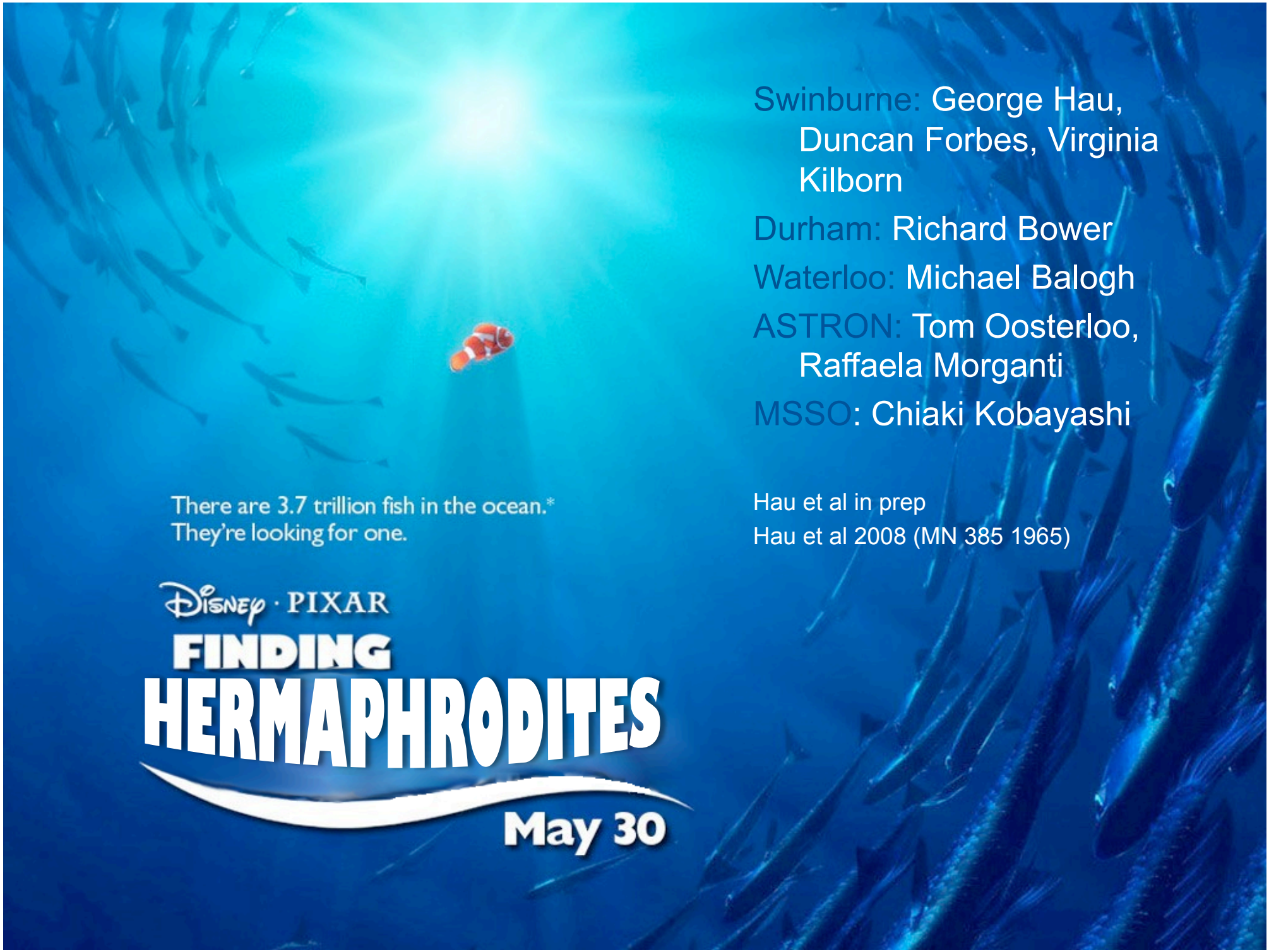


Swinburne: George Hau, Duncan Forbes, Virginia Kilborn

Durham: Richard Bower

Waterloo: Michael Balogh

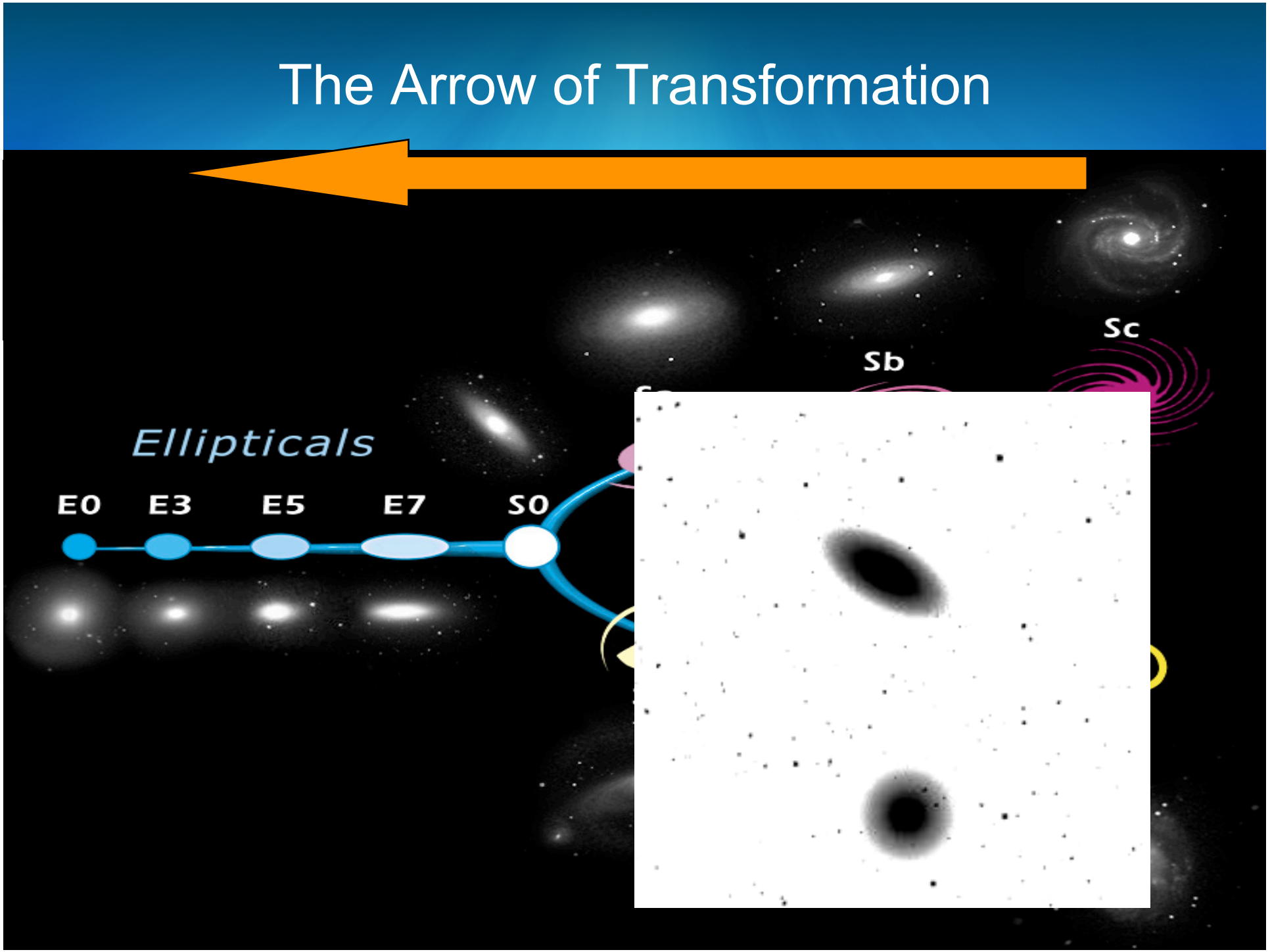
ASTRON: Tom Oosterloo, Raffaela Morganti

MSSO: Chiaki Kobayashi

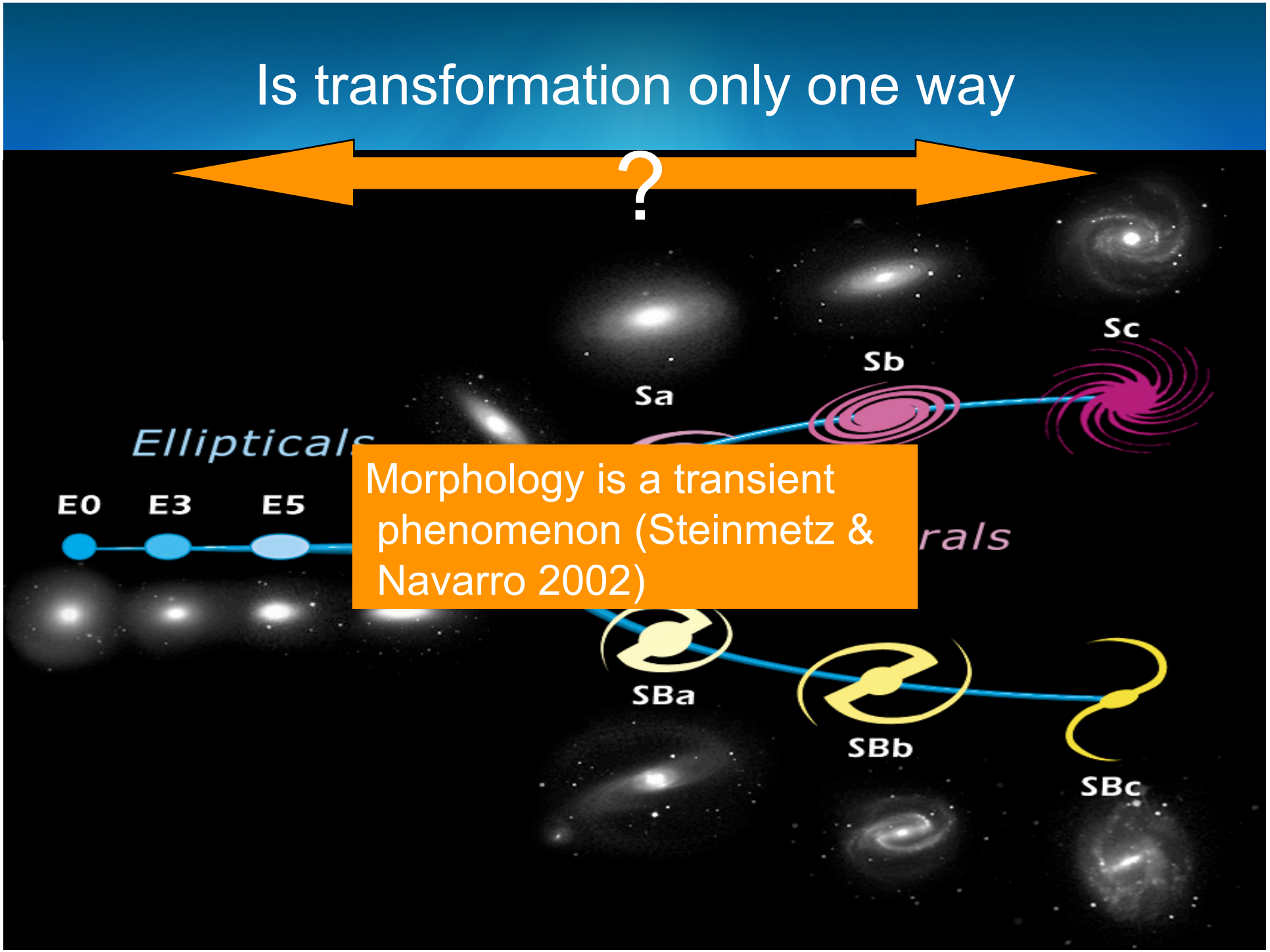
Hau et al in prep

Hau et al 2008 (MN 385 1965)

The Arrow of Transformation

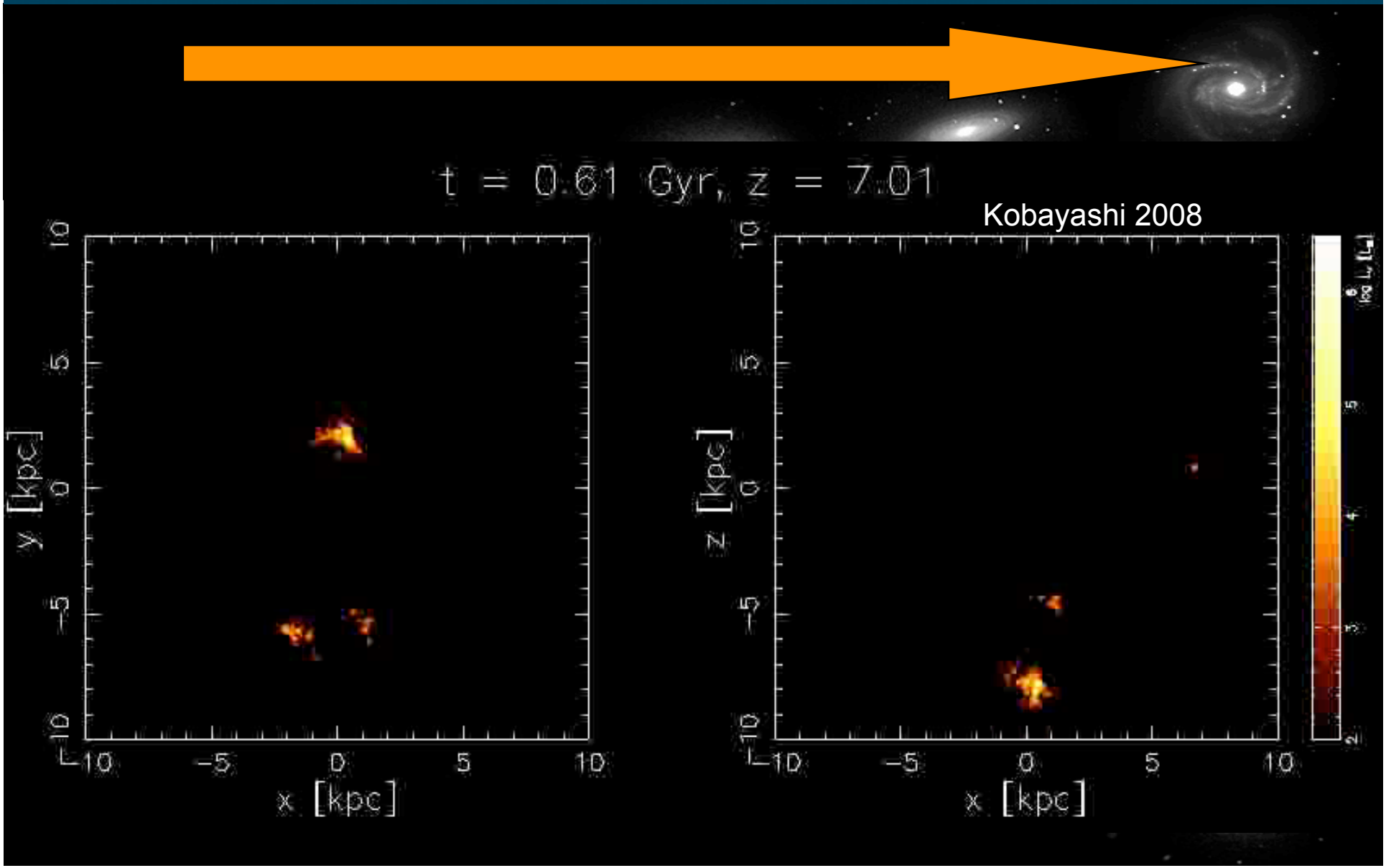


Is transformation only one way

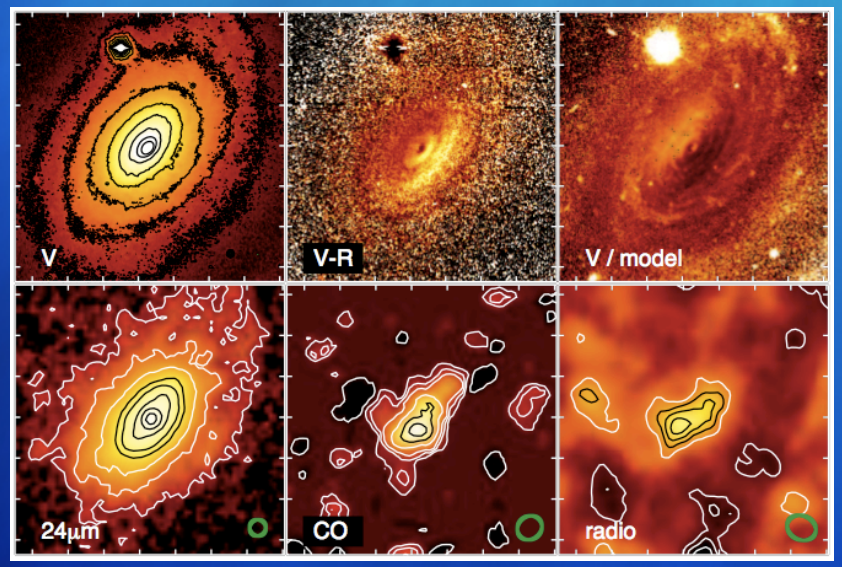


Morphology is a transient phenomenon (Steinmetz & Navarro 2002)

“Inverse” morphological transformation



Low z examples



NGC 807, Young et al 2008

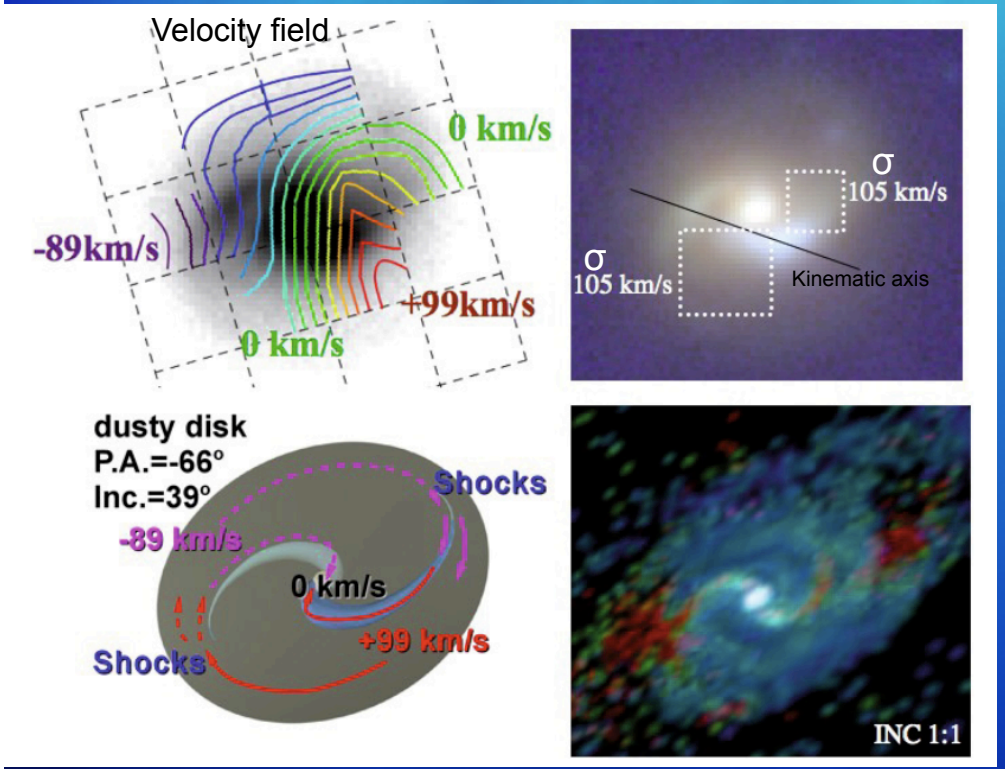
Martin Bureau's talk demonstrates the power of multi-wavelength studies.

Young et al 2008: MIR & FIR emission in E/S0s with molecular gas

- $0.05 < SFR < 0.7$ Mo/yr
- $1.5 < t_{gas\ depletion} < 7.7$ Gyr
- $10^{10} <$ Mstellar $<$ few x 10^{11}

=> final disk mass ~ few % of bulge at best.

Intermediate z example



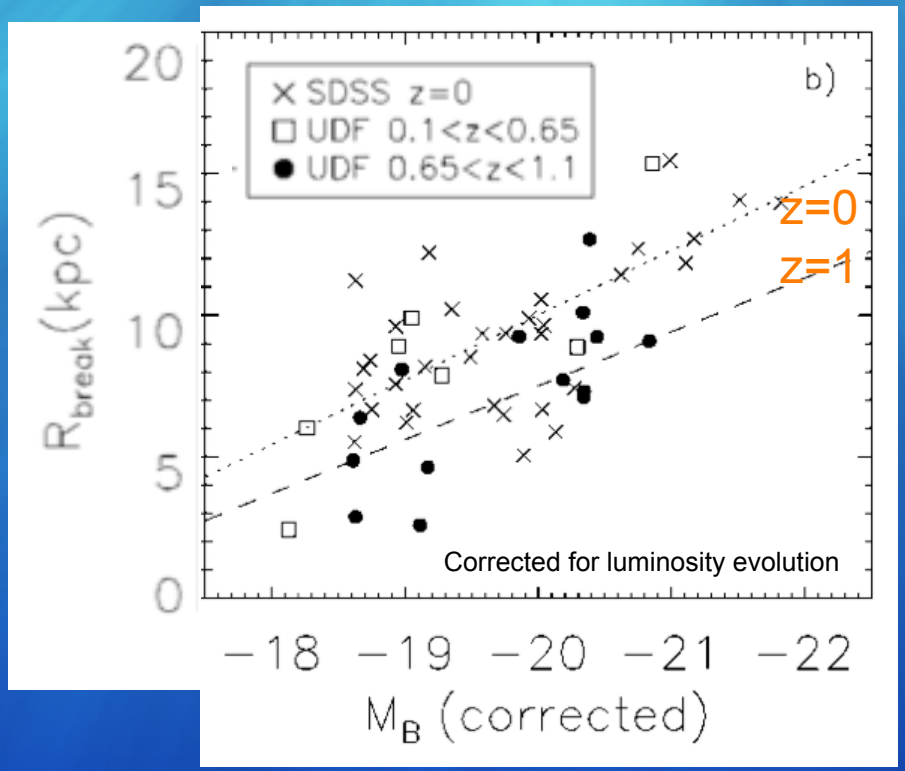
Simulation

If mergers occurred at z~1-2, remnants may be visible at z~0.6, but disks may be enshrouded by dust.

- Hammer et al 2009: J033245.11-274724.0 z=0.43, compact, LIRG, Mass~ Milky Way.
- Blue bulge + red disk + bar system
- Disk contributes ~ 81% of $M_{stellar}$ and ~90% of SFR.
- SFR~20 Mo/yr, Mgas~2.3 x 10^{10} Mo (~40% total mass)
- Large fraction of young stars (< 0.3 Gyr: 20%, 0.5-0.8 Gyr: 30%)
- σ peaks at ends of arms

Galaxy may reach local Tully Fisher relationship if all gas consumed by z~0

Evolution of disk size since z=1



- Trujillo & Pohlen (2005): small to moderate (~25%) inside-out growth of the disk galaxies since $z \sim 1$

High z example?

Smith et al 2002

ERO J003707+0909.5: z =1.6 L* early-type galaxy.

R-K = 5.4

D/B ~ 0.25

Bulge passively evolving

Disk modestly star-forming

SFR ~ 6 Mo/yr

Possess characteristics of both ellipticals & spirals

⇒ Will turn into a spiral at z=0

Smith et al called it "Transvestite"

SAO/NASA Astrophysics Data System (ADS)

Full Text Query Results from the ADS Database

External search systems queried: none

Selected and retrieved **1** page.

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(6) MNRAS, 333, L16 (2002): A Hubble Space Telescope lensing survey of X-ray luminous galaxy clusters - III. A multiply imaged extremely red galaxy at z=1.6

Page L19 ...

Query Parameters:

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Full text words:          TRANSVESTITE
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SAO/NASA ADS Homepage | ADS Sitemap | Query Form | Basic Search | Preferences | HELP | FAQ

A scientific name is needed…

Something Disney/Pixar don't want your kids to know about…

Hermaphrodite: an organism having both male and female reproductive organs. In many species, hermaphroditism is a common part of the life-cycle. (wikipedia)

Hermaphrodite galaxy

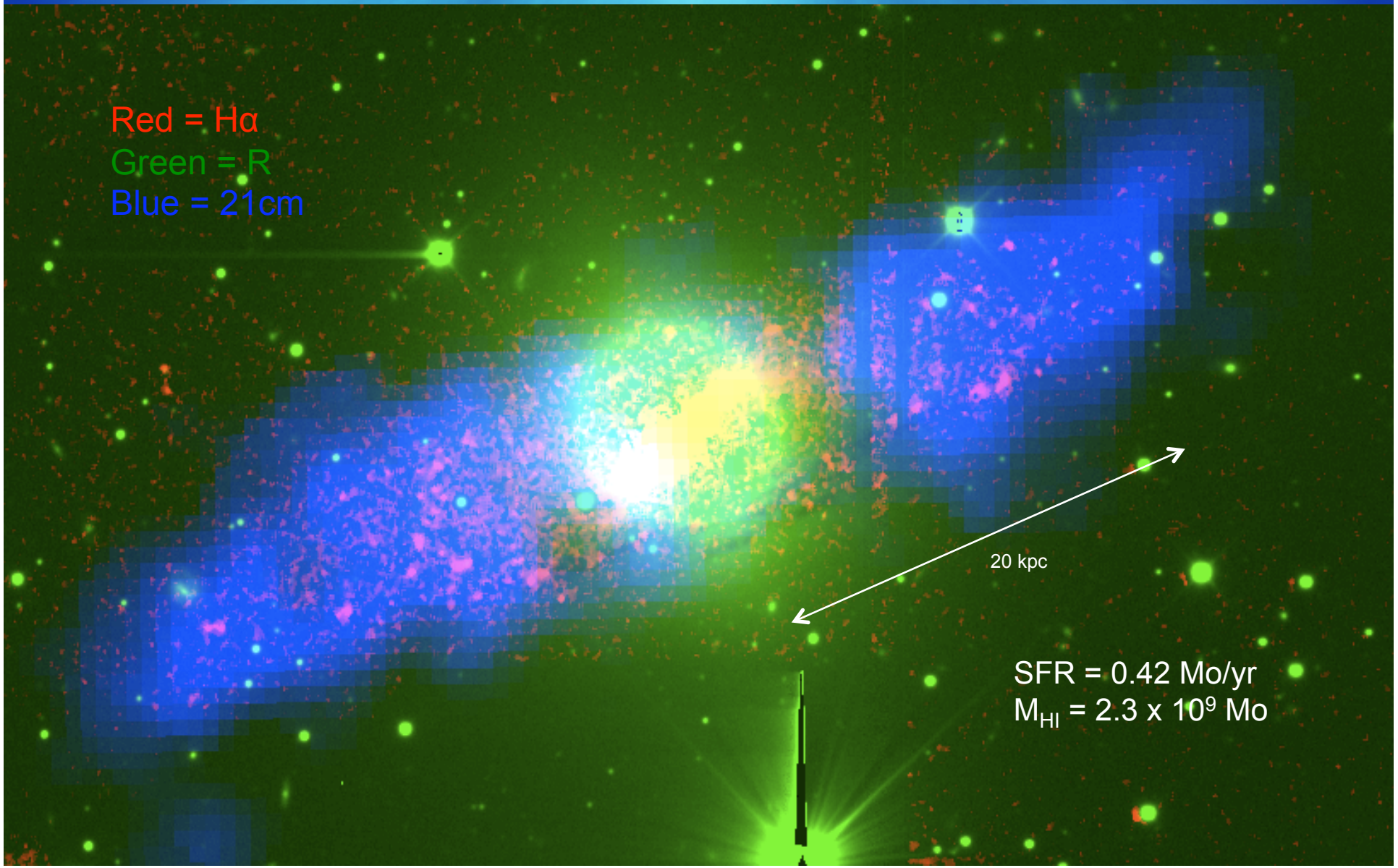
- an early type galaxy in the process of turning back into a spiral

Detailed Research on Androgynous Galaxies (DRAG)

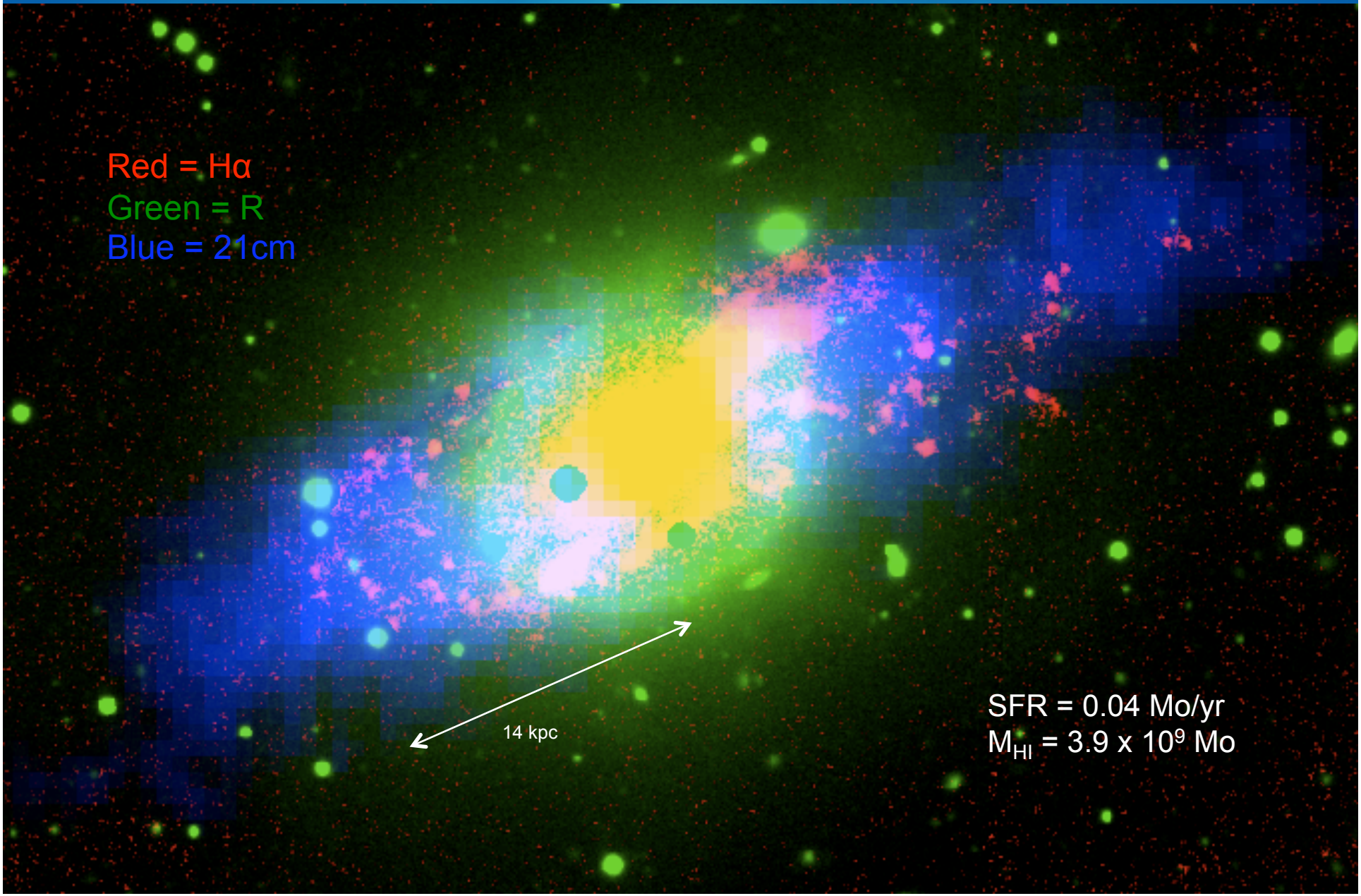
Can we find nearby examples of hermaphrodites?

- Sample:
  - Nearby, HI rich dust-lane ellipticals (Oosterloo et al 2002, 2007)
- Observations:
  - Deep Hα imaging with ESO NTT EMMI
  - Exposrues ~10x deeper than SINNG.
  - Extinction correction from Driver et al (2007) empirical relation: AR=0.41 mag.

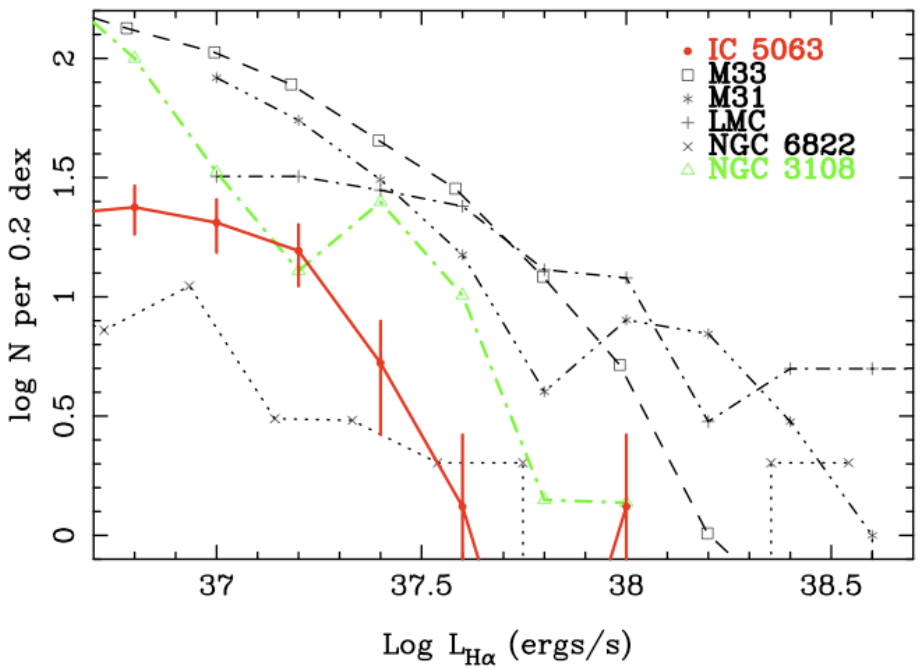
NGC 3108 Ha+R+HI



IC5063 Ha+R+HI



Luminosity Function of HII regions (HIILF)



HIILF of both gals have slope of -2.2

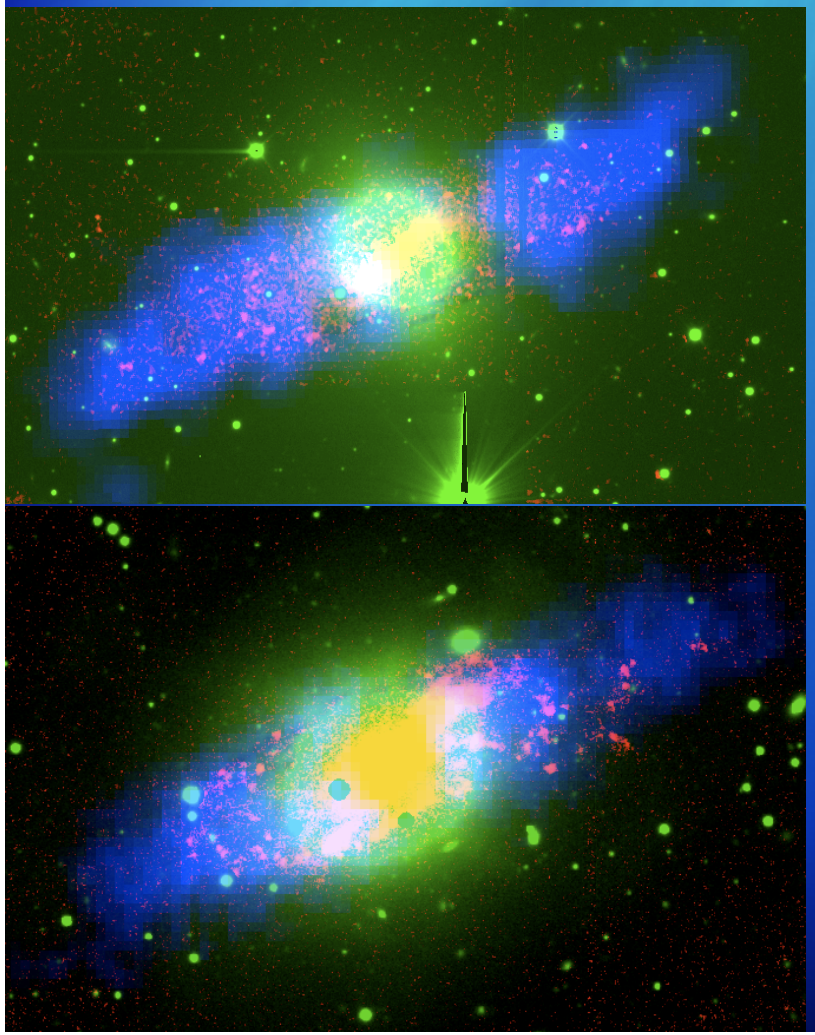
HIILFs qualitatively resemble those of late-type Local Group gals

- NGC 3108 compariable to M33 (Sc)
- IC 5063 compariable to NGC 6822 (Irr)

Lack very bright HII regions

- Unresolved -- upper limit ~ 150 pc (NGC 3108) – 310 pc (IC 5063)

Gas surface density

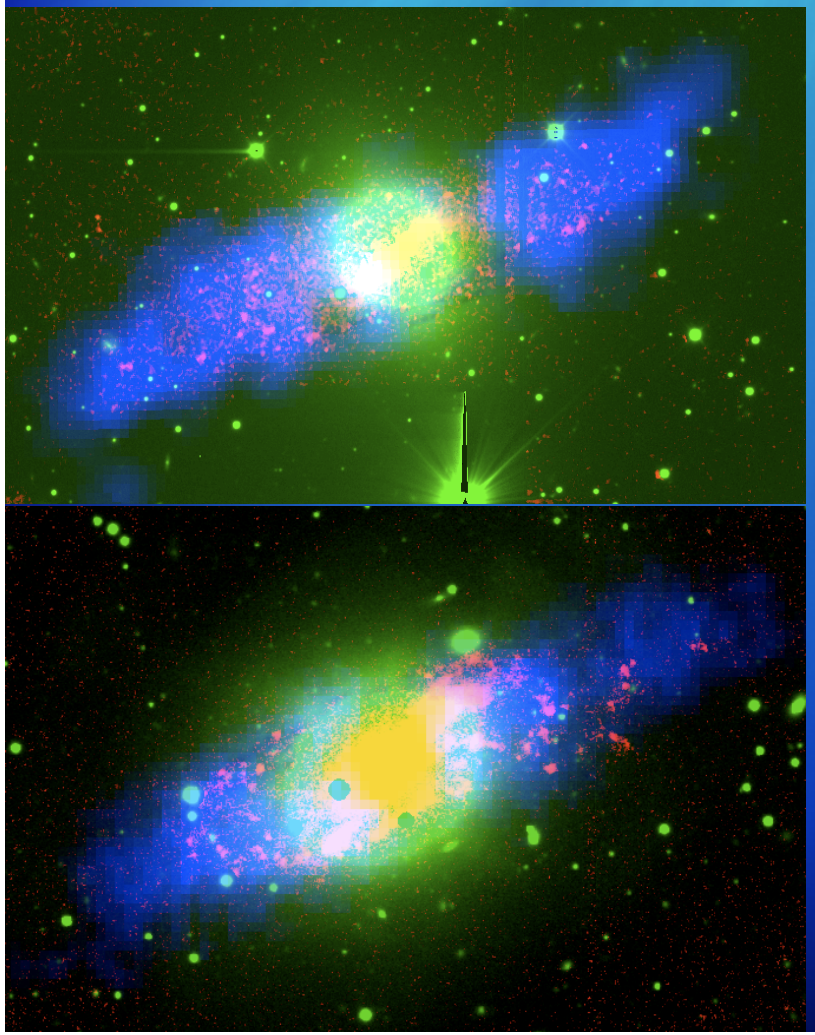


Gas surface densities:

- 4 Mo pc^{-2} (NGC 3108)
- 2.4 Mo pc^{-2} (IC 5063),

i.e. stars are forming at Kennicutt threshold or slightly below (beam size 4 kpc)

Summary of properties



	$M_{stellar}$ (Mo)	M_{HI} (Mo)	SFR (Mo/yr)	D/B (10 Gyr)
NGC 3108	3.6×10^{11}	2.3×10^{9}	0.42	0.02
IC 5063	4.4×10^{11}	3.9×10^{9}	0.04	0.001

Will not transform to giant disk systems without additional gas and boost in SFR

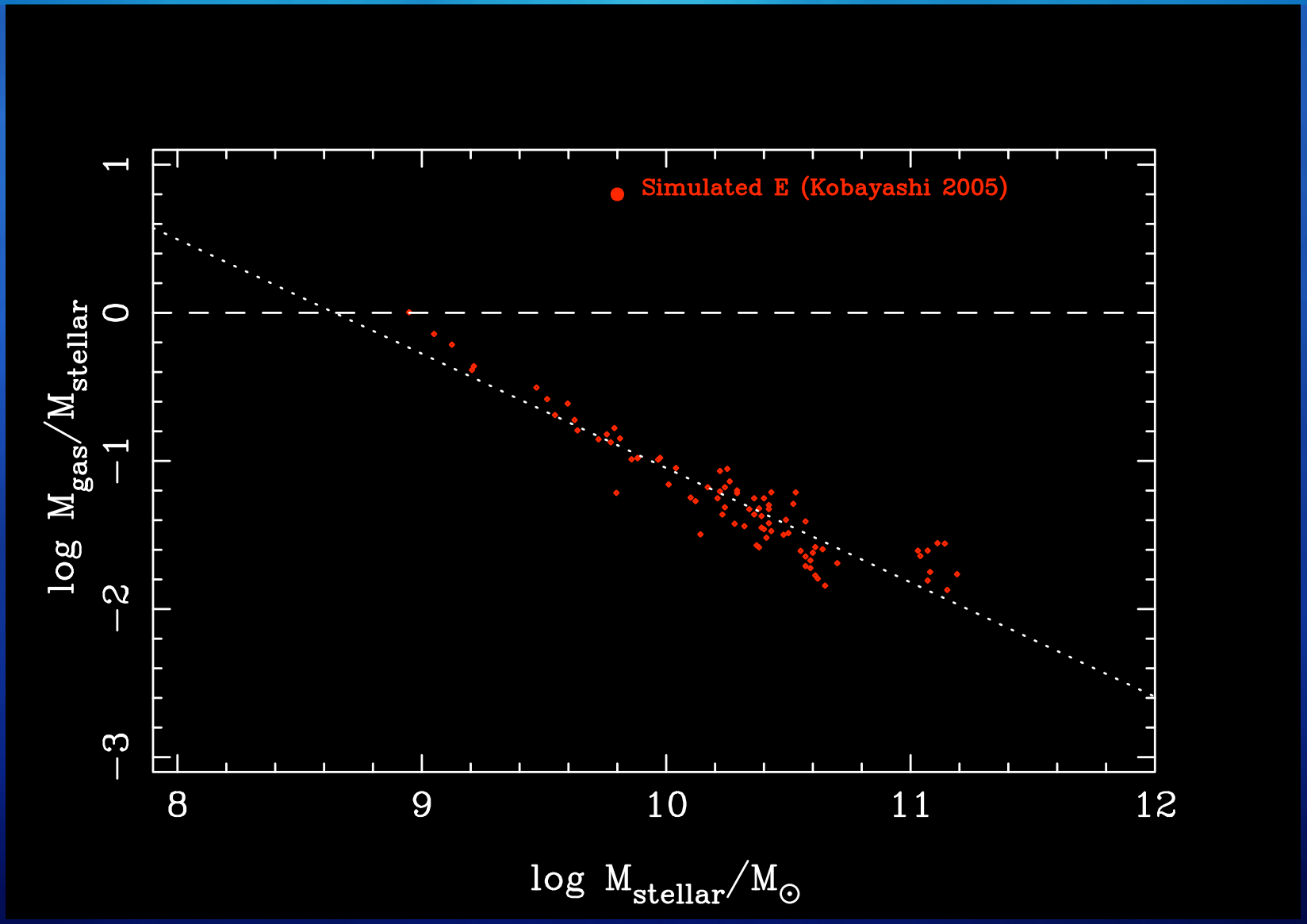

Where to find Present-day Hermaphrodites?

Predicting future Disk-to-bulge ratios

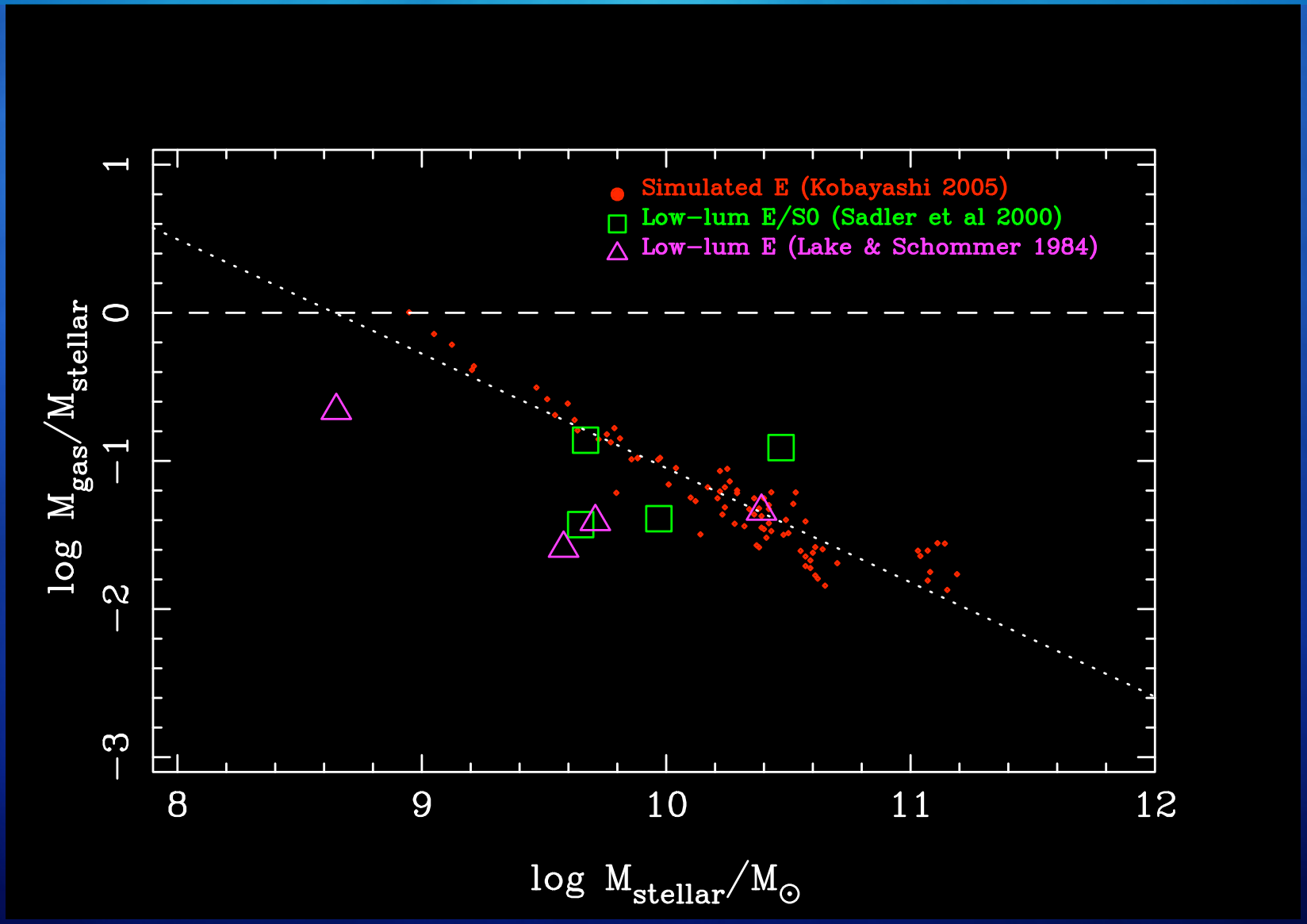
Two key questions:

- Is there enough gas to grow a new disk?
- Is the SFR high enough?

Gas content of field early type galaxies



Gas content of field early type galaxies



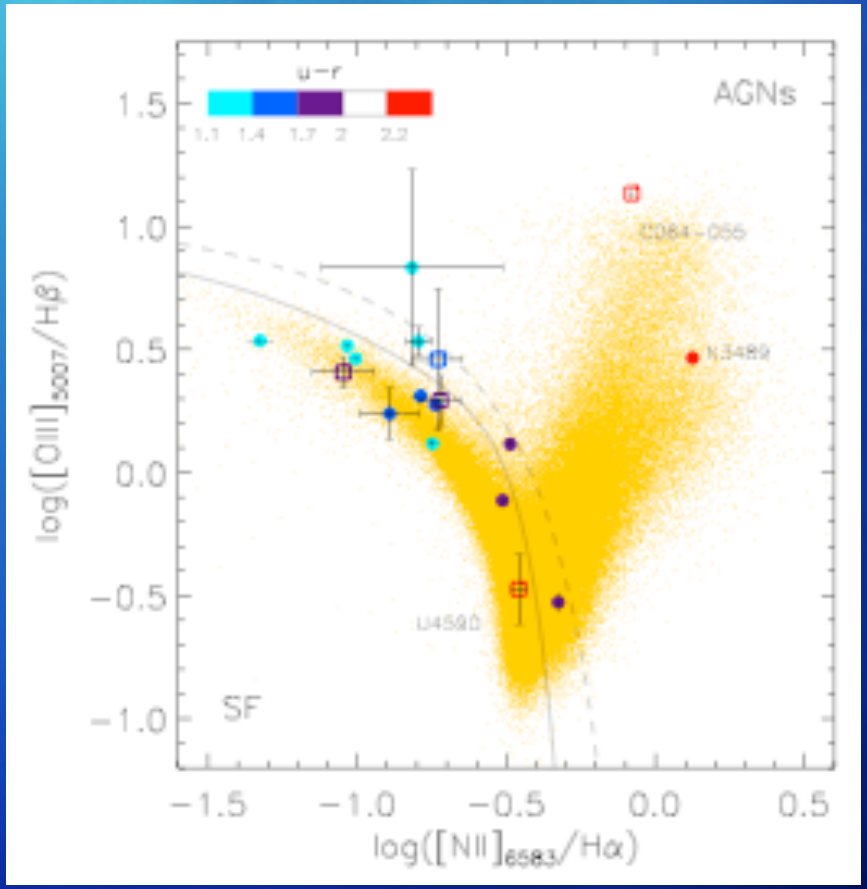
Gas content of field early type galaxies

ALFALFA survey (Grossi et al 2009)

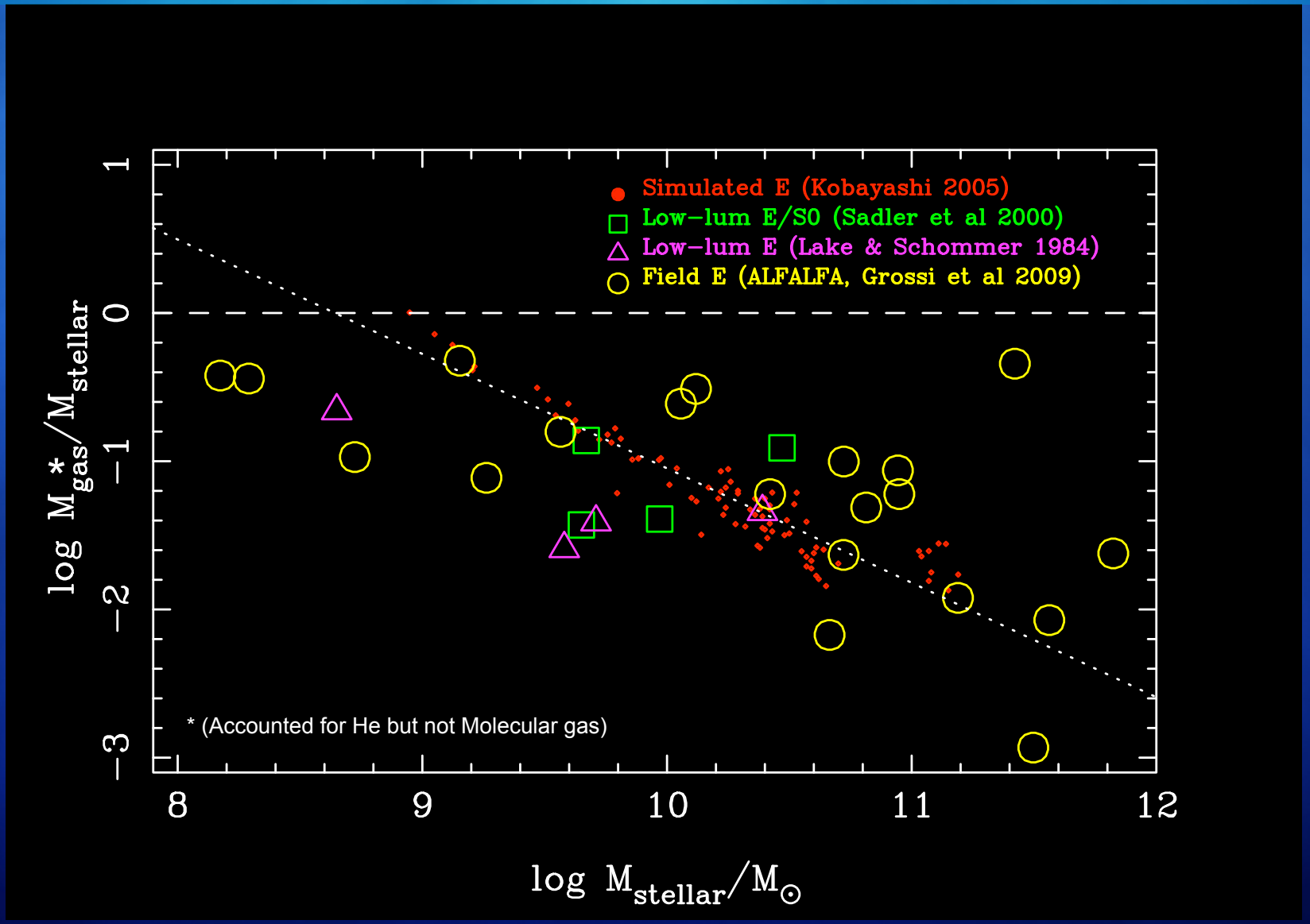
- Volume selected (V < 3000 km/s) from SDSS, visually identified Es in low density environments
- ~25% detection rate

  of these, 60% star forming (not AGN)

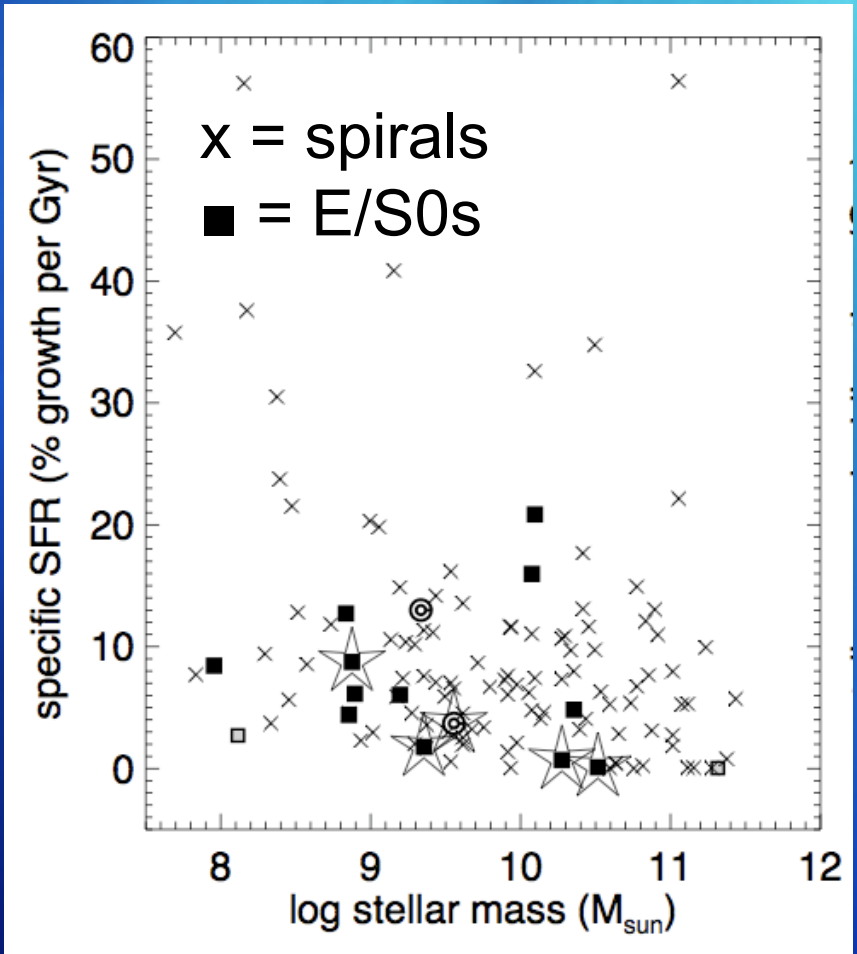
Blue colours -> Young stellar pop esp in low mass subsample.



Gas content of field early type galaxies



SFR of blue sequence E/S0s



Kannappan et al 2009:

- Blue-sequence E/S0s have specific SFR comparable to spirals (2-20% per Gyr).
- - significant disk growth within Hubble time
- Galaxy Zoo (Schawinski et al 2009): 0.5 < SFR < 50 Msun/yr

Conclusions

- Inverse morphological transformation is occurring even at low redshifts
- Present-day massive ($M_{stellar}$ ~ 10^{11}) early-type galaxies will fail to turn into spirals -- disk mass after Hubble time at most a few % of bulge
- Low mass (10^8 – few 10^9 Mo) Early-type galaxies in low density regions may be good present-day hermaphrodite candidates, but they will not turn into substantial disk systems