

# Redshifting galaxies: SDSS to GEMS and COSMOS

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## 1 background+aim

Ground- and space-based galaxy evolution projects as GEMS (Rix et al. 2004) or COSMOS (Scoville et al.) need to describe galaxies with simple parameters (magnitude, shape, structure) to quantify evolution. Two problems arise:

- Any automated program as CAS, GALFIT or GIM2D (but also “eyeballing”), is sensitive to the signal-to-noise ratio, and thus to redshift (“depth  $K$ -correction”).
- At different redshifts, different spectral and morphological  $K$ -corrections have to be considered.

In the course of our galaxy evolution work we developed a simple code to create realistic images of galaxies at redshifts  $0.1 < z < 1.1$ , matching the resolution, depth and bandpass of any (HST) survey, using local multi-band galaxy images drawn from the SDSS. A final selection of 3,000 galaxies will be the first statistically complete sample of its kind. Different versions of the output images can be used to calibrate galaxy fitting routines as a function of redshift, and to evaluate the strength of spectral and morphological  $K$ -corrections for a given data set.

With its different calibration aims and both the sample size and statistical properties this work goes far beyond existing studies (Giavalisco et al. 1996, Bouwens et al. 1998, Kuchinsky et al. 2001, Burgarella et al. 2001).

## 2 redshifting

- Input: SDSS images in  $u, g, r, i, z$  bands; galaxies with  $cz < 7000$  km/s
- Cosmological change: angular size and surface brightness dimming
- $K$ -correction by interpolation between bands with templates (using  $k\_correct$  by Blanton et al.)
- PSF transformation between SDSS and target instrument/filter
- Noise properties matched to specific surveys: currently GEMS (HST/ACS F606W+F850LP), COSMOS (HST/ACS F814W)
- Placed on real data empty sky background
- Output: One image for each target redshift ( $0.1 < z < 1.1$ )
  - set 1: without  $K$ -correction, to calibrate automatic galaxy fitting routines
  - set 2: with  $K$ -correction, to calibrate effects of spectral and morphological  $K$ -corrections
  - set 3: as set 2, but with known brightness evolution terms included

## 3 input galaxies

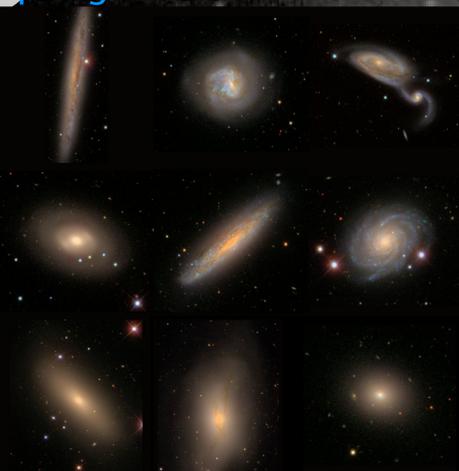


Fig. 1: SDSS colour composites of a selection of input objects. Three of these are redshifted in Figure 2.

## 4 redshifting results

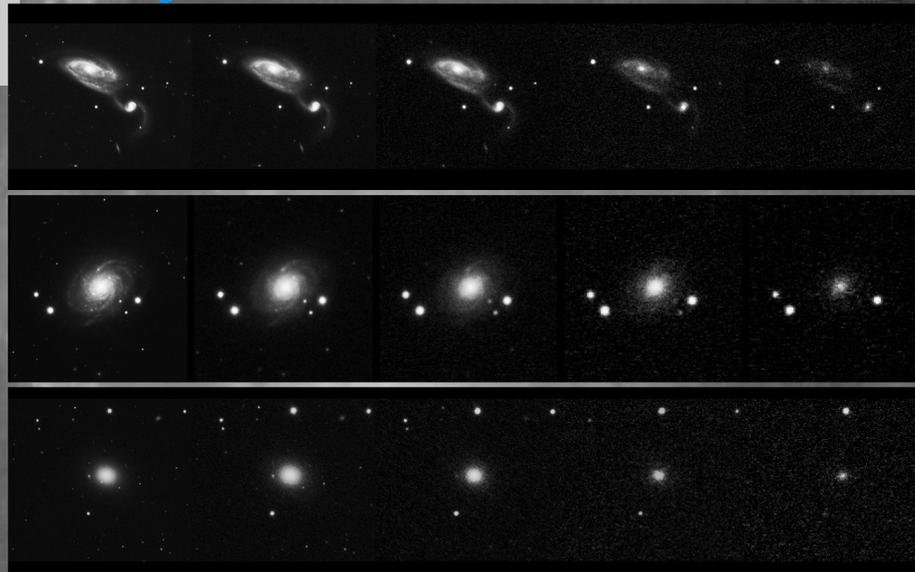
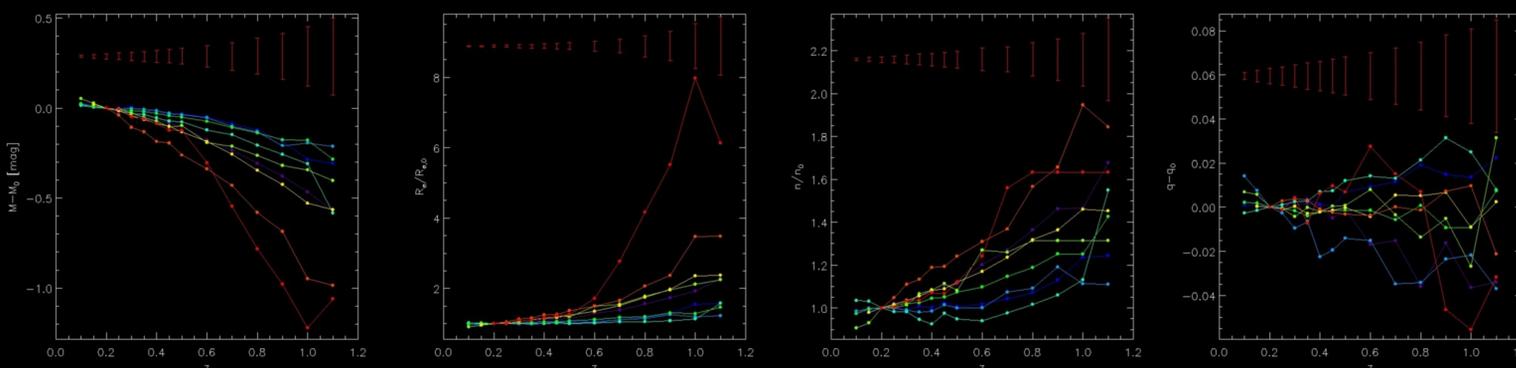


Fig. 2: Three SDSS galaxies placed at  $z = \text{local}, 0.2, 0.4, 0.7, 1.0$ , matched to COSMOS F814W filter (HST/ACS) and depth. Images are plotted so that linear scales are identical to show S/N and resolution degradation.

## 5 test: GALFIT



We use GALFIT (Peng et al. 2002) to demonstrate the dependency of automated routines on S/N and resolution. GALFIT is an often used, very stable and well behaved program for determining structural and photometric information of galaxies. In the limit of high redshifts more and more fainter parts of a galaxy disappear in the noise. Results for the 9 galaxies above, error bars show average values at each redshift. From left:

- Magnitudes ( $M$ ) tend to be overestimated at higher redshifts compared to local,
- effective radii ( $R_e$ ) are often overestimated,
- Sersic indices ( $n$ ) tend to be too large at high redshifts due to disappearance of disks in the noise (one object ran into limits),
- the change of axial ratios ( $q = b/a$ ) depends on the particular geometry.

## 6 conclusions

The example of GALFIT shows that all structural parameters determined for a sample of galaxies have to be calibrated against the “zero evolution, zero  $K$ -correction” case in order not to bias evolution estimates. In a second step spectral and morphological  $K$ -corrections have to be accounted for.

With the final and complete sample of 3,000 galaxies this can be done, as it spans the whole morphological parameter space of (local) galaxies. Further applications include:

- To test whether at earlier times the variety of morphologies is different from today.
- Creation of model host galaxies of type 1 QSO by including a point source in the center – needed to estimate the morphologies of QSO hosts at higher redshifts.
- If UV bands are included, simulated galaxies can be produced out to higher redshifts – only minor changes are required to implement this in our code.

For the complete sample of 3,000 galaxies we will release images redshifted to  $0.1 < z < 1.1$  for the GEMS and COSMOS ACS imaging projects. If there is more widespread demand we plan to release the code later.

## references

- Blanton et al. 2003, AJ, 125, 2348
- Bouwens et al. 1998, ApJ, 506, 557
- Burgarella et al. 2001, A&A, 369, 421
- Giavalisco et al. 1996, AJ, 112, 369
- Kuchinsky et al. 2001, AJ, 122, 729
- Peng et al. 2002, AJ, 124, 266
- Rix et al. 2004, ApJS, 152, 163
- Scoville et al. (see COSMOS session, today, 10:00, Ballroom/Salon 2)

## acknowledgements

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