Setting the scene for Gaia and LAMOST
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The GALAH survey

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Abstract. HERMES is a new high-resolution multi-object spectrograph on the Anglo Australian Telescope. The primary science driver for HERMES is the GALAH survey, GALactic Archaeology with HERMES. We are planning a spectroscopic survey of about a million stars, aimed at using chemical tagging techniques to reconstruct the star-forming aggregates that built up the disk, the bulge and halo of the Galaxy. This project will benefit greatly from the stellar distances and transverse motions from the Gaia mission.

Keywords. instrumentation: spectrographs, surveys, stars: abundances, Galaxy: evolution, Galaxy: kinematics and dynamics, Galaxy: structure

1. Introduction

The goal of Galactic Archaeology is to find signatures or fossils from the epoch of Galaxy assembly and identify observationally how important mergers and accretion events were in building up the Galactic disk, bulge and halo of the Milky Way. The aim is to reconstruct the star-forming aggregates and accreted galaxies that built up the different structures we see in the Galaxy at z = 0. Some of these dispersed aggregates can still be recognized kinematically as stellar moving groups. For others, the dynamical information was lost through heating and mixing processes, but their debris can still be recognized by their chemical signatures (chemical tagging). We plan to find groups of stars, now dispersed, that were associated at birth either because they were born together and therefore have almost identical chemical abundances over all elements, e.g., De Silva *et al.* (2009), or because they came from a common accreted galaxy and have abundance patterns that are clearly distinguished from those of the Galactic disk, e.g., Venn & Hill (2008).

2. HERMES

HERMES is a new high resolution fibre-fed multi-object spectrograph on the AAT. It uses the existing 2dF positioner with 400 fibres over an area of π deg^2 with each fibre subtending 2″ on the sky. It has two resolution modes (resolving power 28,000 and 45,000).

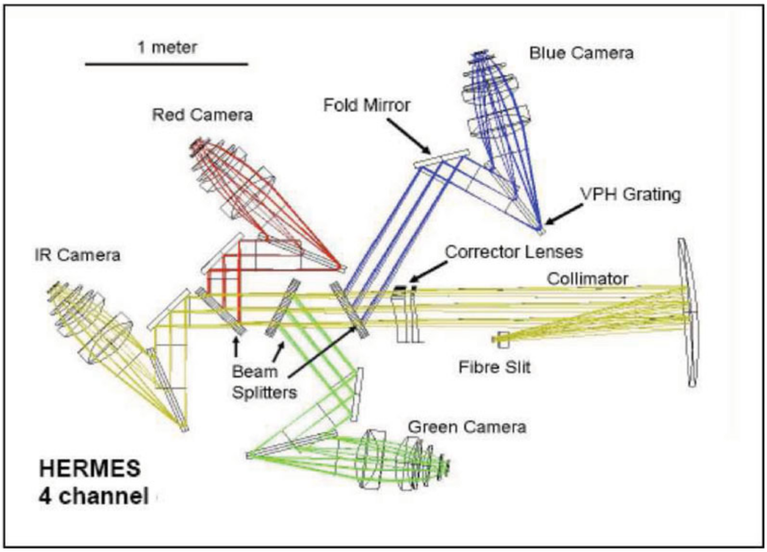

Figure 1. Optical design of the HERMES four-band high-resolution spectrograph.

Table 1. Wavelength ranges of the individual HERMES bands.

Band	λ_{min} **[nm]**	λ_{max} **[nm]**
Blue	471.8	490.3
Green	564.9	587.3
Red	648.1	673.9
IR	759.0	789.0

Four VPH gratings and four cameras give a total wavelength coverage of about 1,000 Å in four non-contiguous wavelength bands chosen to include measurable lines of the elements to be used for chemical tagging, e.g., Heijmans *et al.* (2012), Brzeski *et al.* (2012), Wylie-de Boer & Freeman (2010). First light at the telescope is expected in late 2013. The optical layout of the spectrograph is shown schematically in Fig. 1. Light passes through the instrument from the fibre-fed slit, through the field lens and collimator, to a sequence of dichroic beamsplitters. At the beamsplitters the light is split into the four beams. Each beam then passes to a VPH grating, then on to a camera and detector. The wavelengths of the individual bands are given in Table 1.

3. The GALAH survey

A survey of about a million stars is planned using the HERMES instrument. The faint limit for the GALAH survey is V = 14, chosen to match the typical stellar density on the sky to the fibre density (see Figure 2 for a projection of fields with more than 400 stars per 2 degree field of view. The aim of the GALAH survey is to reconstruct the star-forming aggregates that built up the disk, bulge, and halo of the Galaxy. These aggregates have dispersed and mixed their debris around the Galaxy. Some of these dispersed aggregates can still be recognized kinematically as stellar moving groups. For others, the dynamical information was lost through disk heating processes, but their stars are still recognizable by their common chemical signatures via *chemical tagging*, e.g., Freeman & Bland-Hawthorn (2002), De Silva *et al.* (2007), Ting *et al.* (2012).

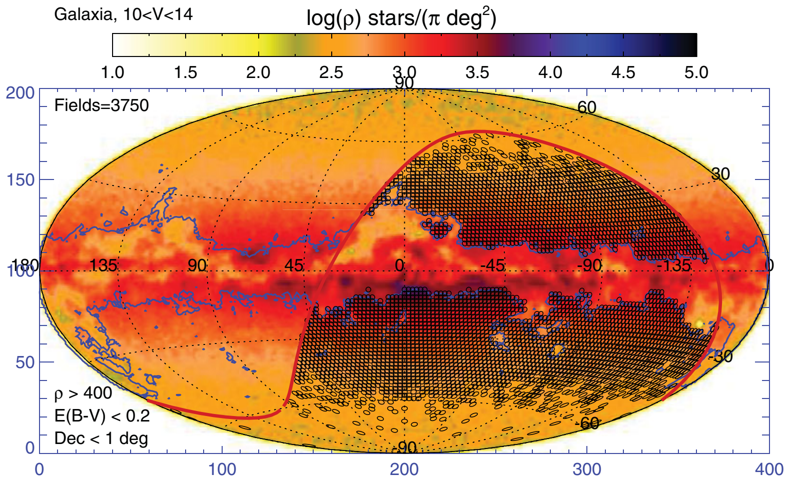

Figure 2. An aitoff projection of fields having more than 400 stars per 2 degree field of view. Data from Galaxia model (Sharma *et al.* 2011).

We expect to be able to measure abundances for at least 25 elements (Li, C, O, Na, Al, K, Mg, Si, Ca, Ti, Sc, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Ba, La, Nd, Eu). HERMES spectral bands were chosen to ensure measurable lines of these elements, which represent most of the major element groups and nucleosynthesis processes. The bands also include Hα and Hβ lines. Detailed chemical abundances will allow us to use chemical tagging techniques to tag or associate the stars to common ancient star-forming aggregates. Chemical studies in the Galactic disk can help to distinguish stars that are part of the debris of common dispersed star-forming aggregates, and also those which came in from disrupting satellites.

4. Science with GALAH

The primary science driver for the GALAH survey, as we described above, is Galactic archaeology. We seek signatures or fossils from the epoch of Galaxy formation, to give us insight about the processes that took place as the Galaxy formed. Other GALAH science areas include:
- stellar physics
- the structure dynamics and chemical properties of the galactic bulge and disk
- stellar populations in the Magellanic Clouds
- star clusters
- interstellar medium

GALAH shares a strong synergy with the Gaia mission, which will provide proper motion and parallax data, while GALAH will provide high resolution spectroscopy and its associated data products of a million of the Gaia targets. The survey will also be directly complementary to wide-area photometric surveys such as Skymapper (Keller *et al.* 2007)

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Discussion

Poul Erik Nissen: It is important to measure abundance ratios with a precision around or even less than $\pm$ 0.05 dex, because the difference we see between Galactic sub-populations are only about 0.1 dex.

Borja Anguiano: Thanks for the comment. We have seen in the [α/Fe] - [Fe/H] diagrams from high resolution spectroscopy that a precision close to 0.1 dex is needed to distinguish between the thin and thick Galactic disk. We hope that the high resolution from HERMES and the high S/N we expect for the GALAH targets ($>$ 100) will allow us to get precision $<$ 0.1 dex for individual chemical abundances.