Local Standard of Rest, Orbital Velocity of LSR

Local Standard of Rest

LSR is the point that is located today at the position of the sun and that moves along a perfectly circular orbit around the galactic center. The figure 1 given below gives a better understanding.

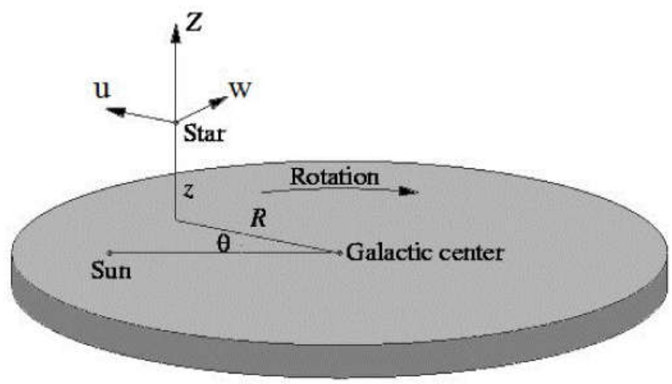

figure 1

where u = velocity in/out from center, v = tangential velocity and w = velocity up and down the galactic plane.

Now we define the velocity of stars relative to the LSR. For example, look at three hypothetical orbits as shown in figure 2:

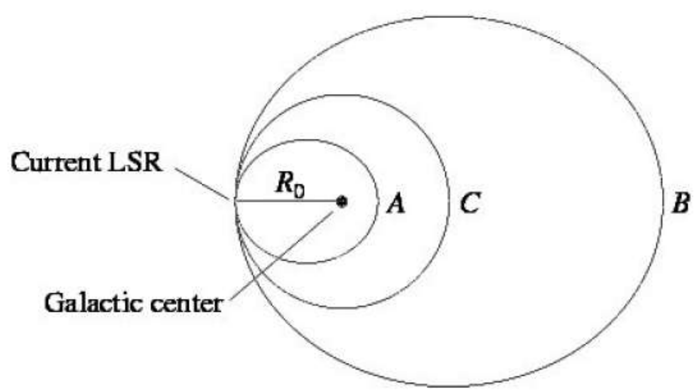

figure 2

- Star A lags the LSR (negative v velocity)
- Star B leads the LSR (positive v velocity)
- Star C has v=0

Sun's Motion Relative to the LSR

Look at all the disk stars around us, and measure their radial velocities (v_r) and proper motions (μ). Do this for lots of stars, and take the average along different lines of sight(figure 3).

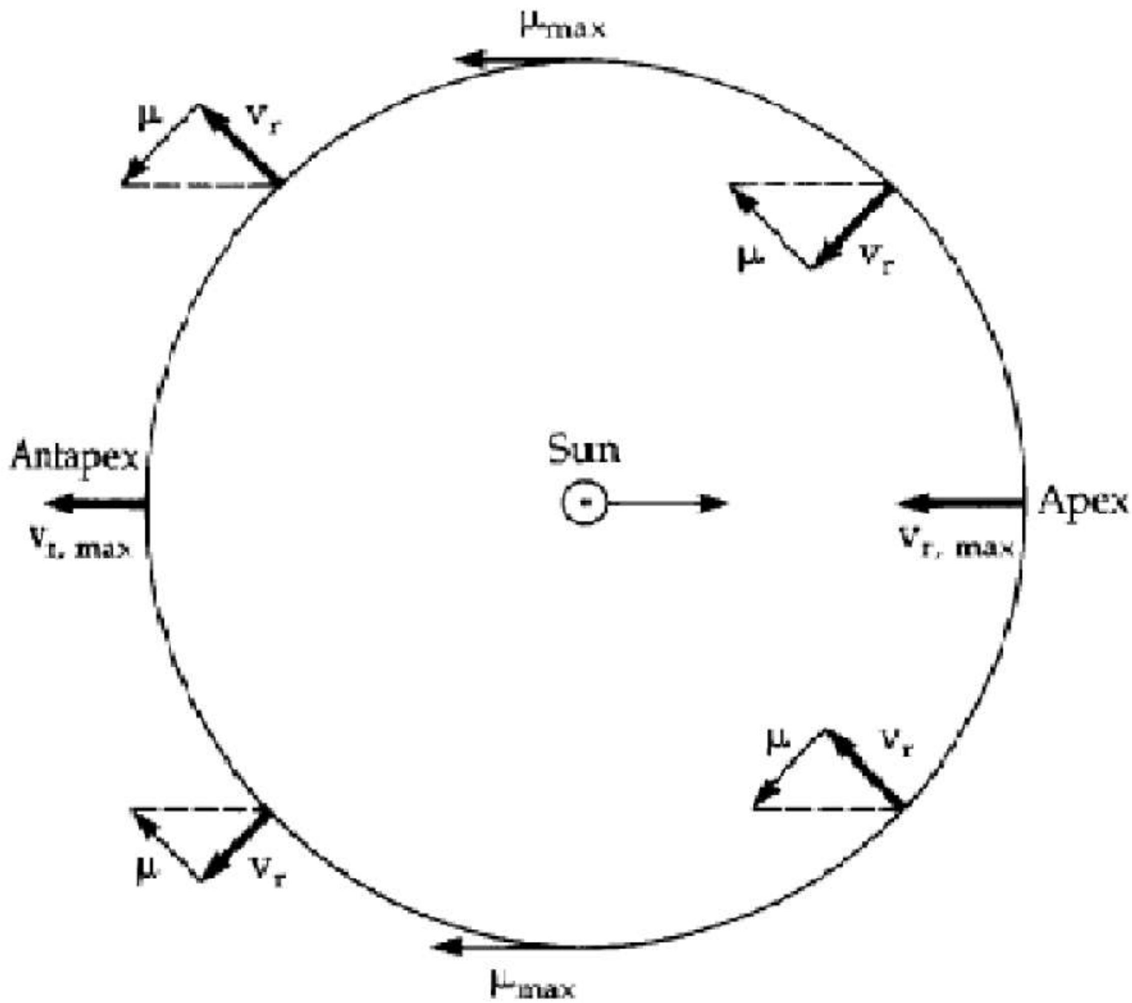

figure 3

- In fact, you should see that, on average, star move towards us in one direction and away from us in the opposite direction, due to the Sun's motion relative to these nearby stars.

- Stars statistically show a diverging pattern in the direction the Sun is traveling (solar apex) and a converging pattern in the opposite direction (solar antapex).
- The residual non-zero averages give us the Sun's peculiar motion: (-10, 5, 7) km/s.
- The solar apex lies in the direction l=53°, b=25∘(a point in theconstellation Hercules)

Asymmetric Drift and Velocity of LSR

Definition: The asymmetric drift is the difference of the local circular speed and the mean rotational speed of the stellar population(Can be described as a function of metallicity and age). Its the tendency of a population of stars to have mean rotation velocity around the galactic center that lags behind that of the Local Standard of Rest.

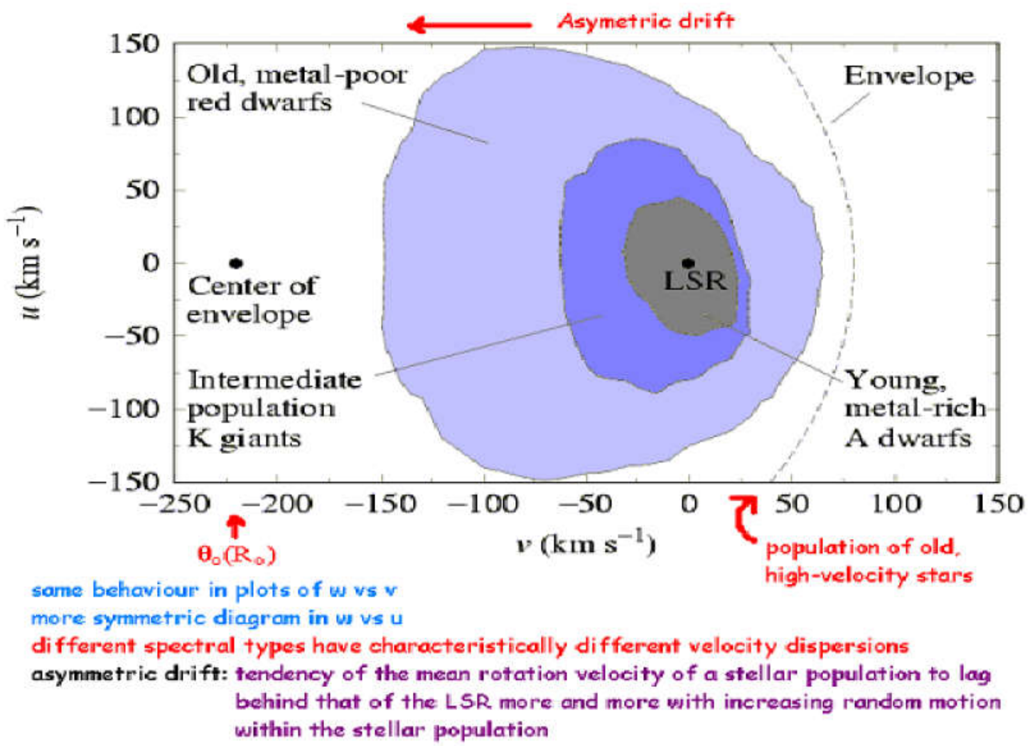

figure 4: schematic diagram of the peculiar velocity components u and v for stars in the solar neighborhood.

In this figure, LSR is located at (u, v) = (0, 0). Younger disk stars have their peculiar velocities centered on the LSR. To get the velocity of the LSR itself, one has to look at peculiar velocities of halo population of stars, since halo is not fast rotating. Halo is occupied by old metal-poor stars. Their velocity distribution is not centered on LSR, but is offset. The older the stellar population, higher is the offset from LSR.

- In general , it increases with random motion within the population, so that the older the population, the more negative the V velocity.
- Stars with small peculiar velocities do not drift away from the LSR quickly, implying that these young stars are members of the thin disk.
- If on average the stellar halo is rotating very slowly, then the orbital velocity of the LSR should reveal itself as a point of symmetry along the v-axis.
- This is because halo stars with no velocity component in the direction of Galactic rotation should exhibit peculiar v velocities that simply reflect the motion of the LSR.

$$V_{LSR} = V(R_0) = 220kms^{-1} \tag{1}$$