Integrated-light properties of simple stellar populations

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(Accepted on 12.12.2008)

Summary of Ph.D. Dissertation; Thesis language: English
Ph.D. awarded 2008 by the SSC on Nuclear Physics, Nuclear Energetics and Astronomy

Интегрални характеристики на еднородни звездни населения

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(Анотация на дисертация за образователна и научна степен "Доктор")

Most of our understanding about the properties of the stellar populations in distant stellar agregates comes from studying the integrated light. Nowadays we are pushing the limits of our equipment to gather more information about high-redshift galaxies and gain understanding about the evolution of the infant Universe. Furthermore, information about the processes that took place during these early periods and the following structure formation is imprinted in the globular cluster systems of the galaxies. Even employing the most advanced instrumentation, at the present moment we could only analyze the integrated light of these far away galaxies and globular clusters.

Not surprisingly this resulted in a significant effort to improve the so called Simple Stellar Population (SSP[1]) Models. These models were employed in a vast number of studies of systems covering a wide range of redshifts/cosmologi-cal ages. Hence, it is crucial to test their performance using stellar populations with the same range of independently known ages and metallicities. Star clusters are the closest existing counterparts of SSPs. Unfortunately testing the models with cluster data is not an easy task to be accomplished in our Galaxy. As we show in Chapter 4, there is no significant population of massive young and intermediate-age[2] clusters in the Milky Way. Also the application of the few members of this group discovered so far in the present investigation is severely hampered (they are located in regions of extremely high optical extinction). Once again the Large and Small Magellanic Clouds (LMC and SMC respectively) assume the role of an important empirical laboratory to study processes that are crucial for our understanding of the Cosmos. The observing facilities available nowadays allow the investigation of the stellar population properties of individual clusters in both galaxies in great detail. The complex star formation history of the

[1] A SSP is a stellar agregate whose individual members have the same age and chemical composition.

[2] Here we use the designation "intermediate-age clusters" for objects with ages from approximately 200 Myr to 10 Gyr

Clouds results in a significant number of massive clusters covering a suitable range of ages and metallicities.

Chapter 2 of the dissertation contains a study of the Near-Infrared (NIR) integrated-light photometric properties of a large sample (84 objects) of populous star clusters in the LMC and SMC. Our goals were threefold: *(i)* provide a modern NIR study of the integrated light from these systems employing the Two Micron All Sky Survey (2MASS) JHK_S photometric system; *(ii)* assemble a database that could be used as empirical template for comparison with unresolved cluster systems in more distant galaxies; *(iii)* use the data to test the performance of the SSP models. We show that due to some inherent limitations the earlier studies available and the 2MASS XSC[3] are not suitable for these purposes.

Chapter 3 is focused on the evaluation of the performance of the most popular and widely used SSP models[4]. In the process an optical extension of the NIR database was created by compiling and cross-correlating information from earlier studies. A wide-spread literature search yielded accurate age and metallicity estimates for 54 objects in our sample. Those were divided in four age bins to probe the modeling of specific stages of stellar evolution. A special care was taken to account for the stochastic fluctuations in the measured photometric properties due to the presence of NIR luminous stars in the clusters. It was confirmed that the combination of optical and NIR photometry breaks the age/metallicity degeneracy and could disentangle massive SSPs of different ages. All of the considered models provide reliable estimates of the ages and metallicities of old (Age $>$ 10 Gyr) Magellanic Clouds clusters, but model performance varies significantly for younger ages.

It is beyond any doubt that the SSP models will continue to evolve and improve. The empirical templates and the observational feedback provided to the modelers will speed up this process. Better and more precise SSP models will broaden our horizons and help better understand the high-z Universe. This is especially important in the light of the upcoming instrumentation.

Acknowledgements: The research on the thesis was conducted at the Space Telescope Science Institute, Baltimore, USA and the Department of Astronomy, Faculty of Physics, SU "Sv. Kl. Ohridski", Sofia, Bulgaria. I would like to express my deep gratitude to the numerous colleagues and friends who invested a lot of support and time for discussions in this endeavor. Thank you!

Key words: galaxies: star clusters — galaxies: stellar content — infrared: general — infrared:stars —Magellanic Clouds — techniques: photometric – Galaxy: open clusters and associations

[3] 2MASS Extended Source Catalog

[4] The list of models considered in the study include: Maraston, 2005; Bruzual & Charlot, 2003; Anders & Fritze, 2003; Vazdekis, 1999

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