Stellar Populations as Building Blocks of Galaxies
Proceedings IAU Symposium No. 241, 2006
A. Vazdekis & R. F. Peletier, eds.

doi:10.1017/S174392130700823X

The Star Formation History of M33's Outer Regions

M. K. Barker[1], A. Sarajedini[1], D. Geisler[2], P. Harding[3] and R. Schommer[4]†

[1]Department of Astronomy, University of Florida, Gainesville, FL 32611, USA
email: mbarker@astro.ufl.edu, ata@astro.ufl.edu

[2]Grupo de Astronomia, Departamento de Fisica, Universidad de Concepción, Casilla 160-C, Concepción, Chile
email: dgeisler@astro-udec.cl

[3]Astronomy Department, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106
email: harding@dropbear.case.edu

[4]Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatories, Casilla 603, La Serena, Chile

Abstract. The stellar populations of a galaxy are a fossil record of its formation and evolution and the various physical processes involved. Therefore, studying the resolved stellar populations of nearby galaxies can provide important constraints on their structure, formation, and evolution. To that end, we have obtained VI photometry with the Advanced Camera for Surveys on the *Hubble Space Telescope* for three fields at deprojected radii $R_{dp} \sim 9 - 13$ kpc ($\sim 4 - 6$ visual scale lengths) along M33's southeast minor axis. We present results for the star formation history (SFH) of these fields based on the technique of synthetic CMD fitting.

Keywords. Local Group – galaxies: individual (M33) – galaxies: stellar content – galaxies: evolution – galaxies: structure – galaxies: abundances

---

1. Method and Results

We have modeled the observed color-magnitude diagrams as linear combinations of individual synthetic populations with different ages and metallicities using the IAC-star and StarFISH codes (Aparicio & Gallart 2004; Harris & Zaritsky 2001). The technique we use is similar to that outlined in Gallart *et al.* (1999), Harris & Zaritsky (2001), and Dolphin (2002). To gain a better understanding of the systematic errors we have conducted the analysis with two different sets of stellar evolutionary tracks which we designate as Padova (Girardi *et al.* 2000) and Teramo (Pietrinferni *et al.* 2004).

The precise details of the results depend on which tracks are used but we can make several conclusions that are fairly robust despite the differences. Both sets of tracks predict the mean age to increase and the mean metallicity to decrease with radius. Allowing age and metallicity to be free parameters and assuming star formation began ~ 14 Gyr ago, we find that the mean age of all stars and stellar remnants increases from ~ 6 Gyr to ~ 8 Gyr and the mean global metallicity decreases from ~ -0.7 to ~ -0.9. The fraction of stars formed by 4.5 Gyr ago increases from $\sim 65\%$ to $\sim 80\%$. The mean star formation rate $80 - 800$ Myr ago decreases from $\sim 30\%$ of the lifetime average to just $\sim 5\%$. The random errors on these estimates are ~ 1.0 Gyr, 0.1 dex, and 10%. By comparing the results of the two sets of stellar tracks for the real data and for test

† deceased.

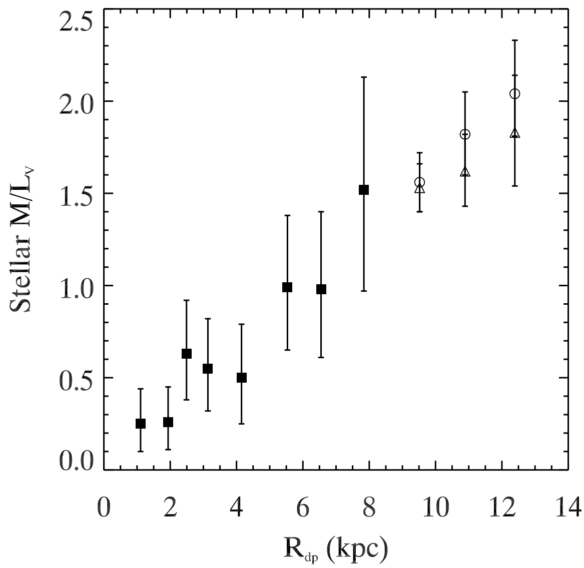

Figure 1. V-band stellar mass-to-light ratio in M33. See text for details.

populations with known SFH we have estimated the systematic errors to be 1.0 Gyr, 0.2 dex, and 15%. These do not include uncertainties in the bolometric corrections or variations in α-element abundance which deserve future study.

We show the stellar V-band mass-to-light ratio calculated from our SFH solutions in Figure 1 assuming a distance of 867 kpc to M33 (Galleti *et al.* 2004). The Padova results are shown as circles while the Teramo results are shown as triangles. The filled squares represent the *completely independent* results of Ciardullo *et al.* (2004) based on planetary nebulae kinematics. Taken at face value, Fig. 1 suggests that M33's disk extends to at least $R_{dp} = 12.5$ kpc and that its mean age increases with radius. Measurements of the SFH in M33's inner disk will help clarify whether the age gradient we observe extends to smaller radii.

Acknowledgements

Support for this work (proposal number GO-9479) was provided by NASA through a grant from the Space Telescope Science Institute which is operated by the Association of Universities for Research in Astronomy, Incorporated, under NASA contract NAS5-26555.

References

Aparicio, A., & Gallart, C. 2004, *AJ*, 128, 1465
Ciardullo, R., Durrell, P. R., Laychak, M. B., Hermann, K. A., Moody, K., Jacoby, G. H., & Feldmeier J. J. 2004, *ApJ*, 614, 167
Dolphin A. E. 2002, *MNRAS*, 332, 91
Gallart, C., Freedman, W. L., Aparicio, A., Bertelli, G., & Chiosi, C. 1999, *AJ*, 118, 2245
Galleti, S., Bellazzini, M., & Ferraro, F. R. 2004, *A&A*, 423, 925
Girardi, L., Bressan, A., Bertelli, G., & Chiosi, C. 2000, *A&AS*, 141, 371
Harris, J., & Zaritsky, D. 2001, *ApJS*, 136, 25
Pietrinferni, A., Cassisi, S., Salaris, M., & Castelli, F. 2004, *ApJ*, 612, 168