# Astronomy 400B Lab 1

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January 28, 2020

## 1 Part A: Local Standard of Rest

The Proper motion of Sgr A* from Reid & Brunthaler 2004 $\mu = 6.379$ mas/yr

Peculiar motion of the sun, $v_\odot = 12.24$ km/s (Schonrich 2010)

$$v_{tan} = 4.74 \frac{\mu}{\text{mas/yr}} \frac{R_o}{\text{kpc}} = V_{LSR} + v_\odot \tag{1}$$

### 1.1

Create a function called VLSR to compute the local standard of res ($V_{LSR}$).

The function should take as input: the solar radius ($R_o$), the proper motion (mu) and the peculiar motion of the sun in the $v_\odot$ direction.

Compute $V_{LSR}$ using three different values $R_o$:

1. Water Maser Distance for the Sun : $R_o = 8.34$ kpc (Reid 2014 ApJ 783)
2. GRAVITY Collaboration Distance for the Sun: $R_o = 8.178$ kpc (Abuter+2019 A&A 625)
3. Value for Distance to Sun listed in Sparke & Gallagher : $R_o = 7.9$ kpc

### 1.2

Compute the orbital period of the sun using $R_o$ from the GRAVITY Collaboration (assume circular orbit)

Note that 1 km/s $\sim$ 1kpc/Gyr

### 1.3

Compute the number of rotations about the GC over the age of the universe (13.8 Gyr)

# 2 Dark Matter Profiles

## 2.1

Try out Fitting Rotation Curves:
http://wittman.physics.ucdavis.edu/Animations/RotationCurve/GalacticRotation.html

## 2.2

In the Isothermal Sphere model, what is the mass enclosed within the solar radius in units of $10^{10}$ $M_\odot$?

Where $G = 4.4988\text{e-}6$ $\text{kpc}^3/\text{Gyr}^2/M_\odot$

What about at 260 kpc (in units of $10^{12}$ $M_\odot$) ?

## 2.3

The Leo I satellite is one of the fastest moving Milky Way satellite galaxies we know.

Vtot = 196 km/s at a distance of 260 kpc (Sohn 2013 ApJ 768)

If we assume that Leo I is moving at the escape speed:

$$v_{esc}^2 = 2|\Phi| = 2\int G\frac{\rho(r)}{r}dV \tag{2}$$

and assuming the Milky Way is well modeled by a Hernquist Sphere with a scale radius of 30 kpc, what is the minimum mass of the Milky Way (in units of $10^{12}$ $M_\odot$) ?

How does this compare to estimates of the mass assuming the Isothermal Sphere model at 260 kpc (from your answer above)?