Stellar, Circumstellar and Interstellar Physics (SCIP)

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Advancing our knowledge and understanding of the stellar and diffuse interstellar content of the Milky Way continues to occupy a central position in astronomy: advances in characterising stellar and interstellar processes, working now, locally support progress in understanding the appearance, content, and evolutionary histories of galaxies in the wider, younger Universe. Uniquely, it is in the Milky Way that we easily access individual examples of the least well-described, short-lived phases in stellar evolution, down to sub-solar-mass objects – and study at maximum angular resolution the relationship between stars and the interstellar medium (ISM). Topics of current significance include environmental effects in the formation of stars, extinction and ISM mapping, the lifecycle of high-mass stars, mass-loss phenomena across the HRD, the consequences of binary interaction, the approach to end states of cooling white dwarfs, X-ray emitting binaries and gravitational wave sources.

This programme is about Galactic Plane science, favouring the higher-mass and young/old extremes of stellar evolution, rather than the more frequent older stars that are the natural focus of Galactic archaeology. It is also about the ISM on the large scale – both ionised gas, made visible via Halpha and other optical emission lines, and also the medium seen in absorption against background starlight. The R=5000 mode of WEAVE will provide unprecedented access to the physical and chemical properties of the gaseous and dusty ISM, along with sufficient kinematic resolution to discern the contributions from major cloud components lying along every sightline sampled. For stars, spectroscopy at R~5000, spanning almost the entire optical range, provides many types of information that cannot be derived from photometry alone: these include systemic/orbital radial velocities, sound stellar parameters and metallicity, first evidence of chemical peculiarity, interstellar absorption features, a broad suite of constraints on circumstellar /nebular matter, mass transfer/loss signatures, and signs of magnetic activity. At the higher resolution available, R = 20000, observations in the Cygnus region and Galactic Anticentre can take this further through the measurement of individual element abundances, the determination of better constraints on binarity, and access to enhanced precision of radial velocity measurement that can expose more subtle localised velocity dispersion.

For target selection, SCIP will draw on Gaia data releases, and also the INT Galactic Plane Surveys (IGAPS, comprising the IPHAS and UVEX surveys) covering the northern plane, and VPHAS+ at the VST in the south (Drew et al 2005, Groot et al 2009, Drew et al 2014, Monguio et al 2020). The groundbased photometric surveys have captured more than half a billion point sources in the Milky Way's disc – its main mass component – from which well-tuned samples of the target object types can be extracted down to at least *V*~19. A defining feature of the SCIP survey, supported by the IGAPS surveys, is that the samples studied will correct previous bias favouring clustered environments – for the first time high-precision target selection across the wide field is possible and has been undertaken (see e.g. Raddi et al 2015, Harris et al 2018, Greimel et al 2021).

The current SCIP footprint is shown below:

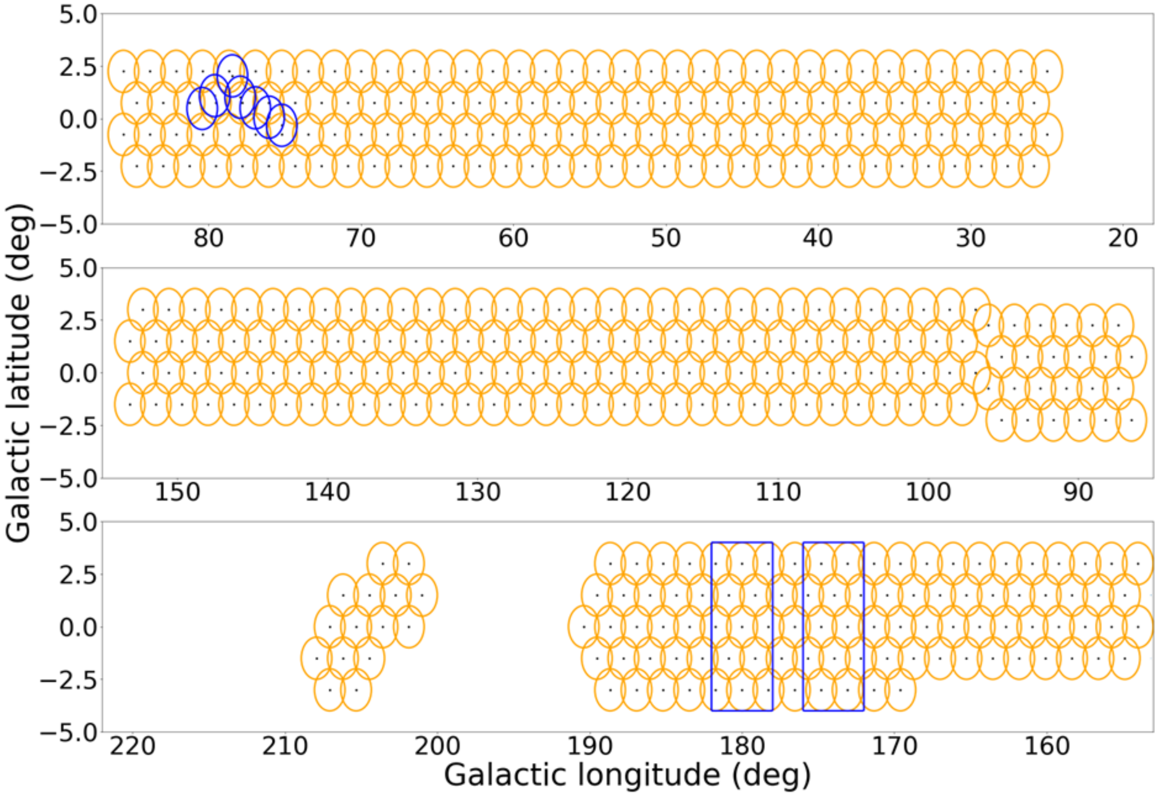

Figure 1: The SCIP footprint broken down into the constituent tiles envisaged for the R=5000 survey, plotted against Galactic coordinates. The sub-regions outlined in blue represent the target regions of the R=20000 Cygnus and HR Anticentre surveys. The island of pointings beyond the Galactic Anticentre captures the Rosetter Nebula/Monoceros part of the plane.

The main target groups for SCIP are, in roughly descending order of total expected target numbers: massive OBA stars, including emission line stars and red supergiants; ionised nebulae and the diffuse ISM; young stars across the wide field; white dwarfs and compact binaries.