STELLAR POPULATIONS IN THE MILKY WAY: BULGE, HALO, DISK AND STAR FORMING REGIONS; INSTRUMENTATION FOR HIGH RESOLUTION SPECTROSCOPY

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Figure 1. Image of the bulge globular cluster HP1 near the Galactic center, observed in the VVV survey.

The main aim of this project is to study the stellar populations and structure of the Milky Way, in order to better understand its formation and evolution. The targets are stars of the Galactic Bulge, Halo and Disk. The bulge is studied in terms of the chemical composition of individual stars as well as kinematics and ages of field and globular cluster stars.

The interplay between the bar and the oldest globular clusters trapped in the bar is studied by deriving their proper motions and distances.

The final goal is to know if the metal-poor stars in the bulge are the oldest in the Galaxy, as this would confirm that the bulge formed first. The Galactic halo is studied through abundance analysis of the most metal-poor stars. A selection of new targets, in particular carbon-rich metal-poor stars, is also carried out based on large surveys. For both the halo and bulge, the abundance pattern of the metal-poor stars ($[Fe/H]\approx-1.0$ in the bulge, and $[Fe/H]<-2.0$ in the halo) give information on the nature of the first supernovae, that produced the chemical enrichment of the gas from which these stars formed. The Galactic disk is studied through a) old super metal-rich stars that seem to have migrated from the inner parts of the Galaxy; b) metal-rich M dwarfs; c) young stars and star forming regions.

The group is expert in spectroscopy of cool stars, using model atmospheres to compute synthetic spectra, that are compared with the observed ones.

In the study of star clusters, we also use imaging in optical and near-infrared colours, to produce colour-magnitude diagrams, and deduce their ages. For star forming regions, X-ray data from the satellites XMM-Newton and Chandra have been obtained, in order to identify young stars.

Instrumentation is an important part of this project, with mainly the development of the CUBES spectrograph for the VLT/ESO, the ECHARPE spectrograph for the OPD/LNA/MCTI, and the MOSAIC multi-object spectrograph for the E-ELT. The MOSAIC spectrograph involves brazilian expertise on optical fibers.

Results on the Galactic Bulge include the abundance analysis of the bulge globular cluster HP 1, and the writing of an important review article on the Galactic bulge by B. Barbuy et al. We are also involved in the survey of the bulge region with VVV (Vista Variables in the Via Lactea), see Fig. 1 – Image of HP 1. In another collaboration the work by Bensby et al. including J. Melendez, analyses 90 microlensed bulge dwarfs. The analysis of data from the Hubble Space Telescope of NGC 6522 by L. Kerber et al. confirms that this is among the oldest clusters in the Galaxy, see Fig. 2 – Colour-magnitude diagram of NGC 6522.

Results on the Galactic Halo include the work published in Nature astronomy on a first age map based on blue horizontal branch stars, as part of the PhD thesis by R. Santucci under supervision by S. Rossi. The oldest stars are found out to 10-15 kpc from the center Precision abundances of metal-poor stars by Reggiani, Melendez et al. Results on young stars in the Galactic disk uses X-ray data from the XMM-Newton satellite, having identified stars in molecular clouds CMA R1 and nebula Sh2-296. Instrumentation work has progressed: Prototyping of the grating for CUBES is being concluded. The MOSAIC spectrograph entered Phase A of studies.

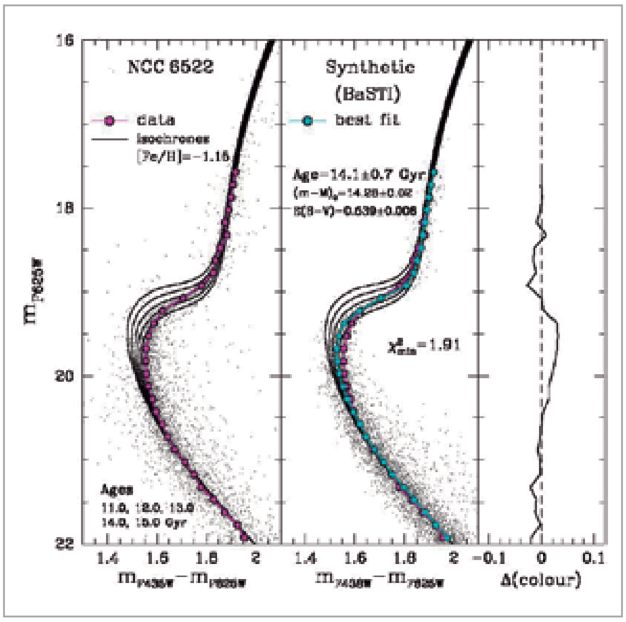

Figure 2. Colour-Magnitude Diagram of NGC 6522 observed with the Hubble Space Telescope, and proper motion cleaned. The theoretical isochrones overplotted indicate an age of 14 Gyr, close to the age of the Universe.

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