# IAUS 298: Setting the Scene for Gaia and LAMOST,
# The current and next generations of surveys and models
Lijiang, China, May 20-24 May 2013

The meeting was a nice overview of i) the recent research on the Milky Way structure and populations, ii) the big issues and unknowns still to be solved, ii) big surveys and missions relevant to Galactic astronomy, with special emphasis to Gaia and LAMOST.

It was suggested to do a next IAU meeting on the Galaxy in Hawaii 2015. The proceedings will be available at the end of the year or beginning of the next year. The program is available here: http://iaus298.csp.escience.cn/dct/page/1

The meeting was organized in honor of J. Andersen and B. Nordstrom. J. Andersen gave a very good summary of the great achievements and the big problems of Galactic astronomy, which he listed as follows:

What would Stromgren have liked the most?
- The realistic LamdaCDM+ galaxy formation simulations
- The SDSS maps of the halo and streams
- The massive use of accurate calibrated photometry
- The wealth and quality of spectroscopic information
- The progress in stellar physics (ages, 3D in Sne, spectra, NLTE, yields-AGN, asteroseismology, …)
- HIPPARCOS and Gaia (parallaxes, proper motions, accuracy, range)
- The attention to quality control and verification
- The number and detailed data on the DSph
- The EMP halo(s) before/beyond the GC
- The new knowledge of the ISM (dust, gas)
- The state of chemodynamical models of the MW
- The quantification of selection effects
- The parallel progress of theory and observations
- The improved parameters for the disc
- The eruption of Chinese astronomy (IAU, Blaauw)
- The achievements of  LAMOST & environment

What would have made Stromgren more impatient?
- We still don't know what/where the spiral arms are
- We still don't know what hi IP2 (aka thick disk) is
- Why are we so slow with the RV follow-up surveys?
- Why do we still not know the nature of the bulge?
- Why do we still not know the SFHs of the MW?
- Why do we still build and run medium-size facilities as purely national tools when the rest of astronomy is so fully international?

The meeting was separated in different sessions that I detail next (although they do not follow the program order!).


## 1) THE MILKY WAY AS WE KNOW IT

- Constraining the Galactic potential of the halo with the observed streams. New methods: i) based on the minimization of the spread in actions space of the stars in the streams and fitting many streams at the same time (Sanderson), ii) more accurate methods taking into account that the stream do not delineate exactly the orbit (Sanders).

- Missing satellite problem still persisting (Belokurov)
- Two distinct (chemical) populations in the halo (Tan, Nissen, Ishigaki)
- Observed chemical gradients in the disc (with Open Clusters and Cepheids) and their relation with the corrotation resonance. Existence of the disc truncation. Plan to observe several hundreds of OC with LAMOST in the second quadrant to study rotation of spiral arms, IMF, disk evolution (age-metalicity relation), chemical evolution. Number of arms in the Galaxy, (Lepine, Hou, Carraro)
- New determinations of Vc and local DM density (Bovy)
- The existence and properties (scale length and height) of the thick disc (Bensby). It is still discussed if the thick disc exists. It could have a shorter scale length than the thin disc in a way that the thick disc actually dominates the inner disc.
- Fitting distributions functions based on actions, and including also abundances, to observed RAVE data (Binney, Sharma) seems to show a thick disc with a higher vertical dispersion than radial or azimuthal one. There seem to be more stars with Vr>0 (asymmetries) than the model predicts. The data seems to have more thick disc than the model. Different surveys give different results (RAVE in conflict with GCS or SEGUE).
- Separation of stars of SEGUE in mono-abundance populations (similar [Fe/H] and [alpha/Fe]) and study their properties: vertical scale height, scale length, age. These populations are found to be isothermal. An Nbody simulation with a similar behavior. (Rix)
- Radial migration and effects of bar and spiral on the kinematics of the stars and disk chemistry (Pozhath, Quillen)
- Recent results (some of them with LAMOST) on the kinematic understanding of the solar volume (Smith):
    - Characterization of velocity dispersion and asymmetric drift with SDSS (Smith)
    - Substructure in the Solar Neighborhood (Q. Xia)
    - Distance derivation for LAMOST stars (Zhong)
    - Duality in alpha elements, thin/thick disc (Y.S. Lee)
    - Abundances in thick disc (Liu)
    - No thick disk in the Galaxy (Bovy)
    - Radial velocity bimodality in the outer disc in the anti-center direction with LAMOS (C. Liu)
    - Causes of the above bimodality with Nbody simulations with bar and spiral (Smith, Shen, in prep)
- The bulge and bar distinction, different populations and dynamical modeling with NBody simulations (Origlia, Shen)

## 2) GAIA, LAMOST AND LARGE SURVEYS

- Review of the LAMOST status and the different LAMOST surveys (Deng, Liu): the LAMOST ExtraGAlactic Survey (LEGAS), and the LAMOST Experiment for Galactic Understanding and Exploration (LEGUE). LEGUE already available pilot survey (480000 stars):
http://data.lamost.org/pdr/das
and soon the first DR with 1.2M stars. Inside the LEGUE survey there are at least three parts:
- ANTICENTER survey
- DISC survey
- SPHEROID/ HALO survey
Review of the main science goals (streams, moving groups, OCs, hypervelocity stars, metal poor stars, disc features such as spiral arms, bulge,...) and the selection of targets (input catalogue). The DSS-GAC survey of LAMOST for Anti-Center (150<l<210, |b|<30) in combination with Gaia will allow us to study populations, streams, gravitational potential, extinction, debris of clusters. They did their own photometric survey for the target selection (10^8 stars, V<19 mag). The pilot survey contains 150000 stars but the target is 250000. They have their own pipeline to derive stellar parameters. Precision in RV is 3.8 km/s, 0.1 dex in log g, 0.15 dex in [Fe/H], 100K in Teff.
- Review of Gaia status and performances (Vallenari)

- Other surveys: LSST (Ivezic), APOGEE (Schultheis, DR in July 2013!), GALAH (Anguiano)
- Gaia follow up surveys (Bonifacio): Gaia-ESO, 4MOST, WEAVE, MOONS, HERMES, BigBoss, DESpec, spectroscopy@ Subaru telescope, next generation @ CFHT, ground based Gaia spectrograph?)
- Stromgren-Crawford all sky survey (Wang): They aim to do an all sky Stromgren-Crawford survey to get accuracy in stellar parameters that can be comparable to high resolution spectra (4 yr, V=19 mag, starting date 2014). They discuss if it is worth doing it now that Gaia is also going to derive all this parameters. They argue that they will get better precision.

## 3) VARIABLE, PECULIAR STARS, THE SUN

- The effects of planets and meteorites can change the abundances in stars, with consequences in finding solar siblings or in chemical tagging (Melendez).
- Gaia detection of variable stars, use of variable stars for Galactic structure studies (Eyer, Whitelock, Feast)
- Asteroseismology (Silva Aguirre), They can derive radius, masses, distances (15%), gravity (0.3 dex), ages (10-20-40%) of stars using asteroseismology using COROT and KEPLER. It has been done already for some COROT fields.
- Chromospheric activity and the calibrations activity-age with RAVE (Zerjal)

## 4) INTERESTELLAR MEDIUM AND GAS

- Gas distribution in disc and halo. (McClure-Griffiths, Fraternali). New generation of 21cm surveys that will bring a revival for Galactic studies of interstellar gas and star formation (ASKAP, GAMES). In particular, we'll be able to study in much more detail the connection (gas) between the disk and the halo, l-v diagrams for Galactic structure, absorption, rotation curve
- Star formation and giant molecular clouds, and the role of spiral arms (Dobbs): Simulations of the formation of GMC with gas, imposing a spiral potential. They see that i) in high density regions they form through self-gravity, ii) in low density regions, they originate from cloud collisions, iii) some GMC are formed in inter-arm regions, iv) little difference in star formation rates between her spiral galaxies and disc without imposed spirals, v) the properties of GMC are similar for flocculent and grand-design spirals but differences in the gas flow, vi) spiral arms seem to influence star formation because they create GMCs but they do not trigger star formation.
- Existing extinction maps (Murthy): Schegel, Neckel, Amores, Marshal, Drimmel

## 5) MILKY WAY MODELLING

- Recent modeling of stellar yields (Karakas, Nomoto)
- Chemodynamical and galaxy formation models (Minchev, Kobayashi, Tissera)
- Types of modeling, comparing data to models (Wilkinson): mass modeling, Jeans equations, kinematic models, dynamical models. This last one includes moment based moments, distribution functions modeling, orbits based methods, action-angle models, M2M and Nbody models.
- Predictions for globular clusters (Gieles): Predictions of the number of cold stream (GC being disrupted in the halo) depending on the initial properties of the clusters. It is possible to infer the properties of GC depending on how many cold streams Gaia finds. They have derived an semi-analytical model that allows them to explore all properties of the clusters and how the GC evolve through two body relaxation (EMACS: Evolve Me A Cluster).

## 6) ELEMENTAL ABUNDANCES IN STARS – PITFALLS FOR INTERPRETERS

- Pipelines to derive stellar parameters and abundances from spectra. How all these are used together for the Gaia-ESO survey (Recio Blanco)
- Models (1D vs 3D) of stellar atmospheres (Caliskan, Ludwig, Mashonkina, Mashonkina)