Astronomy 274: HW #3

Due date: Tuesday, February 22nd

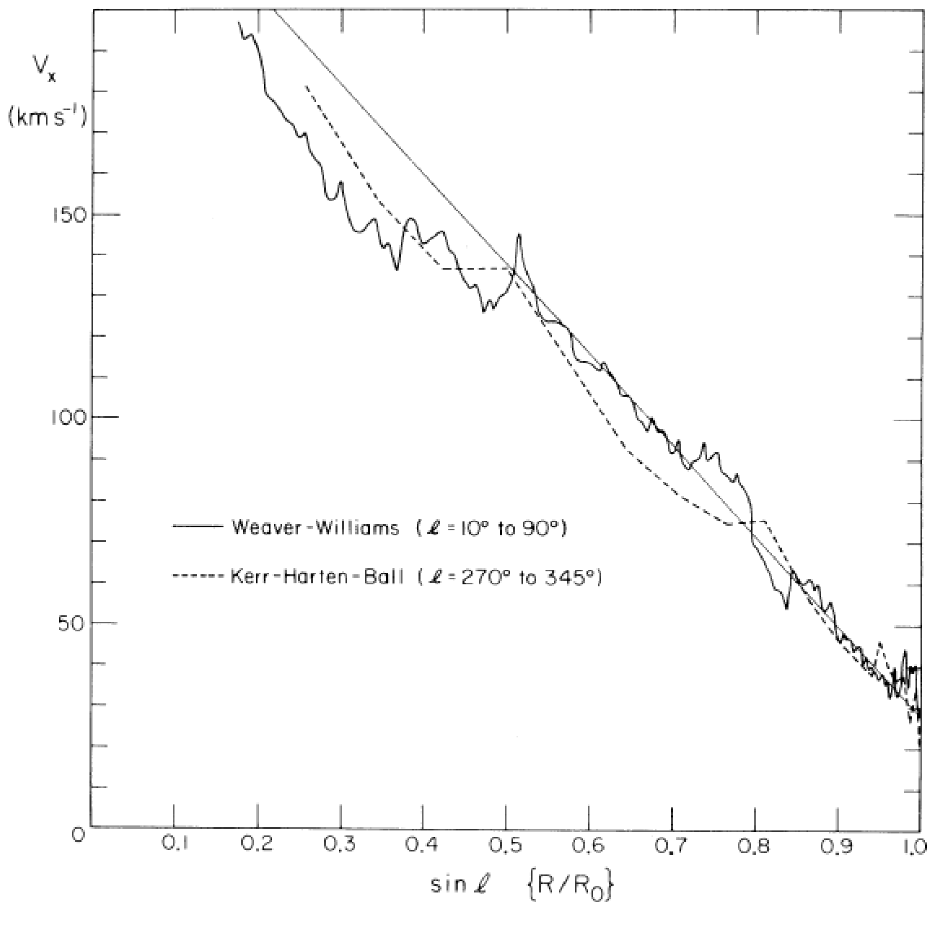
1. **Galaxy Rotation Curve**

   The figure below from Gunn et al. (1979) shows the tangent-point velocity versus longitude curve for HI 21-cm emission within the solar circle. For parts (**a**) and (**b**) below, you can assume that the circular velocity at the solar circle is $V_{c,\odot} = 220$ km s^{-1}, and $R_\odot = 8$ kpc.

   (**a**) Use the data in the figure to derive the rotation curve of the Galaxy, $V_c(R)$, at four Galactic radii in the range 3 kpc $\leq R <$ 8 kpc.

   (**b**) A pulsar at $l = 33°$, $b = 0°$ shows a 21-cm absorption line with radial velocity $v_r =$ 45 km s^{-1}. Compute a lower limit to its distance from Earth.

   (**c**) Convert the pulsar's Galactic coordinates to $J2000$ equatorial coordinates. Show your work (i.e., do not simply use an IRAF or IDL program to perform the conversion).



2. **The Oort Constants**

We can express the radial and tangential velocities for objects in the solar neighborhood at a Galactocentric radius, R, Galactic longitude, l, and a distance, d, from the Sun, as:

$$v_r \simeq \left(\frac{dV_c}{dR}|_{R_\odot} - \Omega_\odot \right) (R - R_\odot) \sin l$$

$$v_t \simeq \left(\frac{dV_c}{dR}|_{R_\odot} - \Omega_\odot \right) (R - R_\odot) \cos l - \Omega_\odot d$$

where $\frac{dV_c}{dR}|_{R_\odot}$ is the radial derivative of the Galactic rotation curve, evaluated at the solar circle ($R = R_\odot$), and $\Omega_\odot$ is the angular rotation velocity at the solar circle.

(**a**) Express $R_\odot$ in terms of R, in the limit that $d \ll R_\odot$ – i.e., the case of objects in the solar neighborhood.

(**b**) Given the standard definitions of the Oort A and B constants, derive the following expressions for v_r and v_t:

$$v_r \simeq Ad \sin 2l$$

$$v_t \simeq Ad \cos 2l + Bd$$

3. **The Stellar Initial Mass Function**

According to the Salpeter initial mass function (IMF), stars form according to the spectrum:

$$\xi(M) = \frac{dN}{dM} = N_0 M^{-2.35}$$

The standard mass range over which this spectrum applies is from $M_{min} = 0.1 M_\odot$ to $M_{max} = 100 M_\odot$.

(**a**) In a star-forming region described by a Salpeter IMF, what fraction of the stellar mass formed goes into stars of main-sequence type A, and more massive?

(**b**) The current star-formation rate in the Milky Way is estimated to be $SFR_{MW} = 2 M_\odot$ yr^{-1}. If stars are being formed according to the Salpeter IMF (over the mass range listed above), calculate the corresponding Type II supernova rate. Would you estimate a higher or lower Type II supernova rate if you instead assumed a Chabrier IMF?