Stellar kinematics

What would we expect for:

Disk?

Bar?

Thick disk?

Halo?

What can we observe?

Reference frames

Any observation of kinematics taken from the Earth has to be corrected for its heliocentric motion

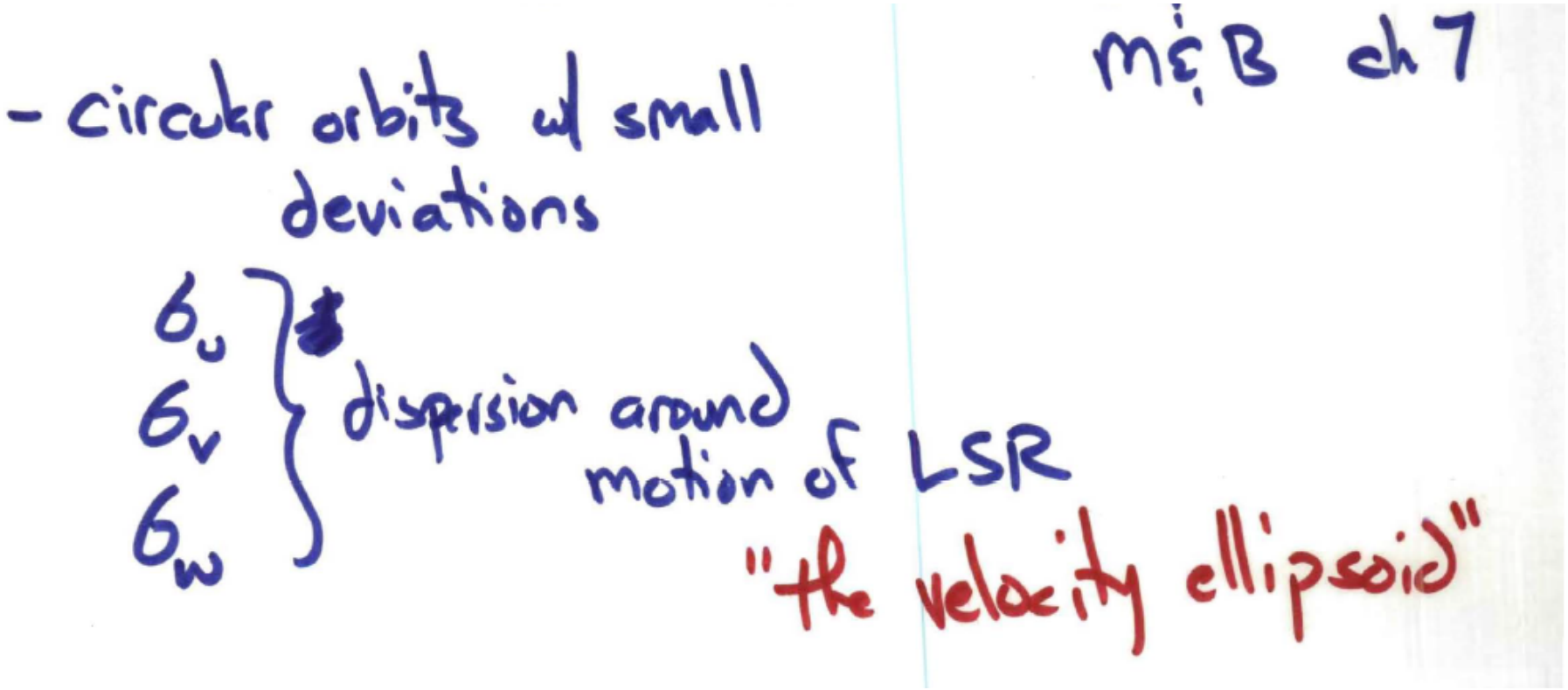
U, V and W are the components of a Sun-centered Cartesian reference frame

U (radial) is positive toward the galactic center

V (azimuthal) is positive toward the direction of galactic rotation

W (out of plane) is positive toward the NGP

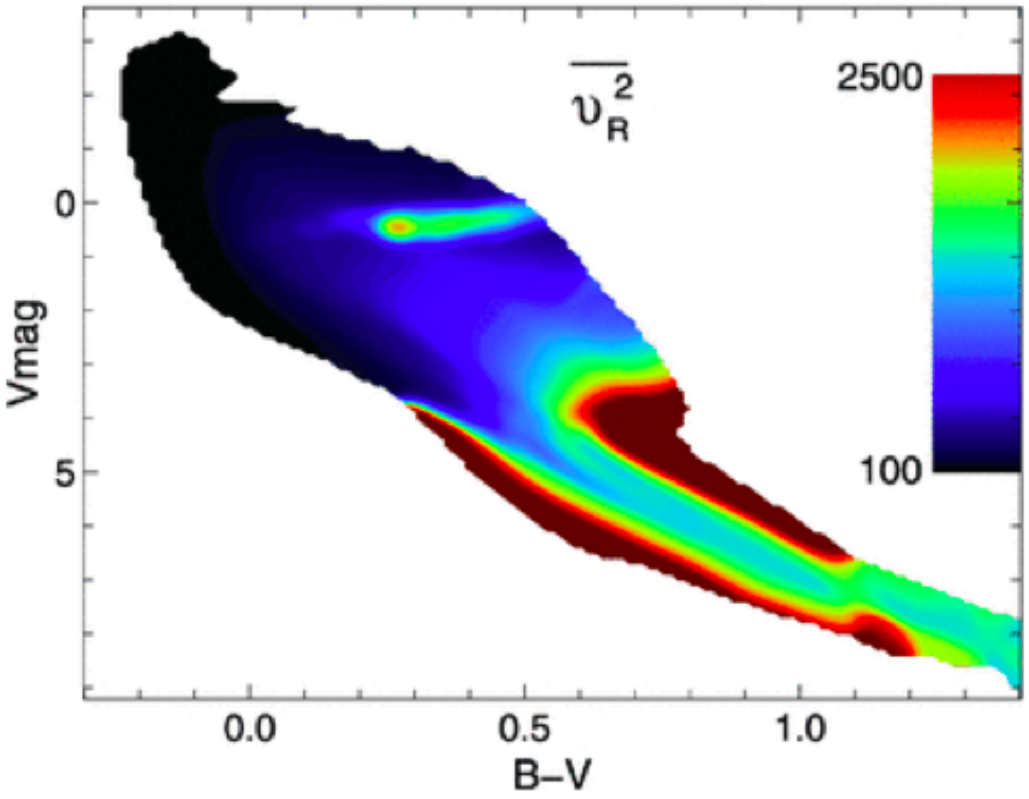
Thin disk kinematics



Disk kinematics

- velocity dispersion ↑ w/ mean age
- $\sigma_U > \sigma_V > \sigma_W$
- $\sigma_U \sim 2\sigma_W$
- young stars not in equilibrium

"vertex deviation"



From Schoenrich et al 2010: model prediction of variation of radial component of velocity dispersion with stellar absolute magnitude and color

Q: why do we see such a complex behavior?

Thick Disk

$\sigma_U \sim 60$ km/s
$\sigma_V \sim 40$ km/s
$\sigma_W \sim 40$ km/s

asymmetric drift ~ 30 km/s

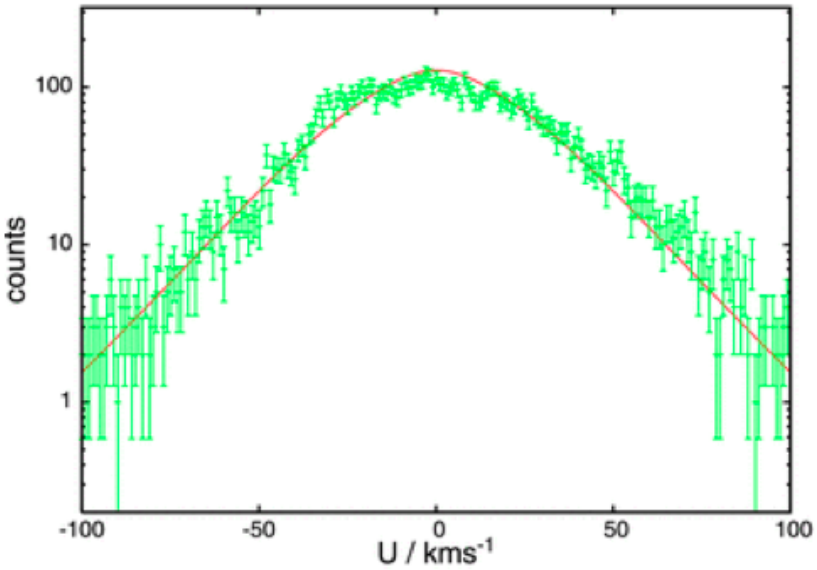
Local Standard of Rest

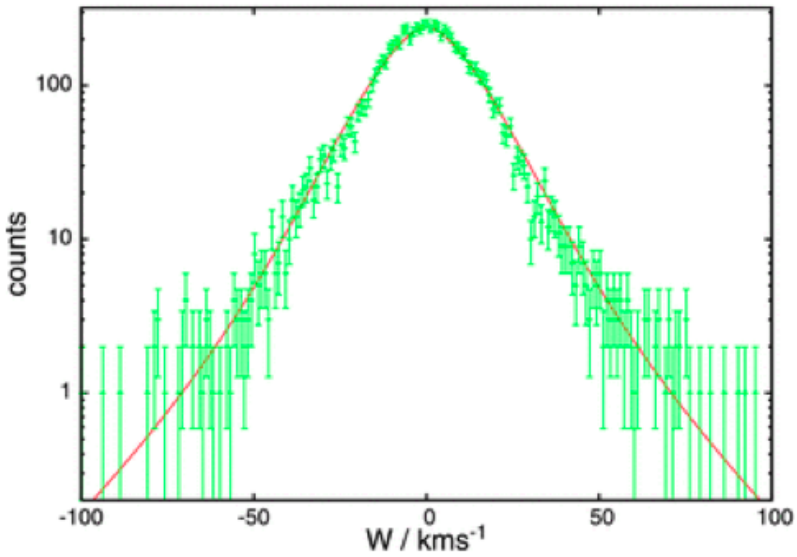
The LSR is a point at R_sun moving in a circular orbit about the galactic center

Q: how would you go about estimating the Sun's velocity with respect to the LSR?

Q: how would you go about estimating the Sun's velocity with respect to the LSR?

A: two components (U and W) are simple: average the velocities of nearby stars with respect to the Sun; U_sun and W_sun will be the reflex velocities





Schoenrich et al 2010, shifted by U_sun and W_sun

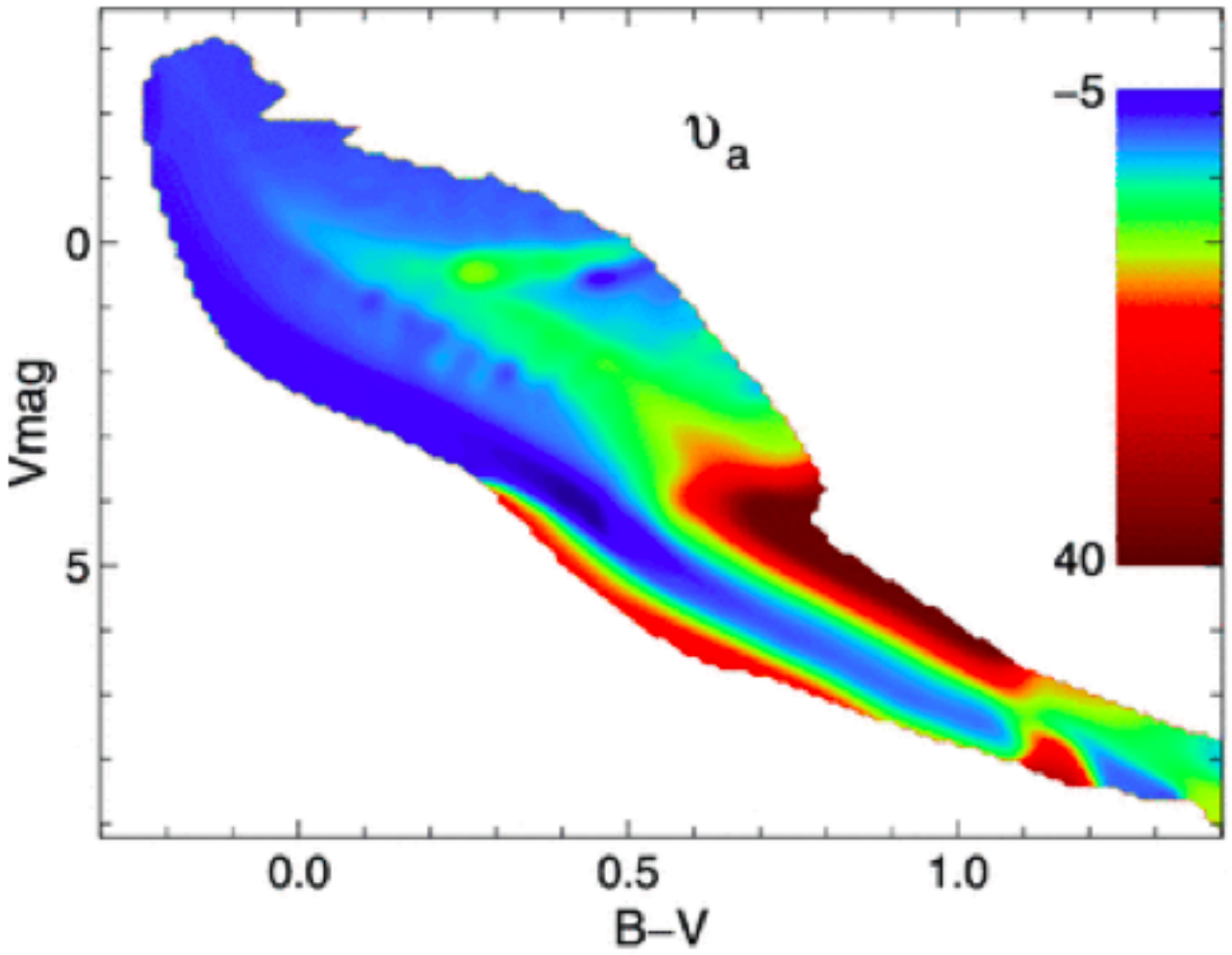
BUT:

Asymmetric Drift

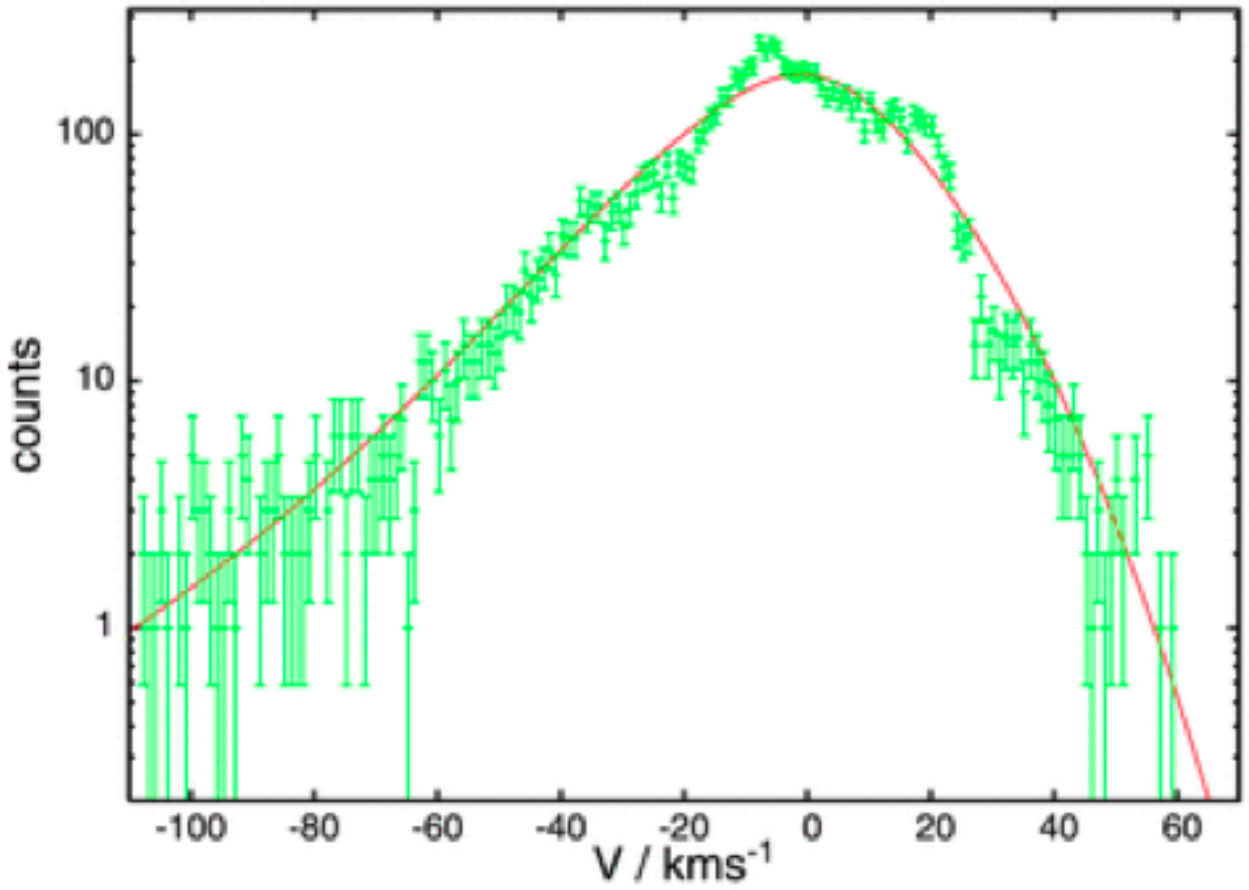
- stars tend to lag the LSR
- lag ↑ w/ ↑ σ/age
- drift velocity for old disk ~ 15 km/s

why?

- think orbits
- why <u>asymmetric</u>?



From Schoenrich et al 2010. Since ages of stars are difficult to measure directly we need to model their behavior to work out how the asymmetric drift will affect measurements of V_sun



Final values: Usun=11 km/s (toward GC)

Vsun=12 km/s (leads rotation)

Wsun= 7 km/s (toward NGP)

Measuring LSR velocity

Q: how would you go about measuring the velocity of the LSR, given that almost all of the nearby stars are moving with the LSR?

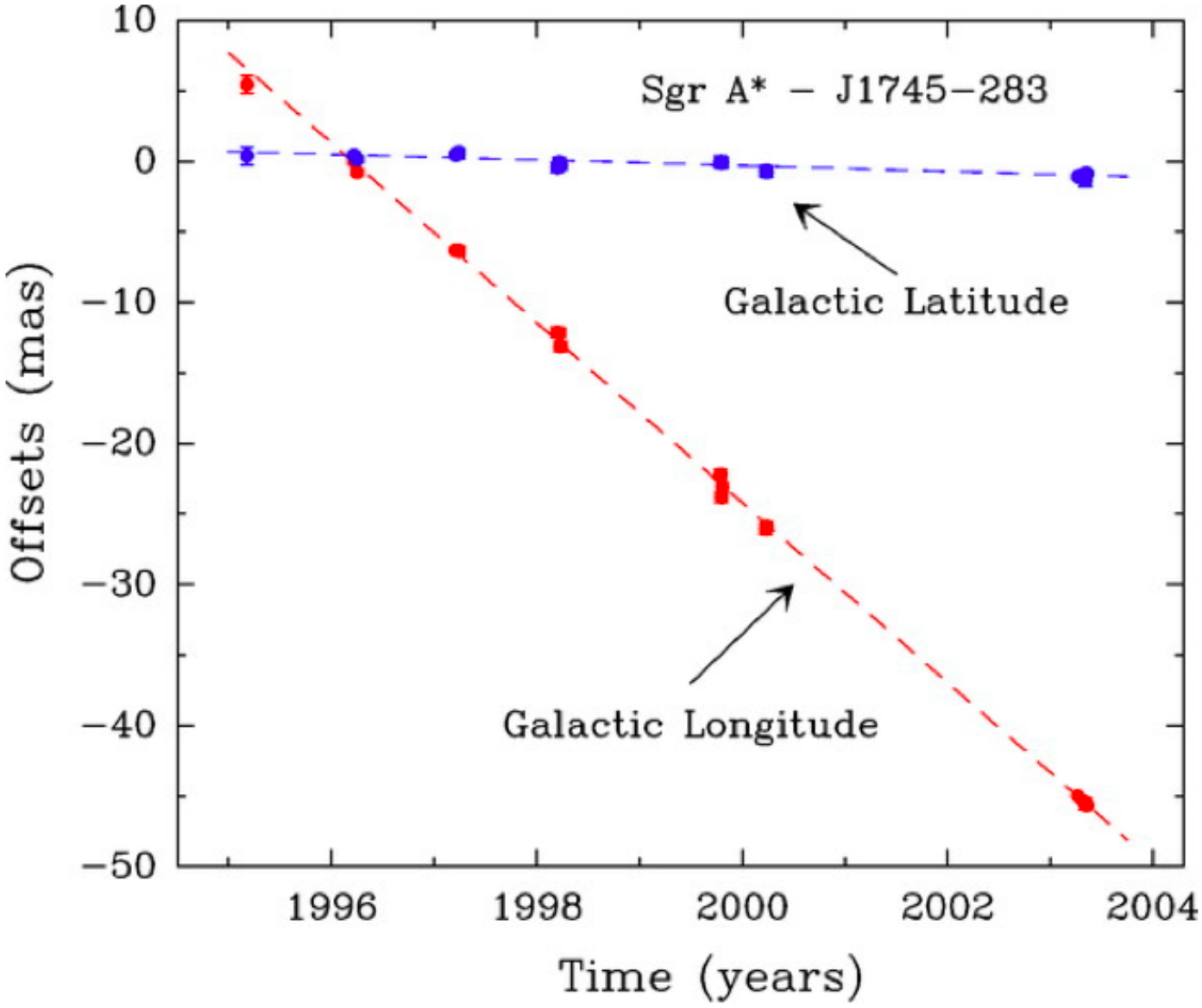
Measuring LSR velocity

Q: how would you go about measuring the velocity of the LSR, given that almost all of the nearby stars are moving with the LSR?

A: you will need an extragalactic reference frame, like that provided by radio galaxies or QSOs

Various groups have measured the proper motion of the black hole in the galactic center, Sgr A* …. After correcting for the Sun's V velocity, this will give us V_LSR=238 km/s (Schoenrich 2012)

Also need a value for the distance to the galactic center



Reid and Brunthaler 2004