

# Evolution in Galaxy Luminosity Function

GALAXY LUMINOSITY FUNCTIONS TO  $Z \sim 1$ : DEEP2 VS. COMBO-17 AND IMPLICATIONS FOR RED GALAXY FORMATION<sup>1</sup>

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Evolution in B-band luminosity of BLUE and RED galaxies from  $z = 1$  to the present.

Data: 39,000 galaxies in total; slightly less than half of it at  $z > 0.8$ .

Combination of data:

DEEP2 survey (covering 4 different fields in the sky).

COMBO-17 survey (a single field of 1 square degree).

## Red and Blue sequence galaxies

“Early type” galaxies populate the RED sequence (E & S0).

“Late type” galaxies populate the BLUE sequence (gas rich star forming disk galaxies).

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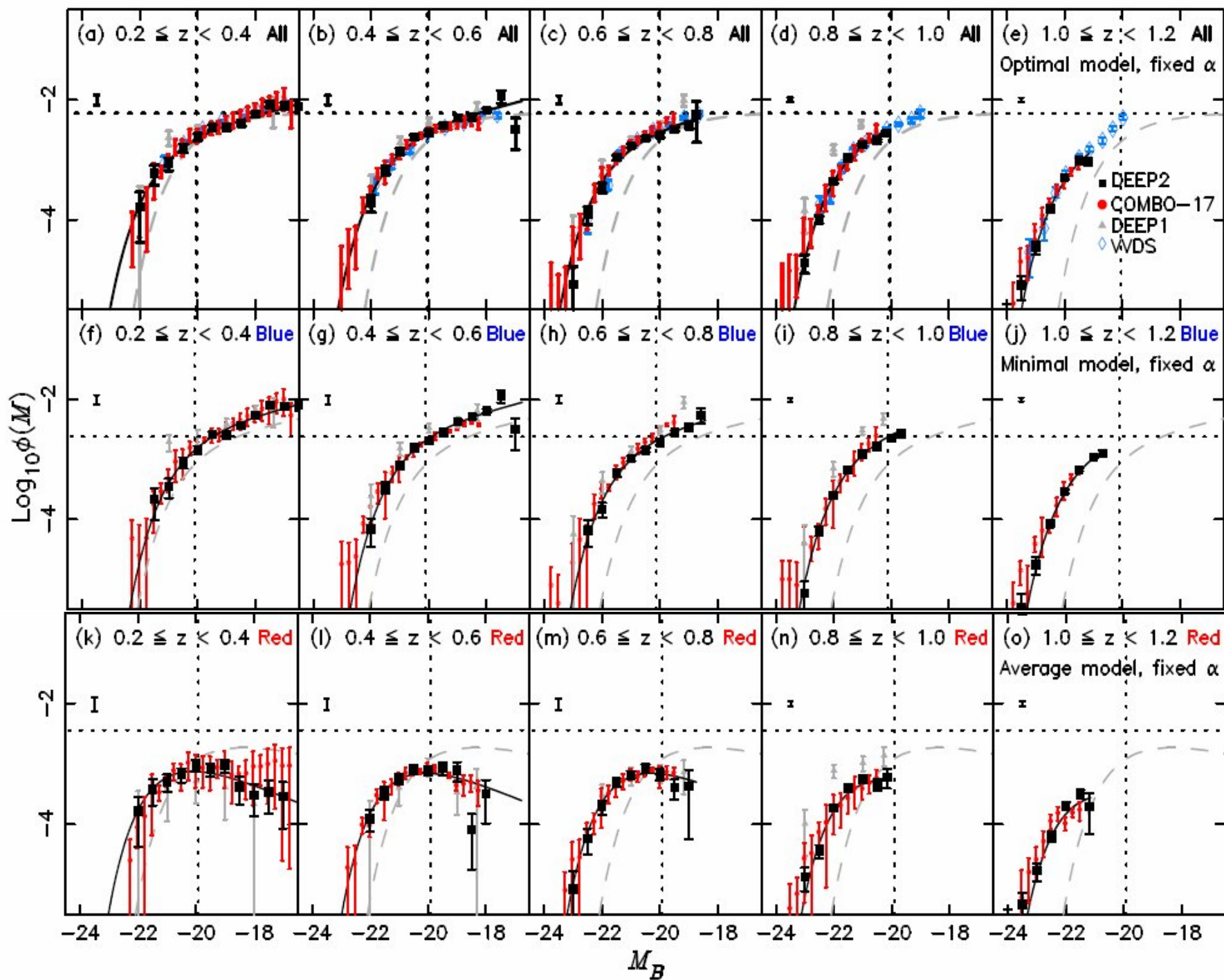
In their sample of 39,000 galaxies, the red galaxies are separated from the blue ones using rest-frame U-B and U-V colors.

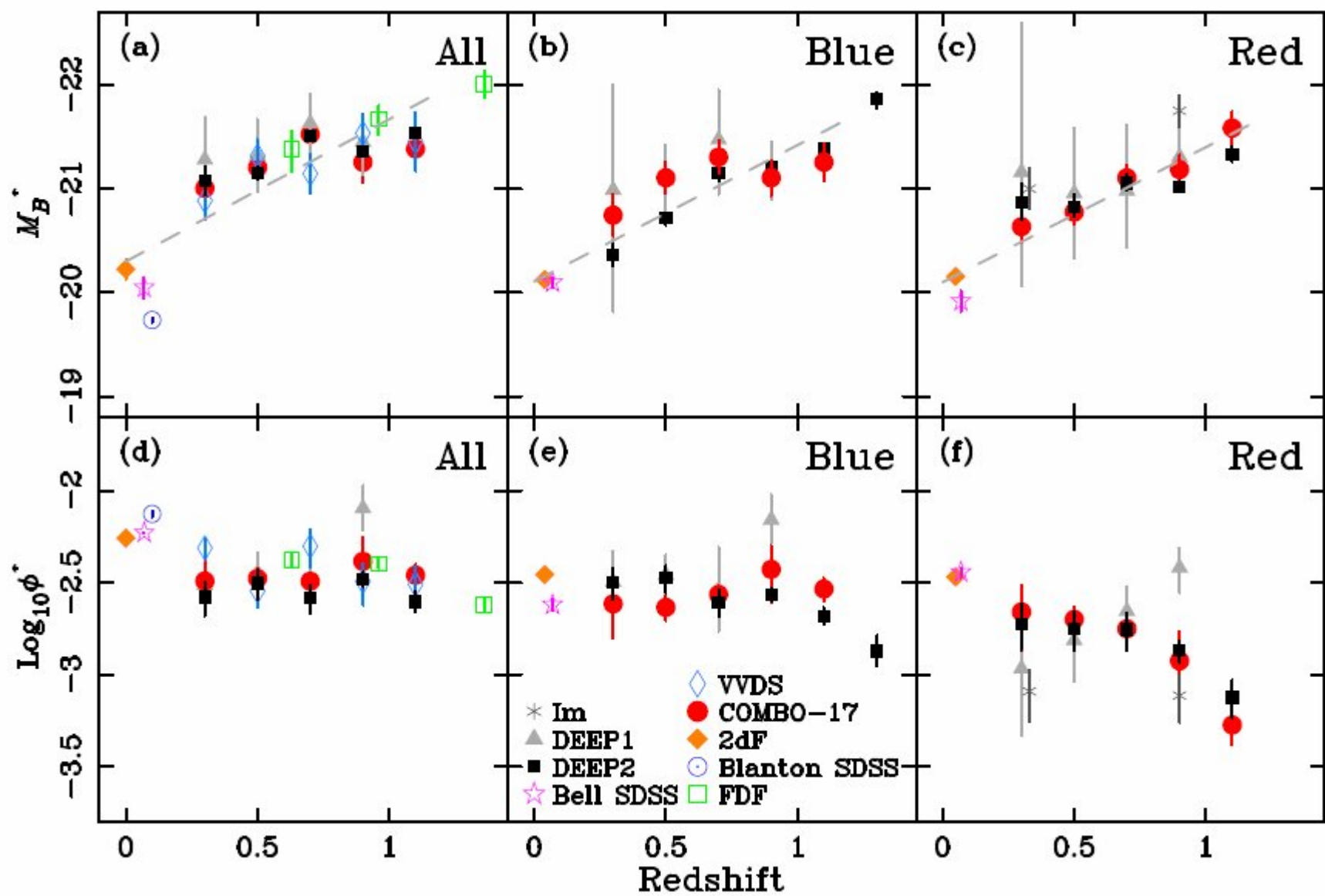
# Schechter Luminosity Function

$$\phi(M)dM = 0.4 \ln 10 \phi^* 10^{0.4(M^* - M)(\alpha + 1)} \{-10^{0.4(M^* - M)}\} dM$$

An evolution in the LF is indicative of how galaxies have changed with time :

- Aging of the stellar population. ( $M^*$ )
- Changes in the number of galaxies with time from merging or fading. ( $\Phi^*$ )





From  $z \sim 1$  to the present :

LF of BLUE & RED galaxies has evolved differently.

$M_B^*$  for both RED & BLUE sequence galaxies dimmed by approx 1.3 mag.

A rise in the number of massive RED galaxies of fixed stellar mass by 0.36 dex.

## What do we know of the present day E galaxies ?

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**Low mass ellipticals** : rotate strongly, structure flattened by rotation, have a “disky” isophote. Formed from wet mergers (less hot gas).

**High mass ellipticals** : rotate slowly, have a “boxy” isophote. Formed from dry mergers (more hot gas).

(Burstein & Faber 1992, Faber et al. 1997).



# Possible physical scenarios

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a) Early quenching - evolution to RED sequence - late mass assembly through “dry” mergers.

Early mass assembly through wet mergers – star formation – quenching – limited dry merging.

b) Early mass assembly through “wet” mergers - late quenching of star formation and evolution to RED sequence.

## Quenching of star formation

wet mergers b/w disk galaxies lead to star burst. Cold gas consumed by the star burst and its aftermath (O, B stellar winds, SNe, photoionized heating).

feed back from AGN activity.

# Summary:

Rise in the number density of spheroidals at  $z < 1$ .

The lateness of this rise is inconsistent with classic, high-redshift monolithic collapse models for E/S0 formation, which predict constant numbers of spheroidal galaxies over the  $1 \geq z \geq 0$  interval.

E/S0 galaxies in the present universe formed from mergers involving blue galaxies with star formation that got quenched at  $z = 1$ .