Bulge science with MSE

The inner regions of the Milky Way (hereafter MW) keep trace of the early phases of formation of the Galaxy, and of its subsequent evolution.

For long time thought as a merger product (see, for ex, Renzini 1999), the Milky Way bulge presents characteristics which reveal that at least part of it corresponds to the MW boxy/peanut bar seen edge on. In fact, the most recent observational studies (Babusiaux et al 2010, 2014; Hill et al 2011; Ness et al 2012, 2013a;b) suggest that the MW's bulge does not consist of a single unique component, but is rather a combination of two or more components or perhaps a continuum of populations, with different chemical and kinematic properties. A significant progress in our understanding of the nature of the MW's bulge has been recently made possible thanks to the ARGOS survey (Freeman et al. 2012), which has observed ~28 000 bulge red giant stars in 28 different fields along the bulge and inner disk. This survey has revealed that the MW's bulge seems to have a very well-organized structure, being mostly made of three main components, whose metallicities extends from super-solar to thick-disk-lime metallicities, and whose weight changes with latitude, in such a way that the most metal-rich component is preferentially found close to the Galactic plane, and fades at high latitudes, where the more metal-poor components become dominant. On the basis of their kinematic and chemical characteristics, it has been suggested (Ness et al 2012, 2013; Di Matteo et al 2014a,b) that the MW bulge is for the vast majority made of disk stars, with only a very limited presence of a classical bulge (B/ D~10%), if any. In this scenario, the two components at metallicities [Fe/H]~0.2 dex and [Fe/H]~ -0.3 dex, would be respectively associated to the inner thin disk and the young thick disk, following the nomenclature recently proposed by Haywood et al 2013, whilst the most metal-poor component ([Fe/H] ~-0.7 dex) would be associated to the old thick disk, kinematically too hot to be trapped in the boxy/peanut-shaped structure. In this scenario, the MW bulge would thus be the result of the mapping of a thin+thick disk into the central Galactic regions, through the bar. Note that the recent findings of strong similarities between the [α/Fe] versus [Fe/H] trends of solar vicinity thick disk stars with the α –enhanced, metal-poor population of the bulge (Meléndez et al. 2008; Alves- Brito et al. 2010; Bensby et al. 2011, 2013; Gonzalez et al 2011), if confirmed with larger high resolution spectroscopic samples, would be a strong additional support to this scenario.

To understand the nature of the different MW's bulge components one must passes through the reconstruction of the detailed metallicity and abundance distribution function of the bulge, at different longitudes and latitudes. This is because these distributions are a fossil record of the chemical properties of the MW disk at all epochs, and, as such, they are directly related to its star formation history. Moreover, the reconstruction of the chemical distribution functions of the bulge and its outskirts, and its comparison with those of the disk, will allow to quantify the link between the bulge and the Galactic disk(s), and ultimately the continuity/ discontinuity between these populations.
Reconstructing these distribution functions at different latitudes and longitudes requires high statistics (see Ness et al. 2013).
Together with high statistics, a future bulge survey also requires high resolution (at least R=20,000) and high S/N spectra to be able to quantify the kinematic and chemical links between the bulge and the inner disk/halo, and find the contribution of a classical bulge (if any).

Note that a resolution of R=20,000 must be really considered the lowest possible limit for this kind of studies.
The classical bulge of the Milky Way, if it exists, is thought to represent no more than B/D~10%. Hence, it is possible that the bulge contains the remains of the most ancient mergers that shaped the

core of our Galaxy. Such stars would probably have low metallicities, and finding them in substantial number implies large statistics.

Because stars in the inner most center of the Milky Way is expected to be kinematically well mixed, only chemical abundances would allow to find their different origins.

Moreover, when comparing the MW disk chemistry to that of the bulge stars, we note that some of the most significant differences between the solar vicinity disk chemistry and the bulge seem to be found at [Fe/H]>0 (Bensby et al 2013), at metallicities where R=20,000 spectra suffer of severe line blending. There is a strong interest in studying these alpha- enhanced, metal-rich bulge stars which may reveal recent bursts of SF in the MW, undetected from solar vicinity data. And this is clearly a case where resolutions higher than R=20,000 are needed.