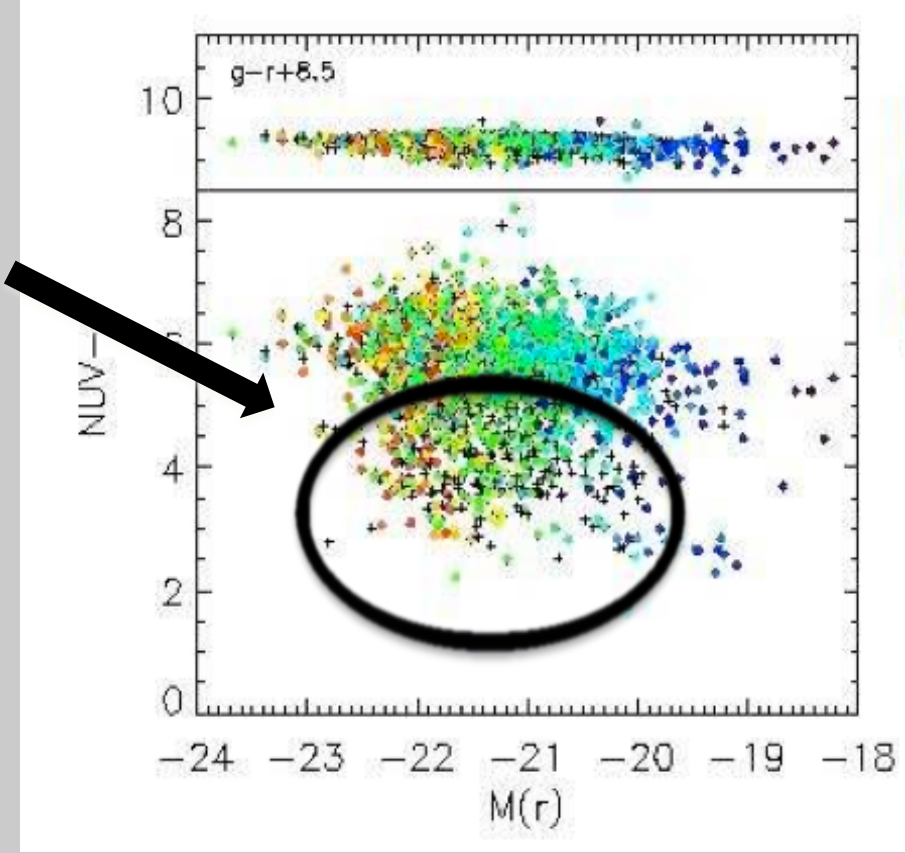

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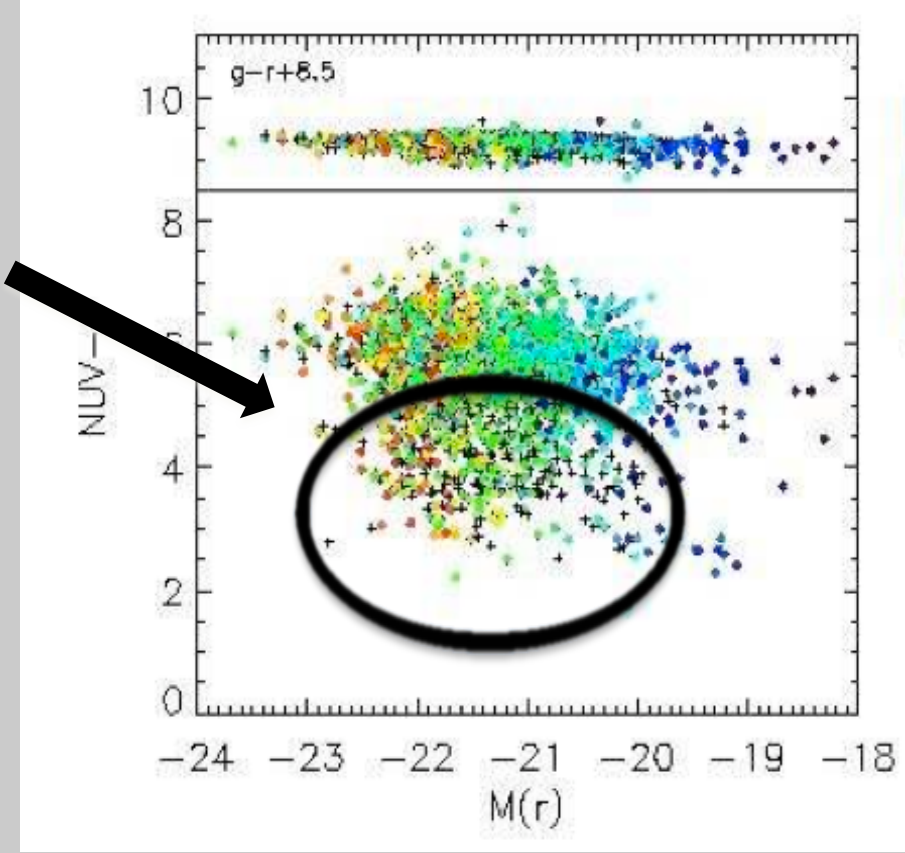
- ~22% of local ETGs have molecular gas
  (e.g. Young et al. 2011)



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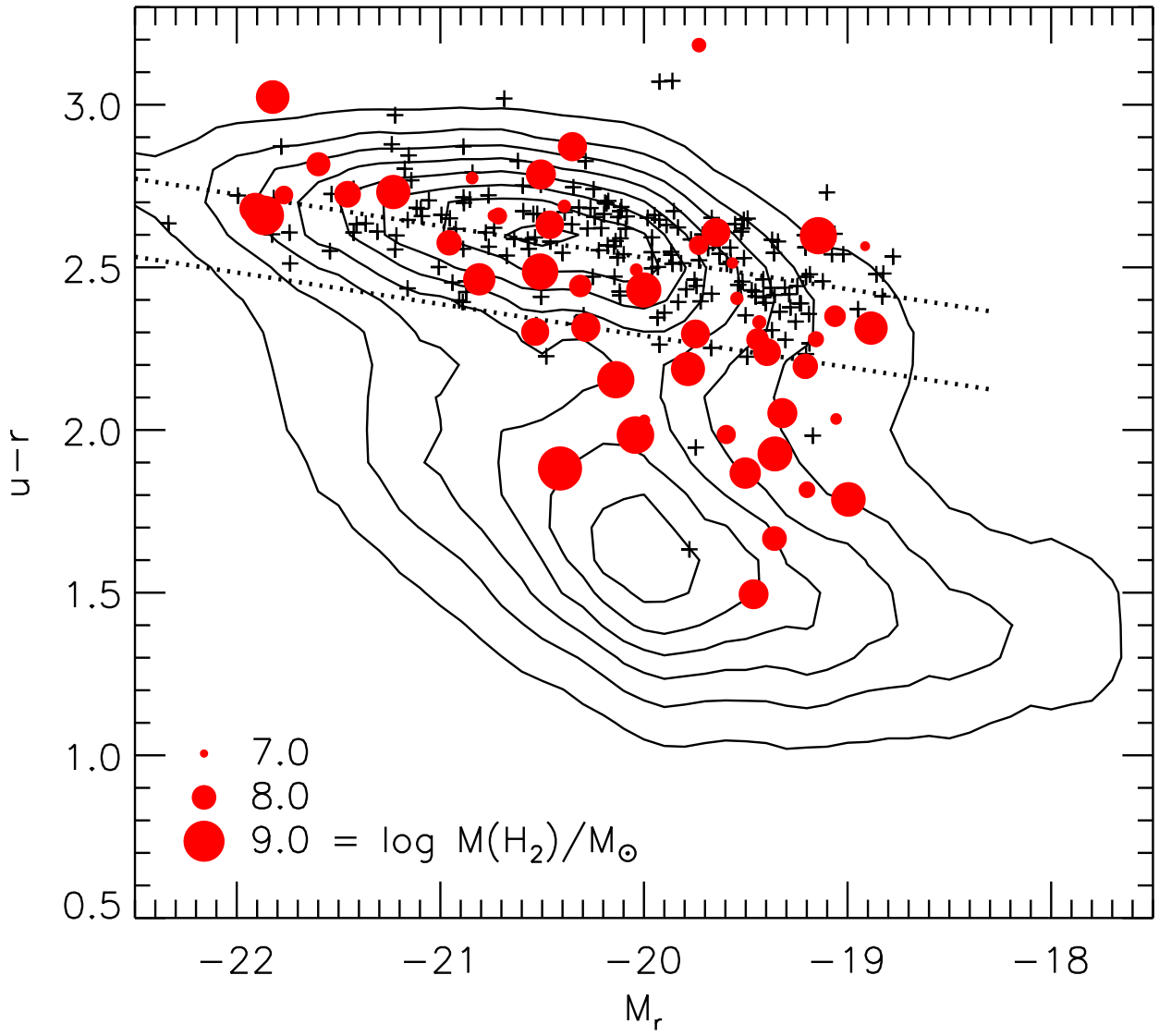
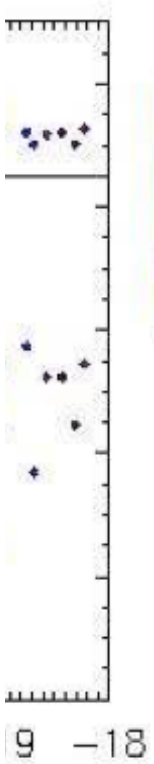
Gas rich ETGs don't avoid the red sequence…



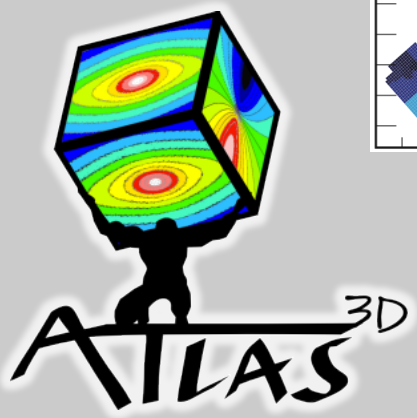


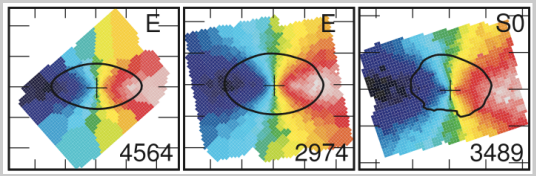
Suppressed star-formation in z=0 early-type galaxies

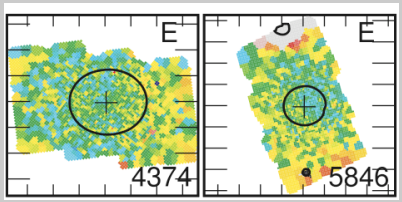
The ATLAS^{3D} project:
A complete, volume limited survey of local early-type galaxies, out to 42 Mpc (and visable from WHT).

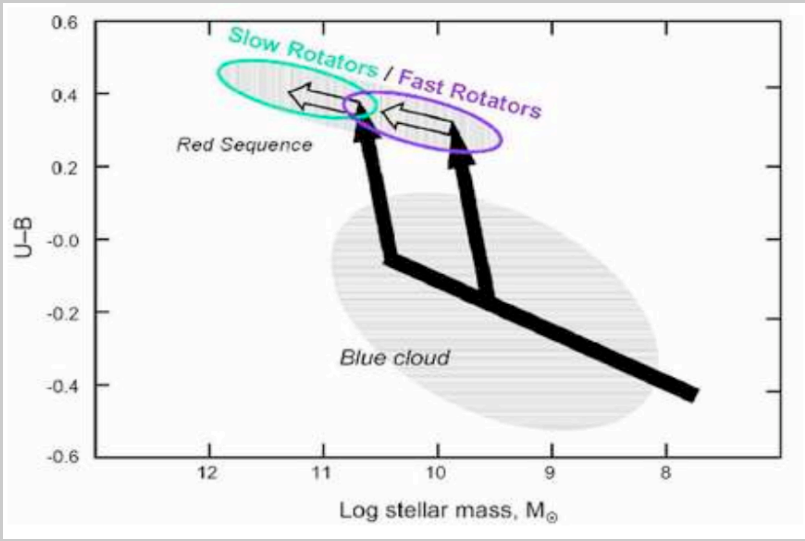
Parent sample of all galaxies with $M_k < -21.5$ → 671 galaxies

Morphologically selection → 260 ETGs





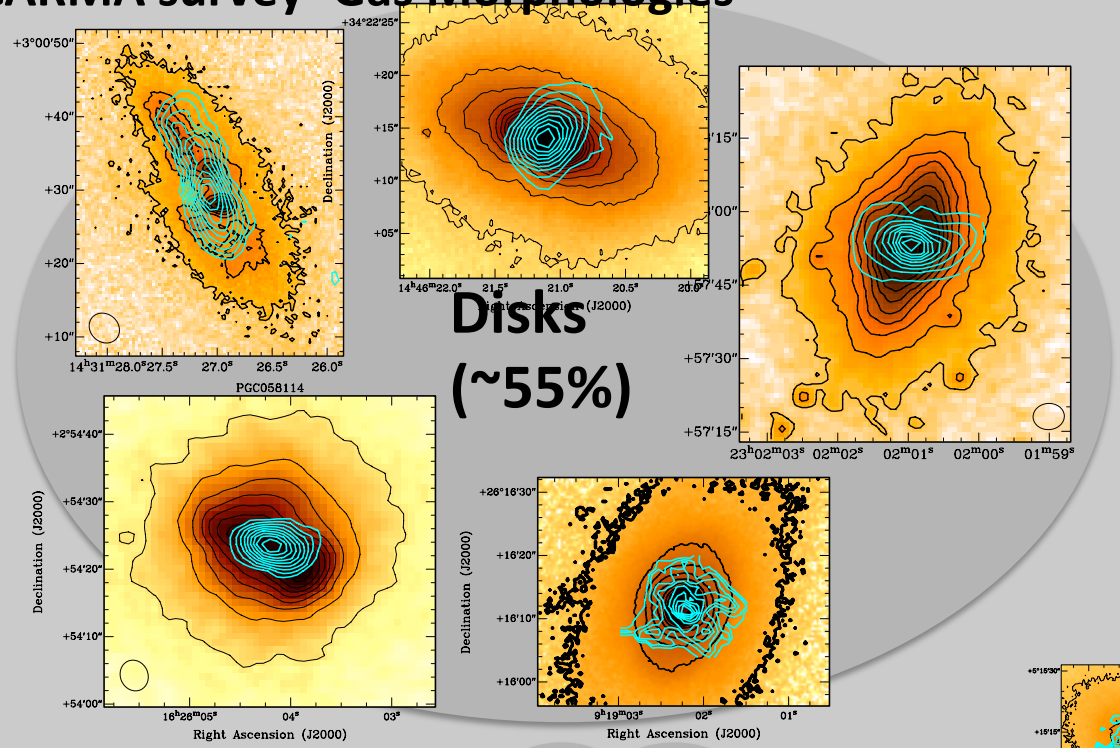




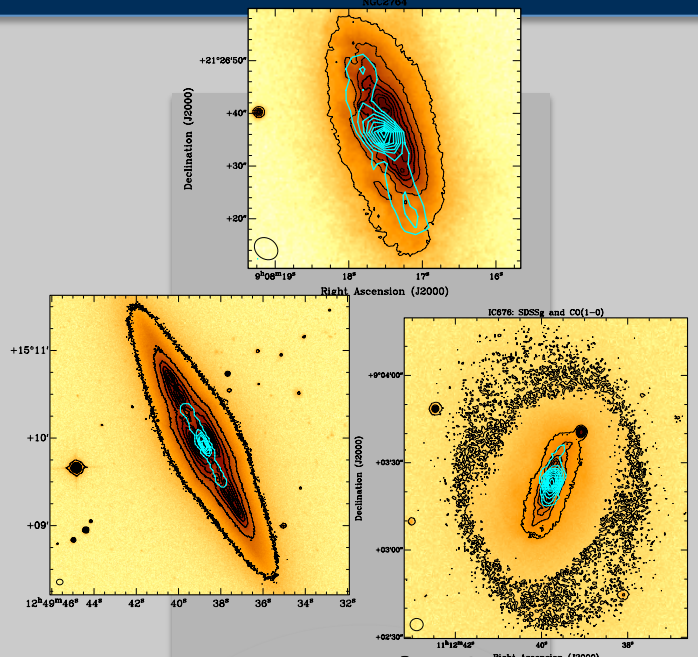
Data sets:
- IFU (Integral Field Unit) spectroscopy [SAURON IFU on the WHT]
- Photometry [INT/SDSS]
- **Single dish carbon monoxide detections [IRAM-30m]**
- **Millimeter interferometry [CARMA/PdBI] (on detections, ~50 galaxies)**
- **HI data [WSRT] (DEC >+ 10 deg)**

Suppressed star-formation in z=0 early-type galaxies

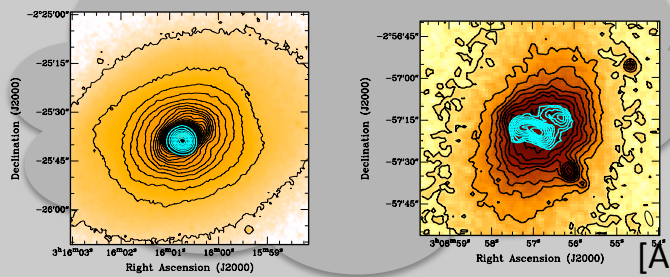
CARMA survey- Gas Morphologies



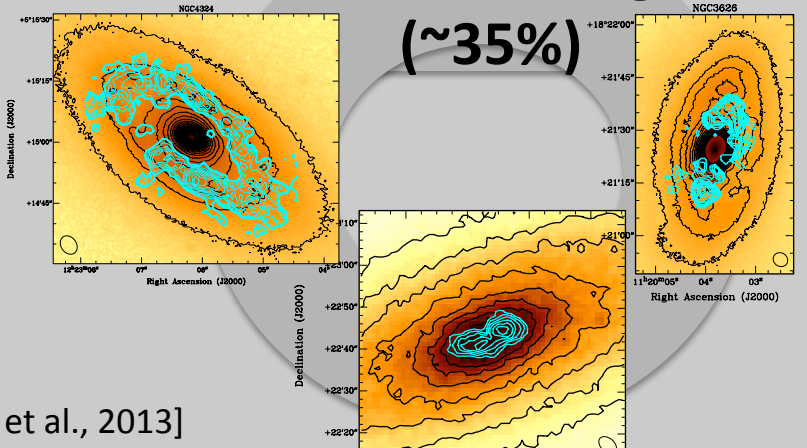
Disks (~55%)



Bars and Rings (~35%)



Disturbed Distributions (~10%)



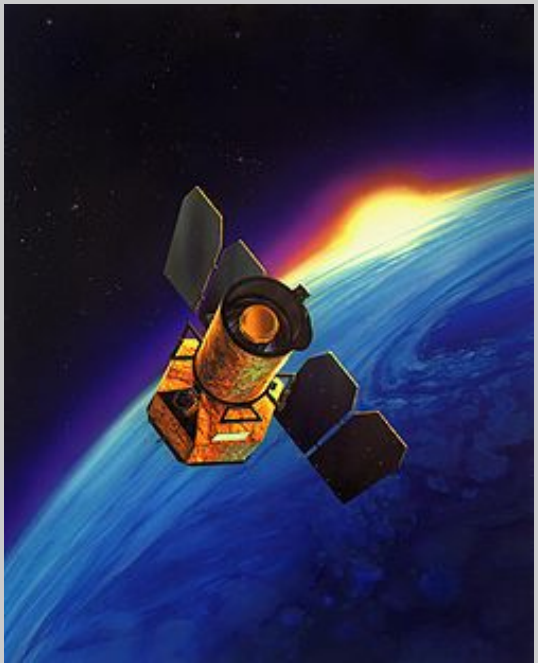
[Alatalo / Davis et al., 2013]

Suppressed star-formation in z=0 early-type galaxies

Are these galaxies forming stars? YES!

- Detected in UV, balmer lines, PAH, hot dust, radio…
- Mean star-formation rate: 0.3 Msun/yr
- Some have more molecular gas, and form more stars than the Milky way!
  (>3 Msun/yr)

→ These galaxies are NOT red and dead!



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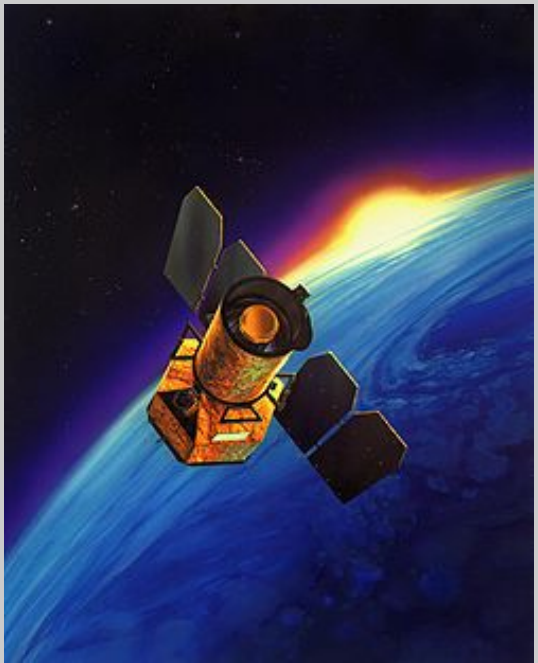
→ These galaxies are NOT red and dead! **BUT:**

- How efficient is this star formation? Galaxies are not blue! (c.f. Martig et al., 2009- morphological quenching)
- Do we know how to measure SFRs well in ETGs?
  - Effect of old stellar populations, deep potential, X-ray halos, alpha-enhancements, magnetic fields…



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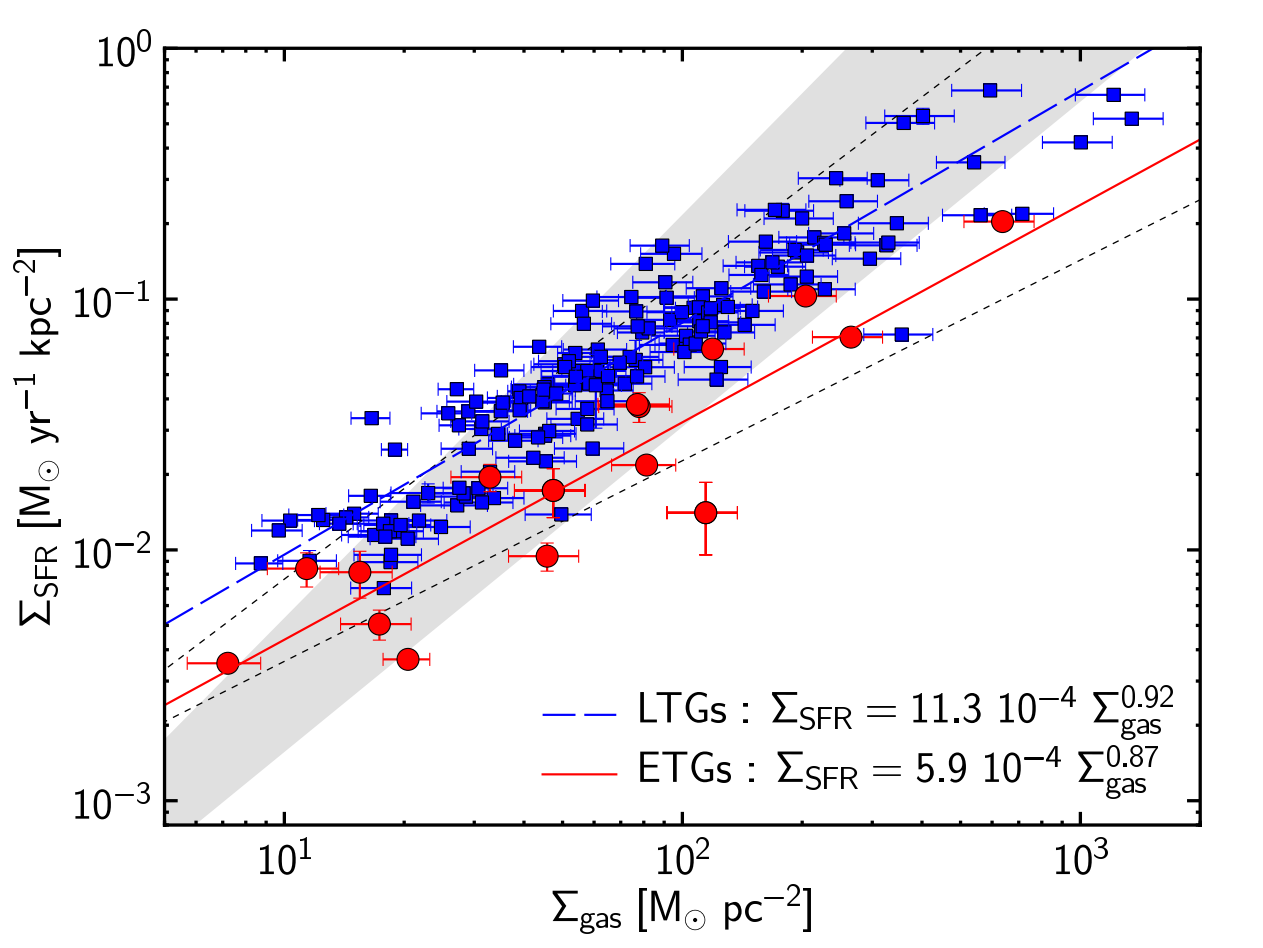


Martig, Crocker et al., 2013

- Resolved star-formation in a sample of 8 galaxies
- 8um SFRs
- Resolved CO (PdBI/ BIMA)
  - Galactic Xco

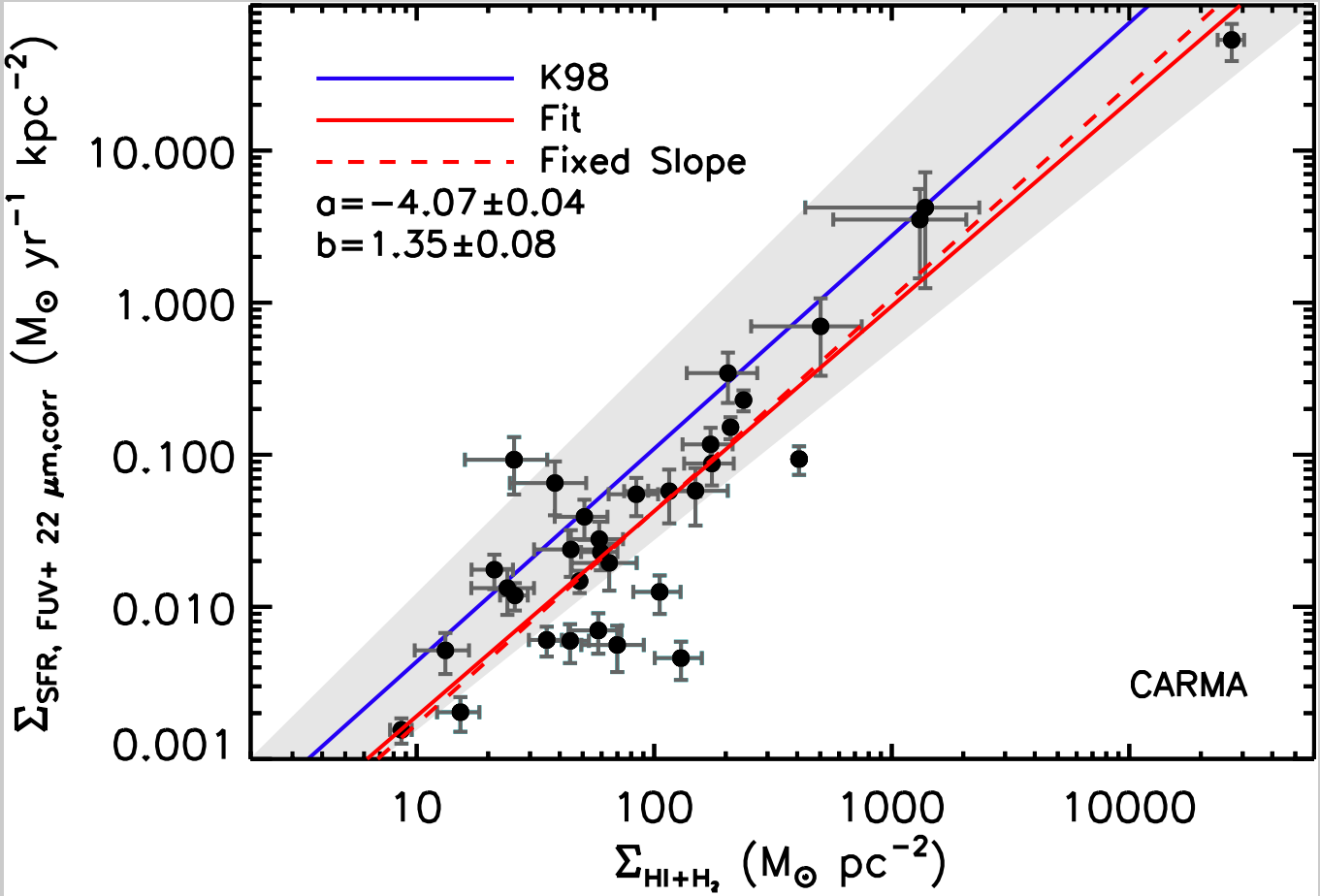
→ ETGs seem to have lower star-formation efficiency (by factor ~3) than spiral galaxies!

Does this hold for all ETGs in local volume (ATLAS^{3D})?

Suppressed star-formation in z=0 early-type galaxies

- Integrated star-formation in the full ATLAS^{3D} CO detected sample
  → 40 *(60)* galaxies
- 22um and 22um +FUV SFRs
- Resolved CO (CARMA)

→ In a large sample we find same result- SFE lower by a factor of 3 in ETGs!



Davis et al., 2013 (in prep)

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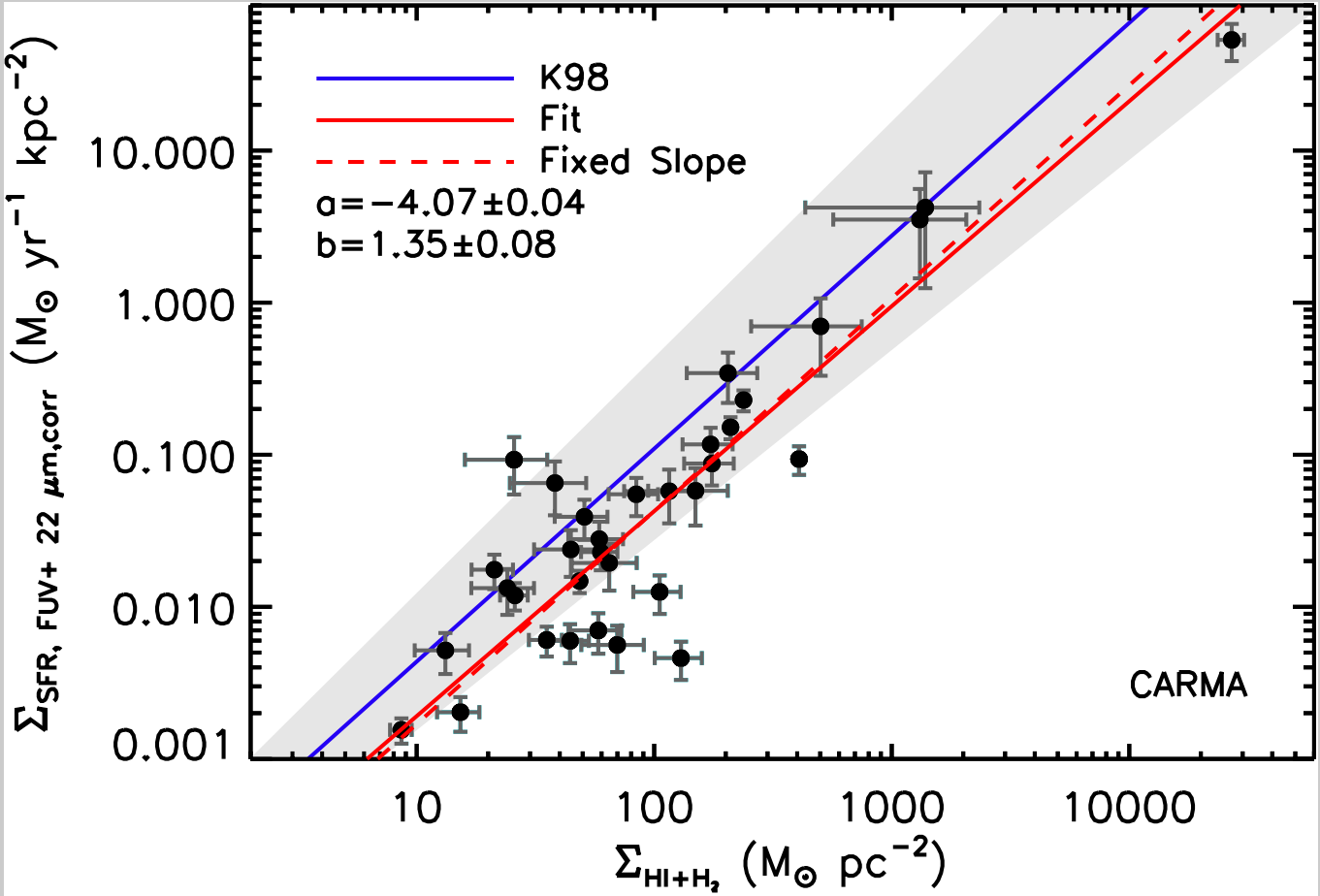

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What is the cause of this?!

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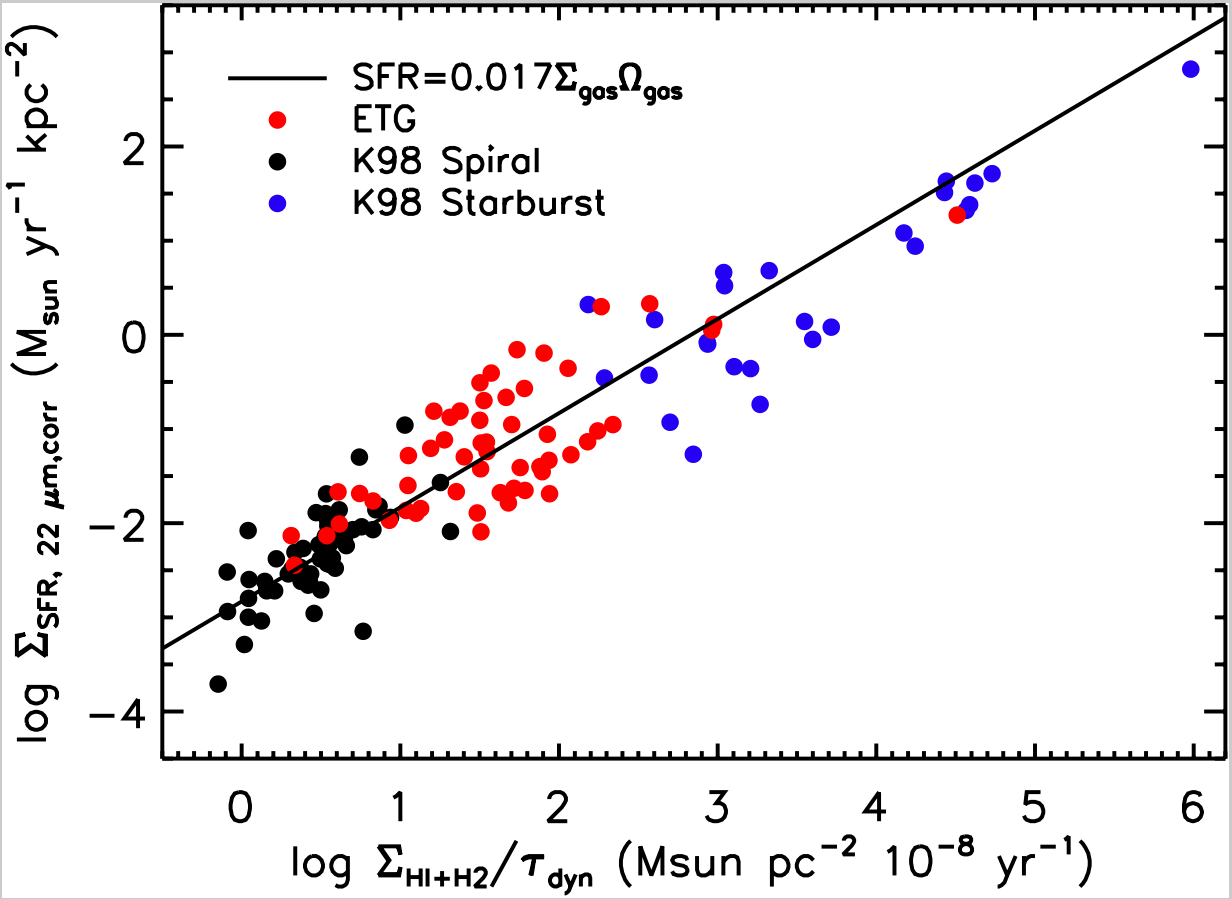

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- If one takes into account the *dynamical time* the ETGs fall back on the same relation!
- Same as for high-*z* galaxies (e.g. Daddi+ 10, Genzel+ 2010)

→ Implies ***dynamically regulated star-formation***

- bars, spiral structure, resonances are likely important

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Conclusions

- Many Early type galaxies not “red and dead”!
  - ¼ have molecular gas, and form ~0.3 Msun/yr of new stars
  - Many have star-formation surface densities HIGHER than those found in spirals

- Despite this they form stars less efficiently!
  - Form 3 times fewer stars per unit gas mass
    → Molecular gas “fuel” lasts 3 times longer in ETGs!
- This difference related to the depth of the potential
  - ETGs form the same number of stars per dynamical time as spiral, starburst and high-z galaxies

→ Growth of spheroid at higher redshift can suppress star-formation without destroying/removing cold gas