THE ACCRETION HISTORY OF THE MILKY WAY HALO THROUGH CHEMICAL-TAGGING

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Diffuse stellar haloes extending for more than 100kpc radius and containing a significant amount of streams and substructures are observed around the Milky Way (MW), M31, and there are indications that they may be a ubiquitous component of galaxies down to the scale of LMC-like objects (e.g. for recent works and reviews, see Helmi 2008, A&ARv, 15, 145; McConnachie et al. 2009, Nature, 461, 66; Martinez-Delgado et al. 2009, ApJ, 692, 955; Mouhcine, Ibata & Rejkuba 2011, MNRAS, 415, 993; Rich et al. 2012, Nature, 482, 192).

Within the Λ Cold Dark Matter (ΛCDM) framework, stellar haloes around galaxies formed by disrupted satellite galaxies are a natural outcome of the hierarchical build-up of structures (e.g. Bullock & Johnston 2005, ApJ, 635, 931; Cooper et al. 2010, MNRAS, 406, 744). In particular, the outer parts of such halos are expected to form almost exclusively by the shredded stellar component of satellite galaxies, whilst the inner regions can contain a mix of accreted stars and stars formed in the primary galaxy at high-redshift from cold gas (e.g. Zolotov et al. 2009, Tissera et al. 2013). The outer parts of the halo are then those that contain precious information about the specific accretion history of a given halo.

Observational support that different formation mechanisms may be at play in the stellar halo of our own MW is given by the analysis of a spectroscopic sample of $\sim$10000 halo stars from the SEGUE survey (Carollo et al. 2007, Nature, 450, 1020), which suggests the existence of an inner and outer component having significantly different structure, metallicity and kinematic properties (see also de Jong et al. 2010, ApJ, 714, 663; Schlaufman et al. 2012, ApJ, 749, 77; Sesar et al. 2011, ApJ, 731, 4 to mention only a few other studies that go in this direction and the seminal work from Searle & Zinn 1978, ApJ, 225, 357).

A very powerful and direct way of identifying what type of small galactic systems contributed to forming galaxies (and their various components) is the determination of the elemental abundances of stars, as these can be used to infer some characteristics of the environment in which the stars formed. Of particular relevance is the ratio of α- elements over Fe, as this is a known "clock" to probe the star formation history of a galactic component.

Interestingly, chemical-tagging" of stars in the inner MW halo has shown that at very low metallicities the inner halo is compatible with having been assembled out of disrupted systems like the classical dSphs and the UFDs (e.g. Tolstoy et al. 2009), while the more metal-rich part of the inner halo needs to have formed in an environment with higher initial SFR than those in the UFDs and classical dSphs (e.g. Tolstoy et al. 2003; Venn et al. 2004), for example by the dissipative merging of gas-rich proto-galactic fragments (Gilmore et al. 1989) or by the accretion of large satellites (for example, Sagittarius-like objects e.g. de Boer et al. 2014). Since the chemical properties of inner halo stars are not necessarily representative of the whole of the halo, it is necessary to determine the chemical abundances of distant outer halo stars to comprehensively understand the build-up of the whole MW stellar halo.

Given the magnitude limits of the Galactic Archaeology surveys planned for WHT/WEAVE, VLT/4MOST, SDSS/APOGEE it is expected that elemental abundances from high resolution spectroscopy will focus mostly in the region within $\sim$50kpc from the Galaxy center. On the other hand, the much fainter magnitudes within the reach of the high resolution mode for CFHT/MSE should allow to explore the chemical abundances of stars probing distances all the way to the MW virial radius.

According to the range of Galactocentric radii probed by the WHT/WEAVE, VLT/4MOST, SDSS/APOGEE surveys of the MW halo, which should become known in the years precending the start of operations of MSE, we would propose that MSE determination of the chemical properties of stars in the MW stellar halo focus in acquiring high s/n, high resolution spectroscopy of all the accessible MW halo stars in regions outside the reach of the aforementioned surveys. This would require a resolving power of at least R=20000 and a S/N$\sim$40-50. This should remain domain of MSE for the foreseable future, since no other dedicated, wide-area, high-multiplex spectroscopic facility with a high-resolution mode on a 8m-10m is planned at present.

Preselection of halo giants could be carried out identifying giants with a color-color selection as for the SEGUE project (Yanny et al. 2009) using SDSS or PAN-STARRS photometry and using Gaia distances and proper-motions to weed out disc and inner halo stars.