The life and times of the disc as viewed by LAMOST
(with a little help from RAVE & TGAS)

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Spectroscopy from LAMOST

• This 4m is China’s largest optical facility. 4000 fibers across a 20 sq deg field of view, working at $R \sim 2000$

• Now into fifth year of the full survey, obtaining 1M stellar spectra per year
  - 3.9M unique stars with S/N > 20
  - 1.2M unique stars with S/N > 100

• SP_Ace analysis led by Corrado Boeche will be released later in the year, including $[\alpha/Fe]$ to 0.08 dex (other pipelines available, e.g. Ho et al. 2017, Xiang et al. 2017)

• International release of DR3 due in June 2017, with LAMOST-2 commencing next year
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We have taken TGAS stars having $d\pi/\pi < 20\%$ and spectroscopy from LAMOST (73k) and RAVE (67k), with typical S/N around 200/60

Derived ages using the standard Jørgensen & Lindegren (2005) method, adopting the PARSEC isochrones, and calculated orbital parameters using MWPotential2014 from galpy

Typical age errors 2-3 Gyr and velocity errors 5-10 km/s, within a volume of $\sim 0.5$ kpc
Our catalogue

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Blurring

Churning

Selwood & Binney (2002); Schönrich & Binney (2009)
Radial flows

• In an equilibrium axisymmetric system, the properties of stars moving inward should be the same as those moving outward.

• Antoja et al. (2017) used RAVE data to show this is not the case.

• This is a consequence of the tilt in the UV plane, which is particularly prominent in the young stars.

• We see that the older stars are more phase-mixed with less asymmetry in \( v_R \).
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(Diagram: A plot showing radial velocity as a function of metallicity with different age groups indicated.)
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Angular momentum evolution

- What about the overall shape of the $v_\phi$ distribution?

- The main points to take away are:
  - Thick disc becomes apparent for the old metal poor stars
  - The majority of stars follow the trend expected for blurring, with (unsurprisingly) the eccentricities matching the velocities
  - At the metal-rich end, there is a hint of churning manifesting as an uptick in $v_\phi$ (with corresponding dip in eccentricity)
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Ages for populations

- Working with postdoc Emma Small, whose background is in modelling star formation histories using photometry

- Our approach is to models the whole population, rather than attempting to estimate individual ages

- We have applied this to the RAVE data with encouraging results

- Also important for probing chemical evolution of the Milky Way bulge beyond the reach of Gaia parallaxes
Summary

• LAMOST has a LOT of high quality spectra, with DR3 coming in the summer. There are caveats: radial velocity offset (Tian+ 2014) or incorrectly estimated errors (Schönrich+ 2017)

• We can estimate ages for large numbers of stars and the prospects for Gaia DR2 are immense

• We can unveil the complexities of the disc, understanding how the kinematic landscape has been shaped over time

• By confronting simulations with these results, we can better understand the processes at play and also uncover their limitations