The Ultraviolet Milky Way

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Despite huge observational and theoretical efforts, there remain gaping holes in our knowledge of galactic systems (e.g. their dark matter distribution, star formation processes, early galaxy evolution), and at present we possess only a broad-brush understanding of their structure. However, by deconstructing the present state of a galaxy into large-scale stellar components and its myriad substructures, separating features by their distinguishing photometric, metallicity and kinematic properties, we can begin to understand these systems in full detail and unravel their complex nature and formation history.

It is for these reasons that we have undertaken "Luau" (CFHT Legacy for the u-band all-sky universe), a large u-band survey of the whole northern sky ($10° < \delta < 80°$, $|b|>10°$) to u=24.2 (S/N=5). The goal of the survey is to obtain CFHT u-band photometry to complement existing Sloan Digital Sky Survey (SDSS) griz data to perform a landmark tomographic study of the structure and metallicity distribution of the Milky Way. The approved first stage will begin in spring 2015, covering 4000 square degrees (1/10th of the entire Milky Way sky) within the SDSS footprint, but will ultimately extend to cover 1/3rd of the Galaxy. Most of the major components of the Milky Way (halo, disk(s), streams, substructures, etc) will be covered in the Luau survey.

By reaching nearly an order of magnitude fainter than existing SDSS u-band data, Luau will calculate the photometric metallicity of >10 million halo main sequence stars to D=50kpc, with an rms accuracy of Δ[Fe/H]=0.3dex. This accuracy exceeds that of Gaia at its observational limits, but more importantly extends an additional two magnitudes fainter, allowing structures to be discovered through the union of the two surveys. These new metallicity estimates will significantly improve the photometric parallax of the stars at D<25kpc, allowing a full 3D analysis of the metallicity structure of the outer Galaxy. Already the first phase of the project will represent more than an order of magnitude increase in the volume of the Galaxy that has been probed in this manner compared to SDSS. The depth of the u-band data is also sufficient to identify effectively every blue horizontal branch star in the northern hemisphere out to (D=150kpc), to examine the global shape and substructure of the distant outer halo.

While the survey is focused towards Galactic archaeology and stellar populations, the legacy value of these data for fields beyond Galactic astronomy is clearly immense (given that we will finally provide a u-band to match the depth of SDSS and PanSTARRS observations). These data can be expected to make critical contributions in the determination of photometric redshifts, the analysis of nearby galaxies and their star clusters, galaxy evolution, and many other fields.

The goal of this PhD thesis is to explore the structure and dynamics of the Milky Way and its sub-components, using the Luau survey together with other state-of-the-art datasets (particularly Gaia). Given the richness and novelty of this gigantic dataset, we expect to be able to discover new features and properties of our Galaxy. Many sub-projects will be open to the student to lead, depending on their particular interests.