Estimation of the stellar masses in 30000 galaxies with redshifts below 1.0

Estimation of the stellar masses in 30000 galaxies at 0.1 < z < 1.0

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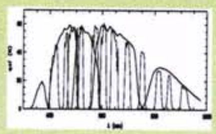
The COMBO–17 survey

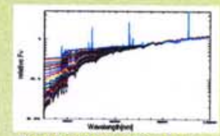
The COMBO–17 survey covers one square degree on the sky and includes about 30000 galaxies up to redshift 1.2. It is taken in 5 broad band and 12 medium band filters in the optical regime. A multicolor classification is used in order to estimate the redshifts and spectral energy distributions (SED). Therefore we use a library of template spectra. For the galaxy class we created a template library, which is based on synthetic spectra obtained by the PEGASE code. (Fioc & Rocca–Volmerange 1997). The PEGASE spectra were fitted to measured spectra of nearby galaxies obtained by (Kinney et al. 1996). The library is created in such a way that it is continuous both in colors and in the astrophysical parameters describing the PEGSAE spectra. This library delivers the colors for different redshifts and allows the classification only in color space without any morphological information.



The COMBO–17 filterset

Field	α	δ
CDFS	$03^h\,32'\,25''$	$-27^\circ 48'\,50''$
A 901	$09^h\,56'\,17''$	$-10^\circ 01'\,25''$
S11	$11^h\,42'50''$	$-01^\circ\,42'\,50''$

The position of the 3 COMBO–17 fields, which are included in the analysis. Each of these fields covers an area of 30' x 30'.



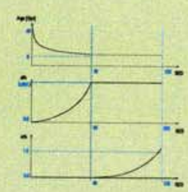
The galaxy temlate library for multicolor classification. It contains 100 different SED types.

The galaxy template library for multicolor classification

The galaxy template library described above is designed as follows: We assume a star formation history which contains three different components: An initial burst several Gyr ago, and a constant star formation rate since the initial burst. These two components deliver the early type galaxies (Sb and earlier). For the starburst regime a third component is assumed, which describes a second burst in the recent past (about 50 Myr ago).

These three components were linear combined, and the coefficients of the linear combination are choosed in order to fit the Kinney et al. (1996) spectra. In a second step we used these fitparameters in order to create a library appropriate for multicolor classification. This library contains 100 different SED types. (SED 1 – 100). SED 40 is the borderline between the early type galaxies and the starburst galaxies.

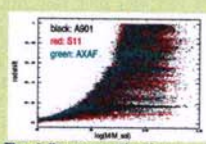
The model of star formation history: We assume an initial burst (b), a constant star formation rate (a), and a second burst in the recent past (c).



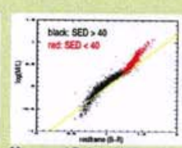
The parameters used for the galaxy template library: The early type galaxies are located at SED's below 40. The age ranges from 20 to 8 Gyr. The a/b ratio describes the constant star formation rate compared to the initail burst. For the starburst galaxies (SED > 40) the second burst (c–parameter) is turned on.

Stellar mass estimation in COMBO–17

The new library contains 100 different SED types for which the star formation histories are given. The PEGASE spectra deliver for each of them a stellar M/L ratio prediction. Hence, the stellar M/L ratio can assumed to be known for each SED type at each redshift. The multicolor classification delivers the SED and redshift estimation and can be used in order to constrain the stellar M/L ratios. In COMBO–17 we have the flux measurement for all of our filters. For the stellar mass estimation we choosed the wavelength as long as possible and took a filter with a central wavelenght of 815 nm. Together with the M/L prediction its luminosity delivers the stellar mass estimation.



The stellar mass estimations vs. redshift. Color coded three COMBO–17 fields are shown.

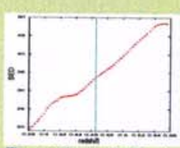


Measured B–band M/L ratio vs. restframe (B–R) color for galaxies above 10^9 M_sol

The absolute gauge of the mass estimation can be compared to a result of (Bell & de Jong 2001): They found a correlation between one optical color and the stellar M/L ratio. The yellow line in this plot is their result for the B–Band M/L vs. the (B–R) color.

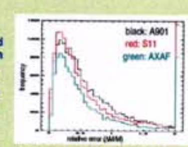
Error analysis

The errors of the stellar mass estimation depend mainly on the redshift errors and the SED errors. We neglect errors in the photometry. The redshift and SED errors are not independent on each other. In order to investigate their mutual dependence, we use our classification method and determine in a first step the redshift. Then we fix the redshift and reclassify again the SED type. We do it for a certain regime around the right redshift and use the results for determining the covariance matrix. The covariance matrix has to be diagonalized and then the gaussian error analysis can be done.

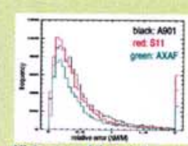


The covariance of SED and z: The redshift is fixed and the SED type is reclassified.

The green line shows the originally classified redshift. (Acceptable in a chisquare sense.) The red pionts are the reclassified SED types at fixed redshifts in a certain regime around the assumed redshift.



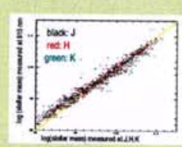
Histogram of the relative errors for all galaxies in our sample. The three fields are color coded.



Histogram of the relative errors for all galaxies above 10^9 M_sol. The three fields are color coded.

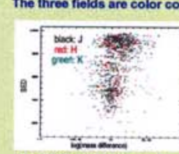
Infrared regime vs. optical regime

The stellar mass estimation is done so far in the optical wavelength regime above the (restframe) 400 nm break. Howewer, it is hard to estimate the mass of the underlying old stellar population from optical data alone. For a small subarea in the AXAF field there are ISAAC J, H, K data public available from the ESO Imaging Survey. These data can be used in order to derive a stellar mass estimation in the infrared regime for a subsample of 400 galaxies. This is very useful in order to test the mass estimation in the optical regime against this smaller subsample in the infrared regime.



Comparison of the mass estimation in the optical and in the infrared (J, H, K).

The mass estimation in the infrared is done by using the flux measurement in one of the filters J , H or K instead of using the 815 nm filter. As a first step the SED and z estimation is still done with the 17 filters in the optical without taking into account the infrared colors.

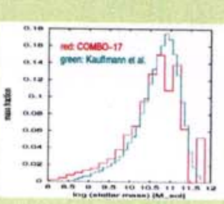


Derivation of both mass estimations as a function of SED type.

Results

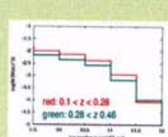
Comparison with the result of (Kauffmann et al. 2003).

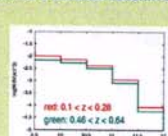
Kauffmann et al. used the 400 nm break together with the H index in order to constrain the M/L ratios of 10^5 SDSS galaxies. We compare this to the COMBO–17 result in the redshift bin 0.1 < z < 0.3.

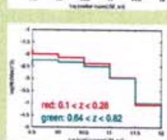


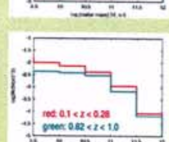
The evolution of the stellar mass function

At masses above 10^9.5 M_sol COMBO–17 is complete. Here we show the stellar mass function for 5 different redshift bins.



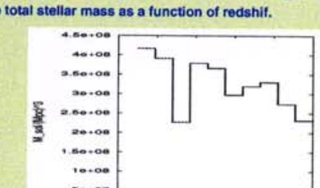






The evolution of the integrated stellar mass in galaxies

Summing up all galaxy masses above 10^9.5 M_sol leads to the total stellar mass as a function of redshif.



The integrated stellar mass has increased by a factor of about 1.6 since redshift 1.