Stellar Populations as Building Blocks of Galaxies
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Radial Dependency of Stellar Population Properties in Disk Galaxies from SDSS Photometry

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Abstract. The evolution of stellar disks is of great importance for understanding many aspects of galaxy formation. In this work we perform stellar population synthesis on radially resolved photometry of 564 disk galaxies from the SDSS DR5, selected to have both spectra of the central regions and photometry. To explore fully the multi-dimensional likelihood space defined by the output parameters of the spectral synthesis, we use Markov Chain Monte Carlo to quantify the expectation values, the uncertainties and the degeneracies of the parameters. We find good agreement between the parameter values obtained using the SDSS broad-band colors and the spectra respectively. In general the derived mean stellar age and the best-fit stellar metallicity decline in value from the galaxy center to the outer regions (around 1.5 half-light radii), based on sub-samples defined by concentration index. We also find that the radial dependency of the stellar population parameters exhibits a significant variation, and this diversity is likely related to morphology and the physics of star formation.

Keywords. galaxies: stellar content – techniques: photometric

1. Introduction

The quantification of radial gradients of stellar population parameters provide a powerful constraint on galaxy formation models, as distributions of stellar metallicity and age are basic predictions (e.g. Larson 1976, Wyse & Silk 1989, Robertson *et al.* 2004). The completion of the SDSS−I (York *et al.* 2000) has allowed us to investigate this issue with an unprecedented large sample of nearby disk galaxies, with uniform photometric calibrations.

2. Analysis and Main Results

Our sample is chosen from the SDSS DR5 disk galaxies with both spectroscopic (for the central 3 arcsec) and photometric observations. The availability of both types of data allow us to characterize the parameter uncertainties using only the photometry. They are low-inclination (isophotal minor axis/major axis $= 0.25 - 1$) with distance ranging from $\sim 20 - 700$ Mpc. We adopt the PÉGASE (Fioc & Rocca-Volmerange 1997) stellar population synthesis models, with the ages of the oldest stars in the range from $12.5 - 13.7$ Gyr, the stellar metallicity from $0.0001 - 0.05$, an exponential star-formation law with the e-folding time from $0.2 - 12$ Gyr, and the reddening E(B-V) from $0.0 - 0.8$. We are thus solving simultaneously for several parameters. To obtain estimates and covariance matrices of these parameters from the SDSS radially resolved photometry (u, g, r, i, z), we developed a Markov Chain Monte Carlo (MCMC) code to perform the

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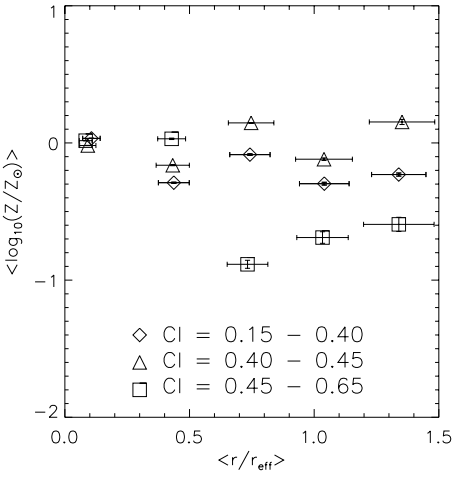

Figure 1. Radial dependency of stellar metallicity, averaged in three ranges of concentration index (CI): $0.15 - 0.40$ (rhombus), $0.40 - 0.45$ (triangle) and $0.45 - 0.65$ (square). The smaller the CI, the more concentrated is the galaxy light.

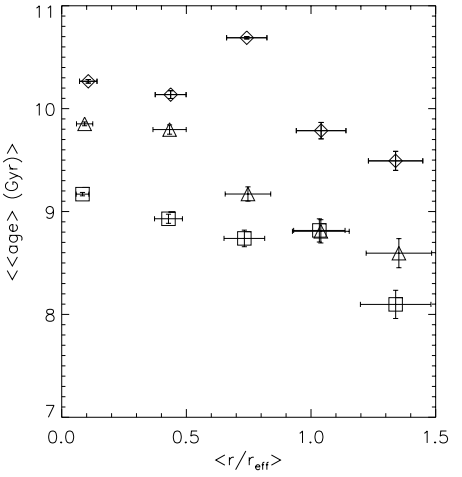

Figure 2. Radial dependency of the mean stellar age.

minimization in N-dimension. Each annulus of each galaxy is treated independently in the minimization.

The stellar metallicity and $\langle$age$\rangle$ as a function of radius ($r/r_{\rm eff}$, where $r_{\rm eff}$ is the half-light radius of the galaxy) are shown in Fig. 1 and 2 respectively. The error bar indicates one sigma of the mean value in each axis. Radial dependencies are found for these two parameters, in that they decrease toward larger radii (cf. similar results for 121 disk galaxies, from a combination of broad-band optical and near IR data from Bell & de Jong 2000). In addition, we find a clear separation between galaxies of different $r-$band concentration indices (CI's)): the more concentrated are the galaxies, the higher the values in the stellar metallicity and $\langle$age$\rangle$. While the overall trends are compatible with 'inside-out' models of disk galaxy formation, there are interesting systematics in the gradients shown in the figures. Further, we see features in individual galaxies at intermediate radii that could be a manifestation of resonances associated with bars and we are embarking on a more detailed morphological characterization of the galaxies e.g. bulge to disk ratio, barred nature etc. In particular, some models predict that bars could lead to a localized old age within $r/r_{\rm eff} \sim 0.7$ (V. Debattista, private communication). The details of our analysis and results will be presented in a separate paper.

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References

Bell, E.F. & de Jong, R.S. 2000, *MNRAS* 312, 497
Fioc M. & Rocca-Volmerange B. 1997, *A&A*, 326, 950
Larson R. B. 1976, *MNRAS*, 176, 31
Robertson B., Yoshida N., Springel V. & Hernquist L. 2004, *ApJ*, 606, 32
Wyse R. F. G. & Silk J. 1989, *ApJ*, 339, 700
York D. G., Adelman J., Anderson J. E. *et al.* 2000, *AJ*, 120, 1579

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