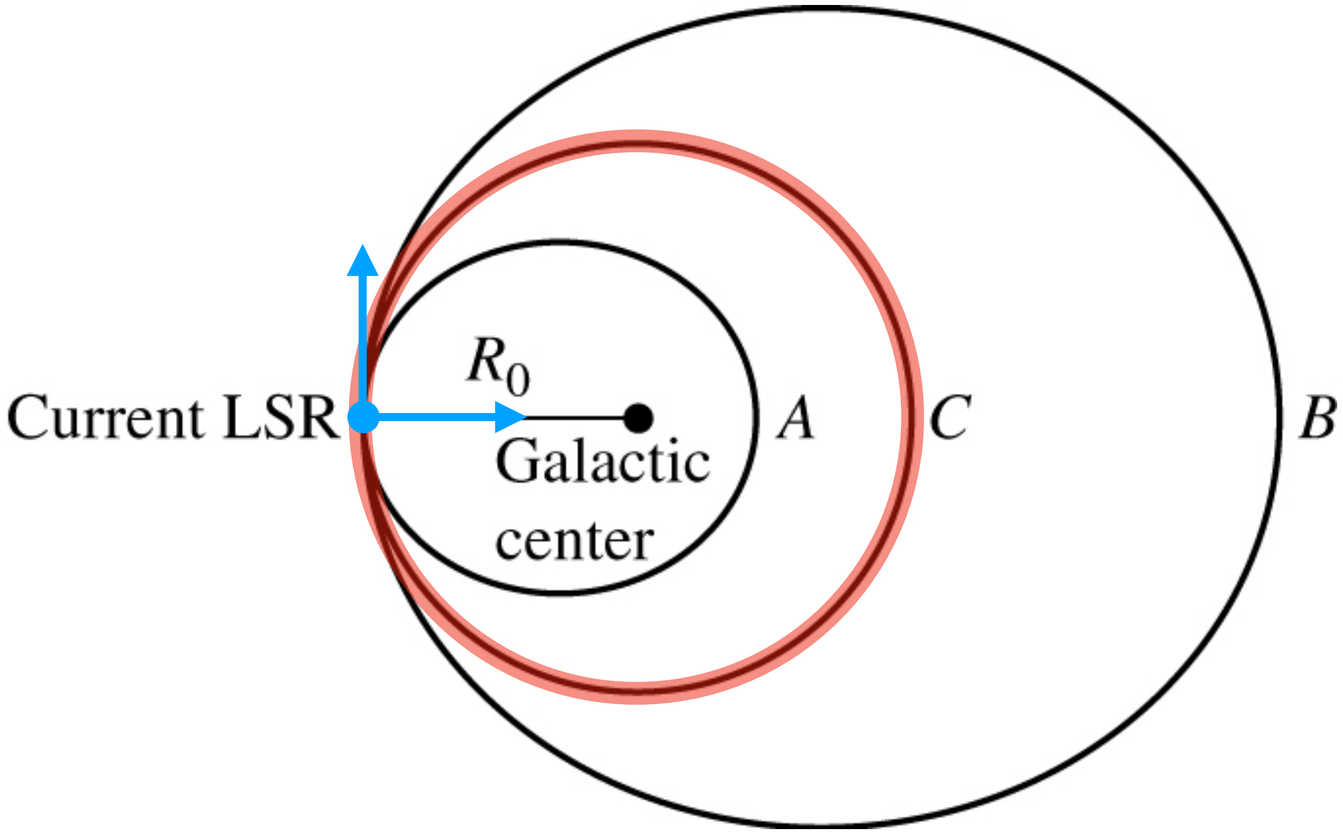


LSR definition

$$(\Pi, \Theta, Z) = (0, V_{circ}, 0)$$

What we really see…

$$(u, v, w) = (\Pi, \Theta - V_{circ}, Z)$$

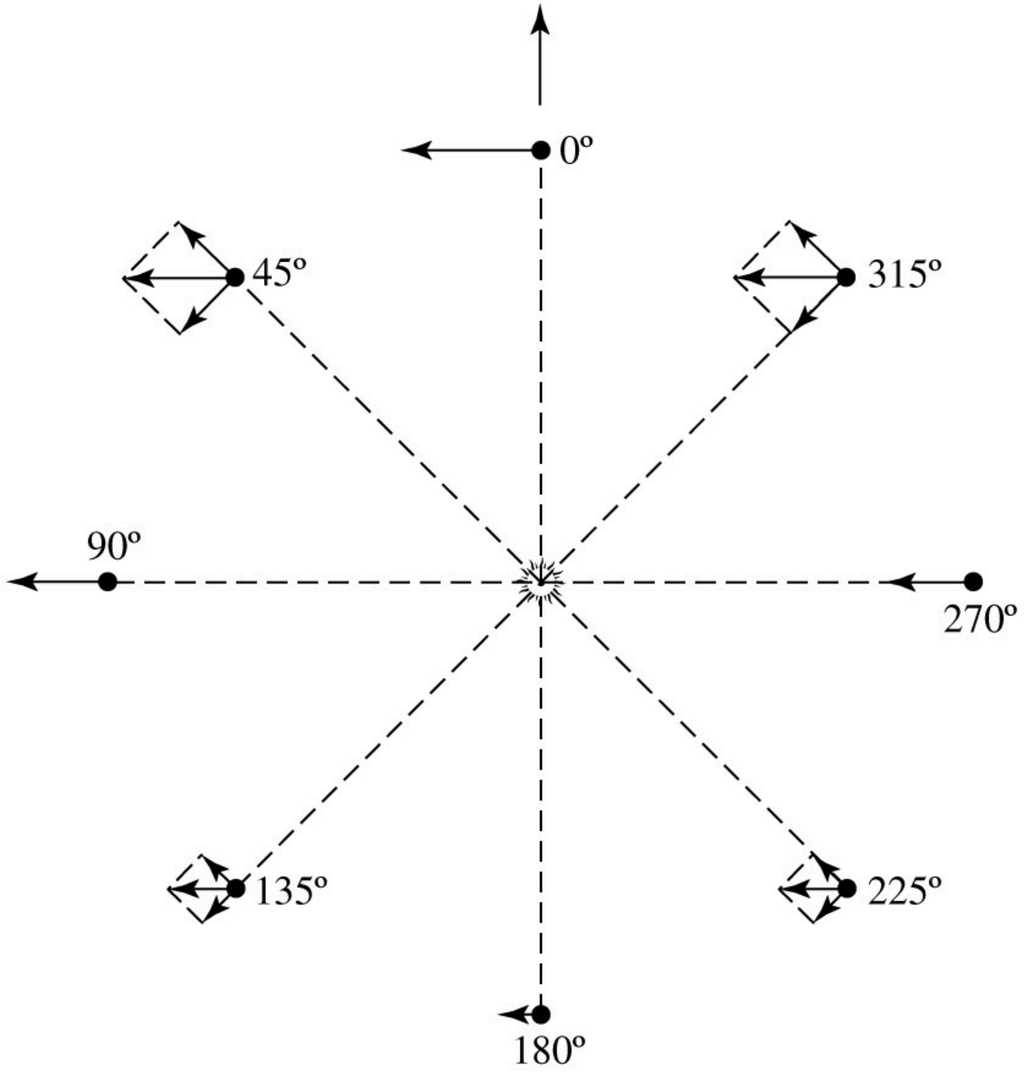
A: star at apogalacticon, ***v < 0***, “lag”

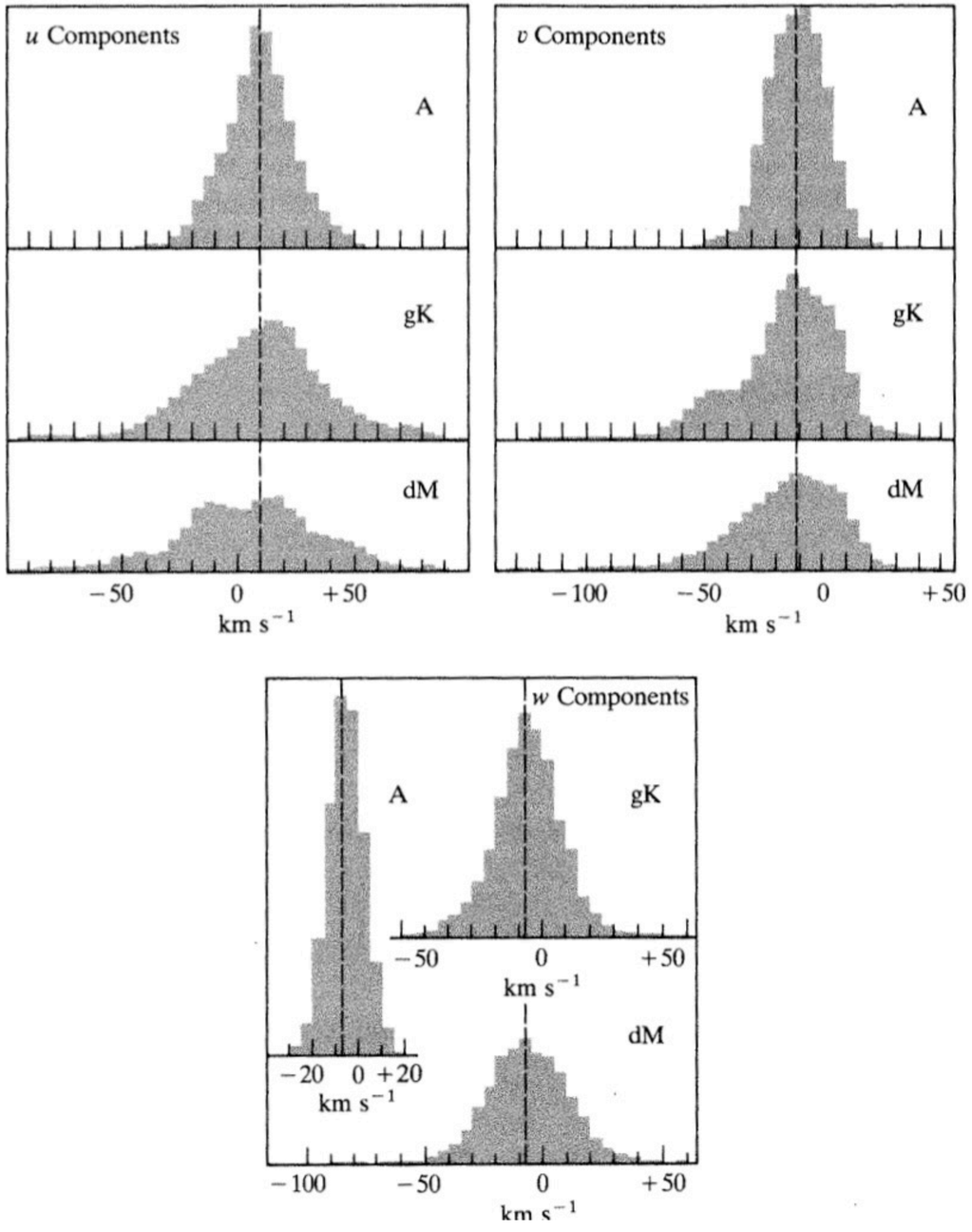
B: star at perigalacticon, ***v > 0***, “lead”

C: star on circular orbit = LSR, ***v = 0***

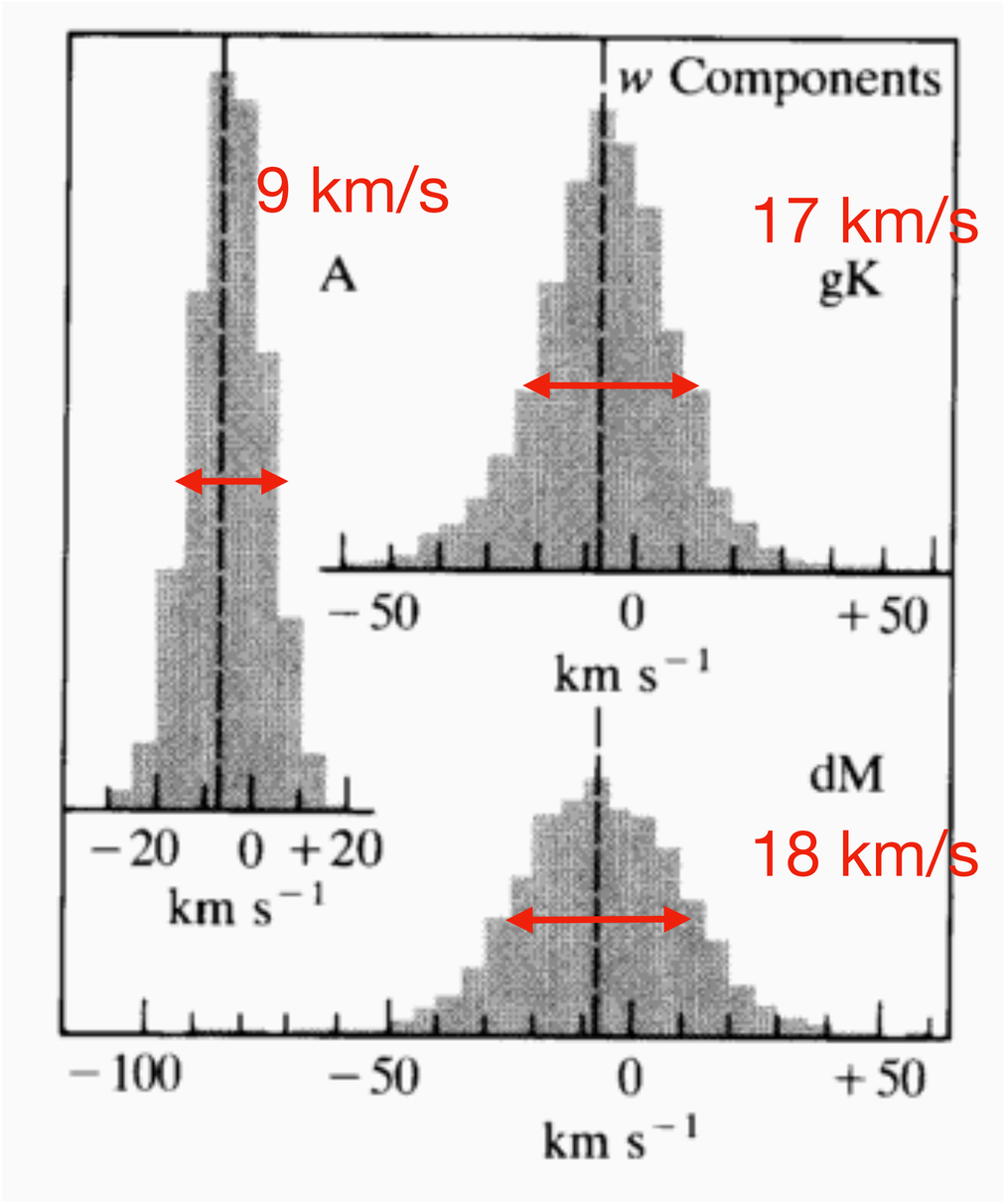
Sun : (*u, v, w*) = (-10, 5, 7) km/s

Wait, how do we measure this??


0°
45°
315°
90°
270°
135°
225°
180°


u Components
A
gK
dM
−50
0
+50
km s−1
v Components
A
gK
dM
−100
−50
0
+50
km s−1
w Components
A
gK
dM
−20
0
+20
km s−1
−50
0
+50
km s−1
−100
−50
0
+50
km s−1

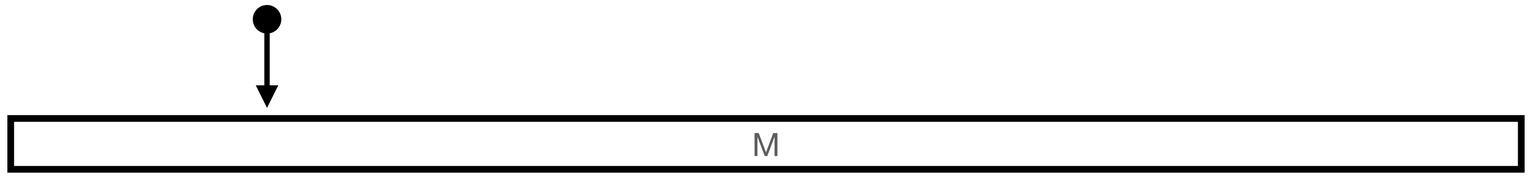
Look specifically at Z motion (*w* velocity)



width of distributions = “velocity dispersion” σ

Spectral Type	Dispersion (km/s)	Scale Height (pc)
B	6	60
A	9	120
K giant	17	270
M dwarf	18	350
white dwarf	25	500

Why do σ and z increase with spectral type?



balance KE with PE for a small mass orbiting a big mass

$$\frac{1}{2}mv^2 \sim \frac{GMm}{r}$$

$$v^2 \sim \frac{2GM}{r}$$

the big mass M is a disk and has a radius r and surface density Σ_0

$$M \sim \Sigma_0 \pi r^2 \qquad \Sigma_0 = (M_\odot/pc^2)$$

$$v^2 \sim 2\pi G \Sigma_0 r$$

extended to a group of stars

$$\sigma_z^2 \sim 2\pi G \Sigma_0 z_0$$

find surface density from scale heights and velocity dispersions

$$\Sigma_0 \sim 2\pi G \sigma_z^2 z_0$$

Oort Limit = 75 $M_\odot/pc^2$

Stars	30 $M_\odot/pc^2$
White dwarfs, neutron stars, black holes	5 $M_\odot/pc^2$
Brown Dwarfs	2 $M_\odot/pc^2$
Gas (HI + H2 + He + molecules)	13 $M_\odot/pc^2$
Total	**50 $M_\odot/pc^2$**

???

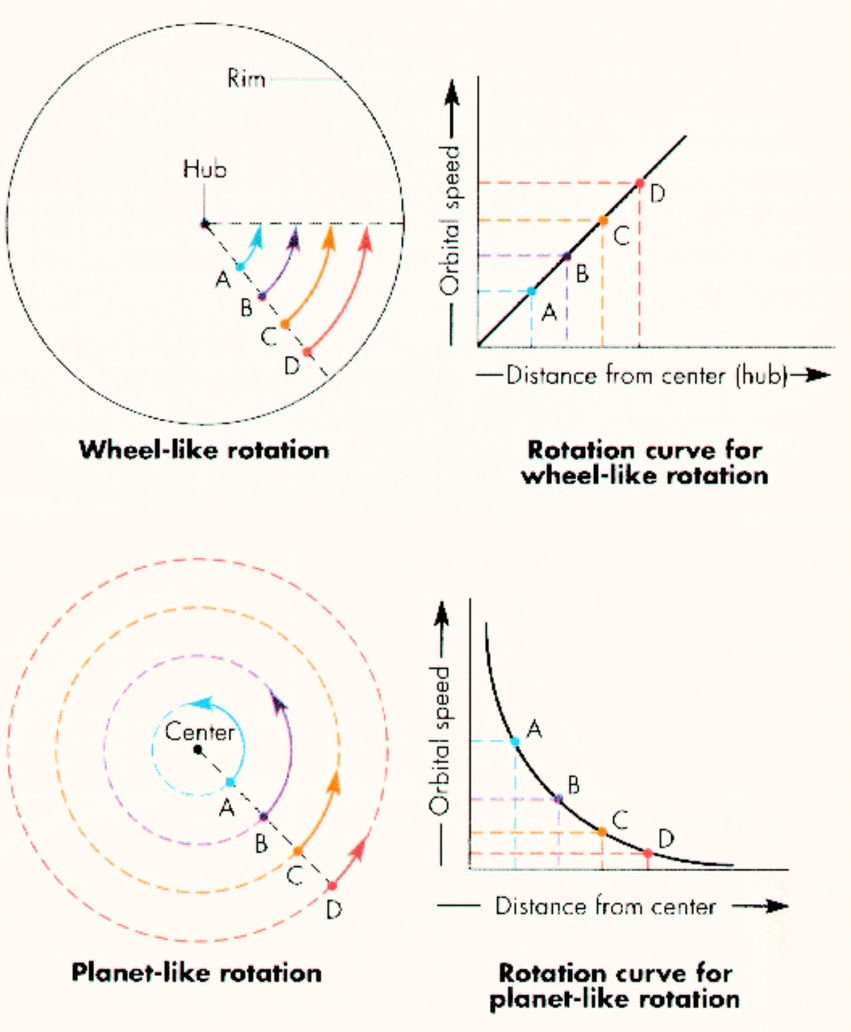
Rotation Curve

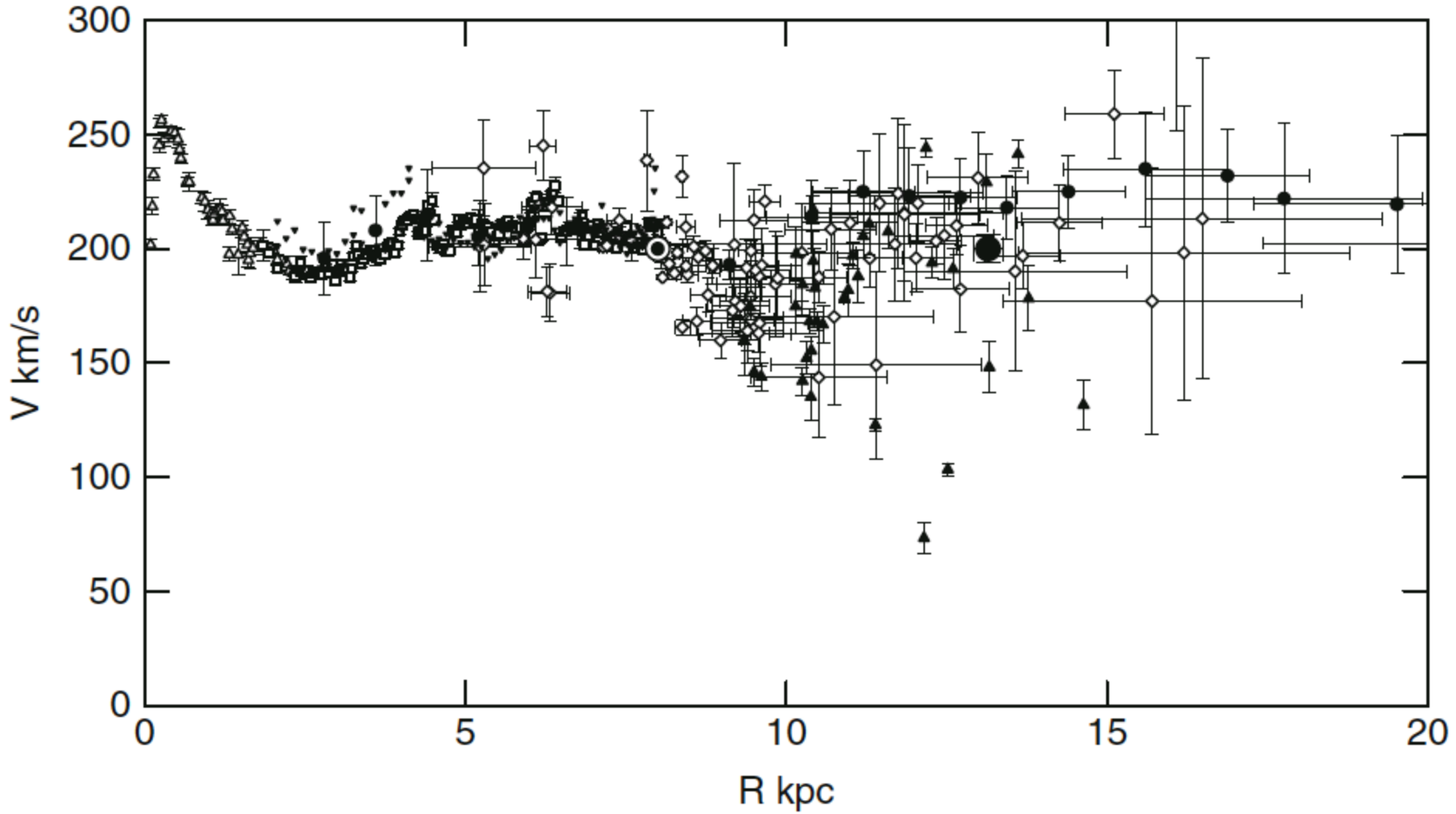
a plot of circular (tangential) velocity v. radius

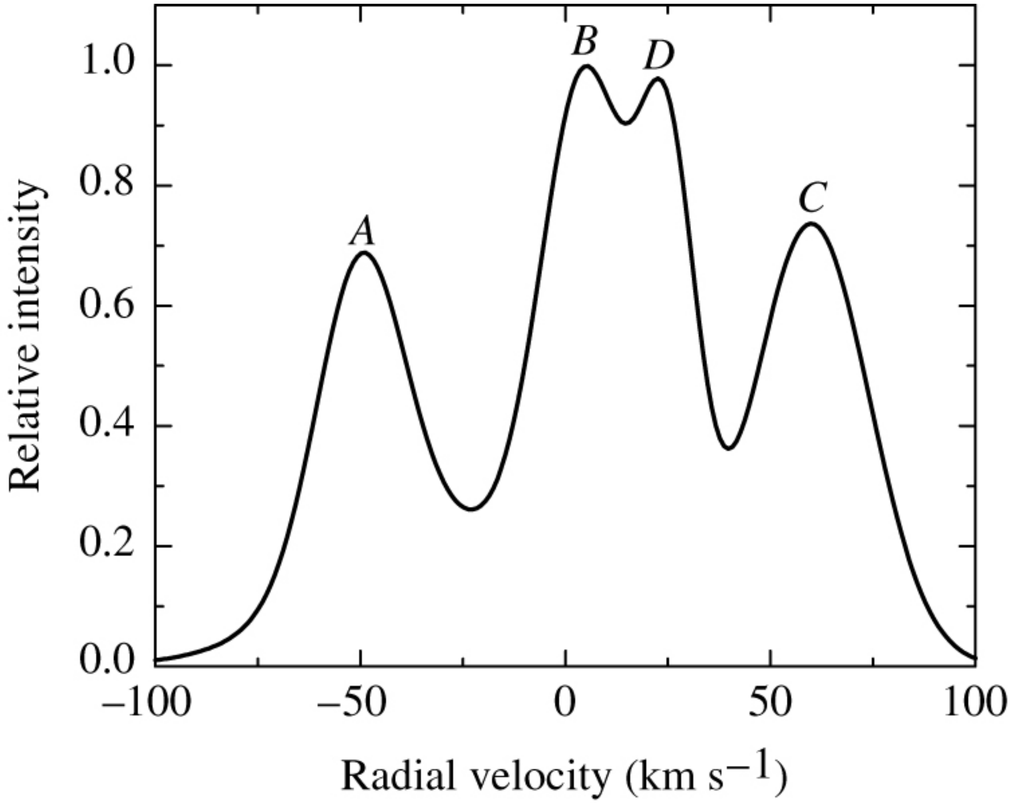
What does the rotation curve of a solid disk look like?

What does the rotation curve of the Solar System look like?

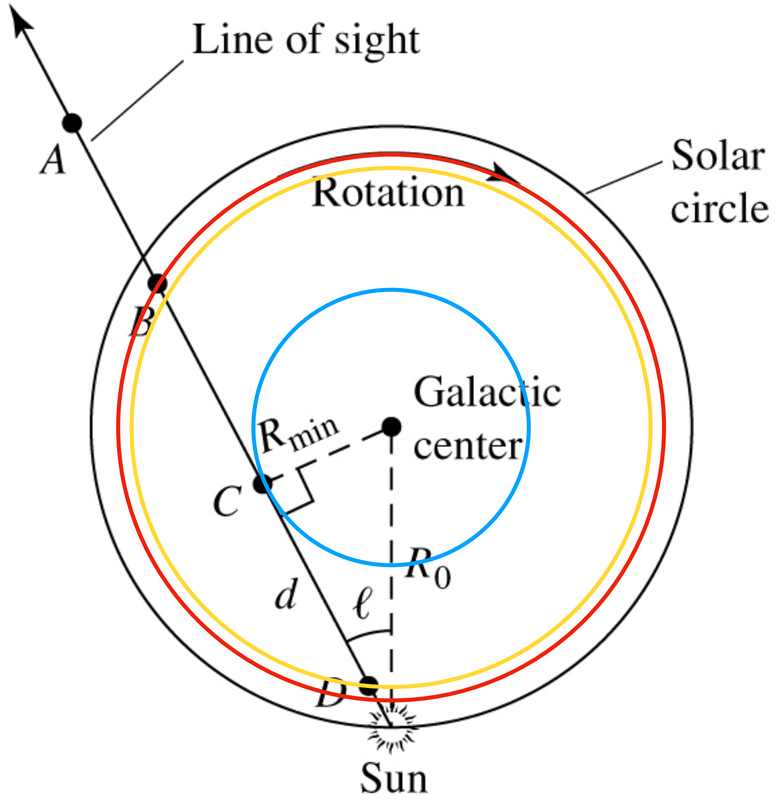
What do you expect the rotation curve of the Milky Way to look like?




300
250
200
150
100
50
0
V km/s
0
5
10
15
20
R kpc


Relative intensity
1.0
0.8
0.6
0.4
0.2
0.0
−100
−50
0
50
100
Radial velocity (km s^{-1})
A
B
D
C

(a)


Line of sight
A
Solar
circle
Rotation
B
Galactic
center
R_{min}
C
R_0
d
ℓ
D
Sun

(b)