Measuring V_{solar} with TGAS & RAVE

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Gaia

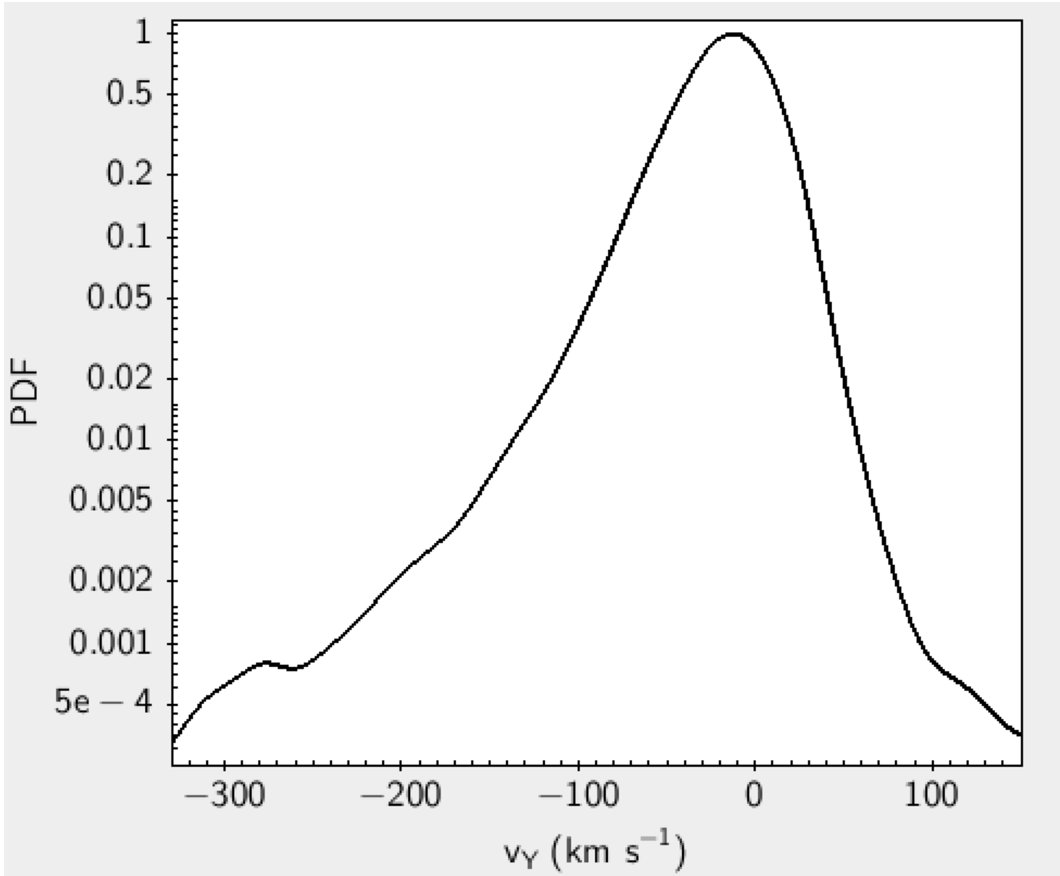
- Gaia DR1 released 14th September.
- Contains the TGAS catalogue, sky positions, parallaxes and proper motions in the solar neighbourhood for ~2 million stars.
- TGAS data calculated using ~30 year baseline from Tycho-2 catalogue.

Data Set

- TGAS provides a new window on dynamics in the solar neighbourhood.
- 3D motions available for over 200,000 stars in common between RAVE & TGAS.
- Can thus estimate (U,V,W) velocities.

Distribution of Tangential Velocities

- Shallow dip noticeable in the KDE (or histogram) of tangential velocities.
- Real effect, or noise?
- Appears to be roughly centred on the negative of the Solar motion.
- Why should there be a dip here?

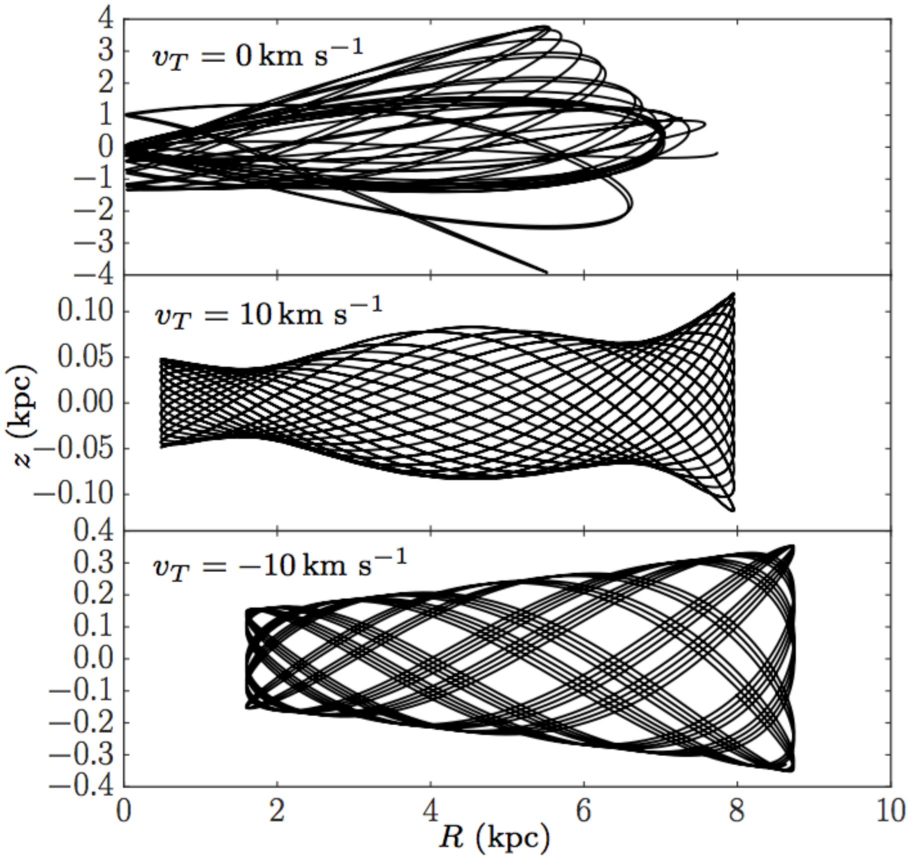


Potential Explanation

- Carlberg & Innanen (1987) predicted this feature.
- Stars with very low rotation and vertical velocity should plunge into the Galactic centre and get scattered to higher scale heights by the nuclear potential.
- These stars will then spend very little of their orbits near the Galactic plane, and are unlikely to be observed near the Sun.

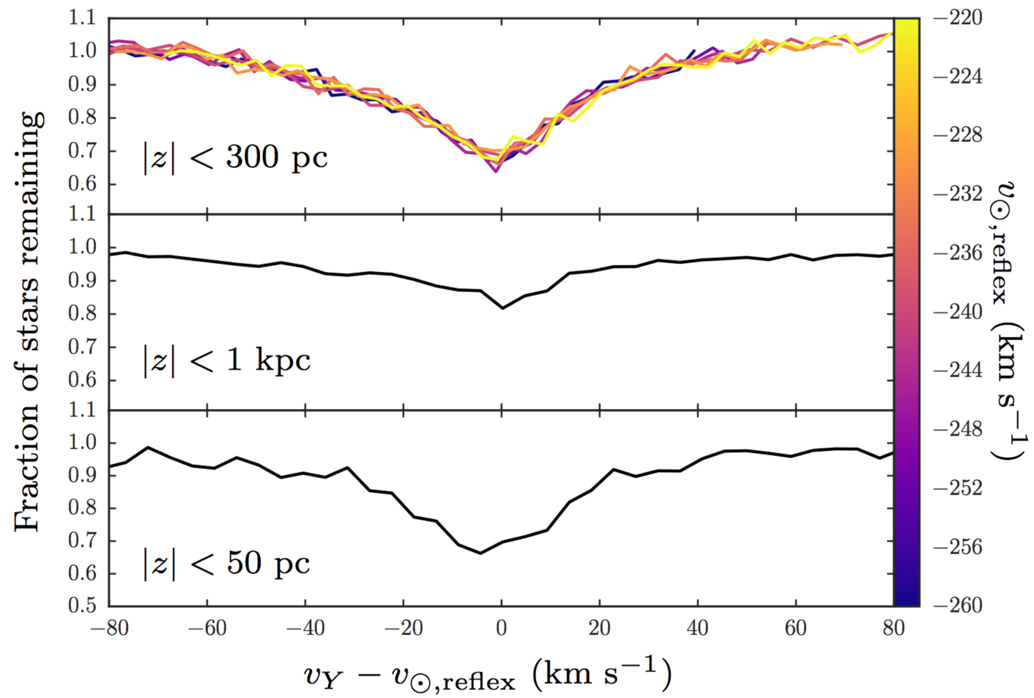
Simulated Orbits

- We injected test particles into a Milky Way like potential from GALPY (Bovy 2015).
- Example orbits close to v_T=0.
- Top panel shows an example orbit for a star which plunges into the Galactic nucleus and is scattered to a chaotic orbit.
- Lower panels show stars which retain their initial 'well behaved orbits'



Construction of a model function

- We ran simulations with different values of v_{solar}.
- We measured what fraction of stars remained on regular orbits for velocities near v_T=0.
- Profiles appear very similar (top panel)
- Lower panels show different criteria for 'orbits remaining near the disc plane'.



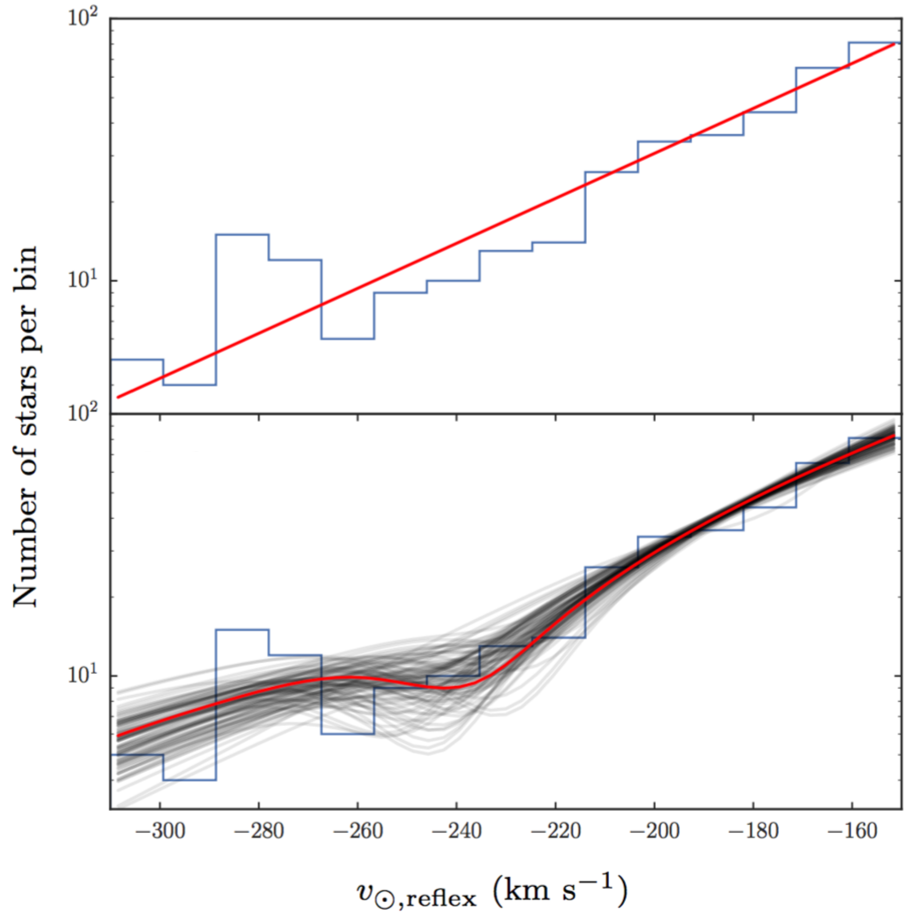
Fitting the data

- We fit an exponential, and one combined with the dip profile to the data by maximizing the likelihood.

- For the dip model we find a best fit value of -239 km s^{-1}.

- We the run MCMC to get uncertainties.

- We find v_{solar}=239 ± 9 km s^{-1}.



Summary

- This in turn gives R_0=7.9 kpc ± 0.3 kpc when combined with proper motion measurement of Sgr A*.
- We find that the dip is present at a likelihood of 2.7σ.

- But, we are fitting to low number counts, the feature does need to be confirmed in the next *Gaia* data release.
- If still observed, precision will be improved substantially (~1 km s^{-1}).
- At which point, systematics will become very important.