(Astro)Physics 343 Lecture # 8: Green Bank trip; gas dynamics

This week's schedule

Monday – Wednesday: observations for lab # 4

Monday + Thursday: regular office hours

Wednesday: SPS talk at 8:00pm in Physics Lecture Hall

"Galaxy Formation and Transformation"

(before) Friday: email your preferences re Green Bank trip

for Monday: start thinking about topics for last lecture

Trip to Green Bank: 4/24-26

Friday, 4/24:

drive NJ → GB

Saturday, 4/25:

tours, observing session(s)

Sunday, 4/26:

drive GB → NJ

estimated driving time = 7-8 hrs

Observing at Green Bank: 40 ft telescope

Compared to SRT:

D = 12m, so area larger by factor 28.

Located in radio quiet zone, so less RFI.

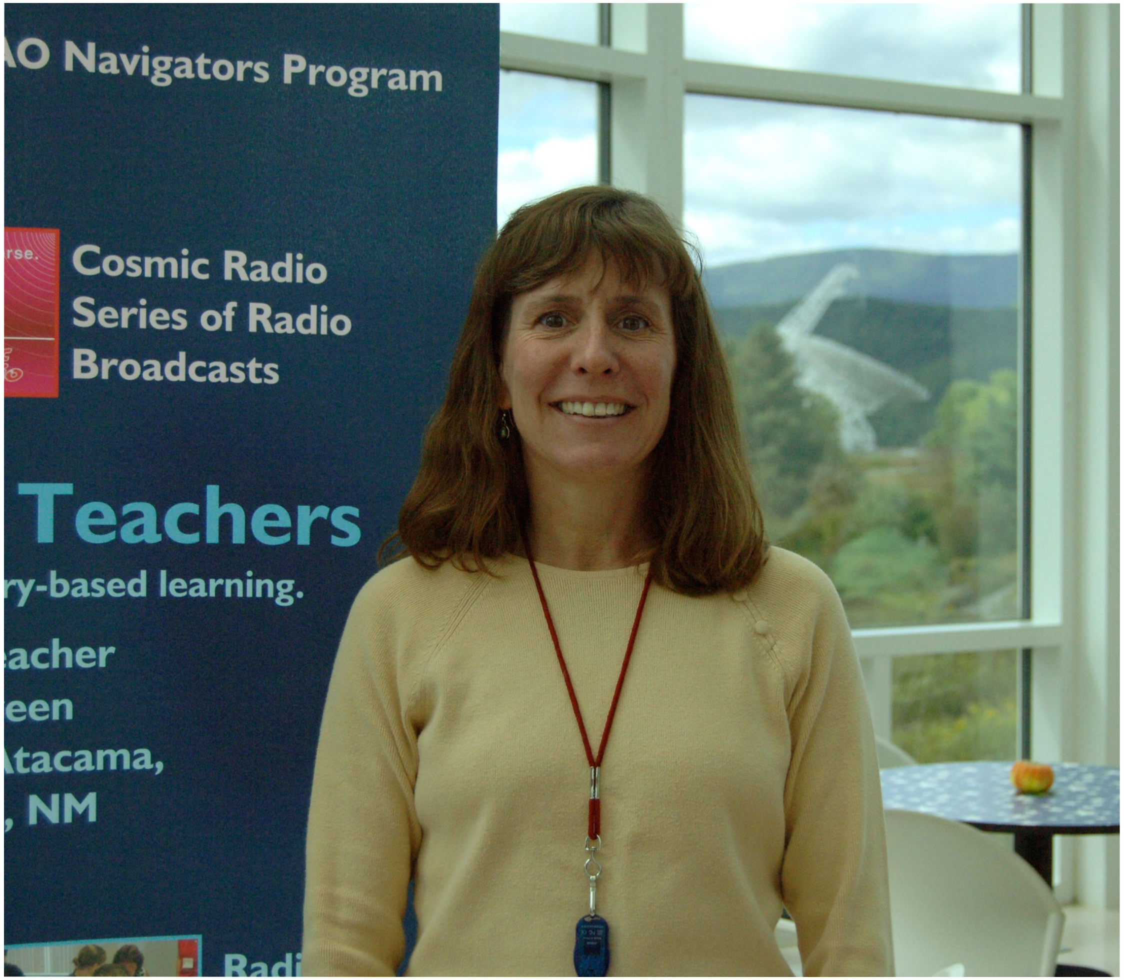
Transit telescope: doesn't track.

Data acquisition less automated.

Observing at Green Bank: instructor

Sue Ann Heatherly

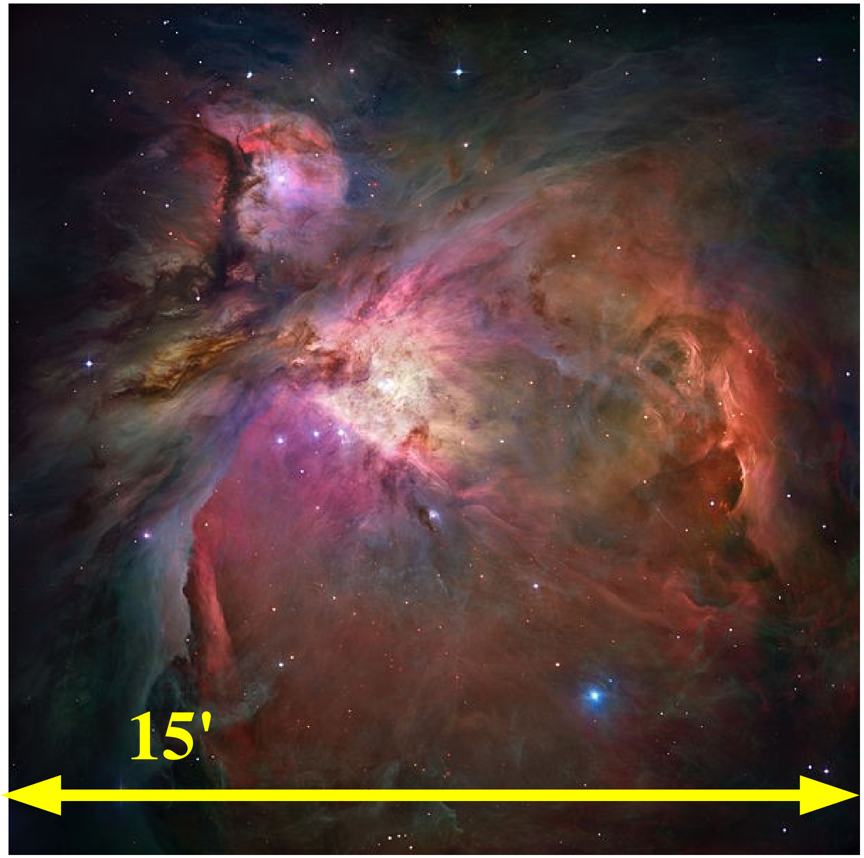
Education Officer, National Radio Astronomy Observatory



PI of a $892,000 grant from the National Science Foundation to involve teachers and students in the discovery of new pulsars.

Observing at Green Bank: target(s)

~4pm EDT: Orion Nebula (500 pc)



***Hubble Space Telescope* (optical)**

optional:

~5am EDT: Galactic Center (8 kpc)

***Spitzer Space Telescope* (infrared)**

Staying at Green Bank: instructors

two "chaperone" rooms

Staying at Green Bank: students

bunks in the two bunkrooms have hard plastic mattresses:

bring sheets or sleeping bags...

Staying at Green Bank: the rest of you

...and bring towels.

Staying at Green Bank: common area

For doing homework, lab analysis, etc. (internet access tricky: no wireless on the Green Bank site, and no cell phone service...).

What I need from you via email by Friday

(1) Do you plan to come on the trip?

(2) Do you need me to write a letter to a boss or teacher so that you will be able to participate?

(3) How early can you leave campus on Friday, and how late can you return on Sunday?

(4) Can you drive your own car (if necessary)?

(5) Do you have any special dietary constraints?

Gas dynamics: the Keplerian case

If an ensemble of gas clouds is distributed in a disk orbiting a single massive object with $M \gg m$, then for each cloud we can write

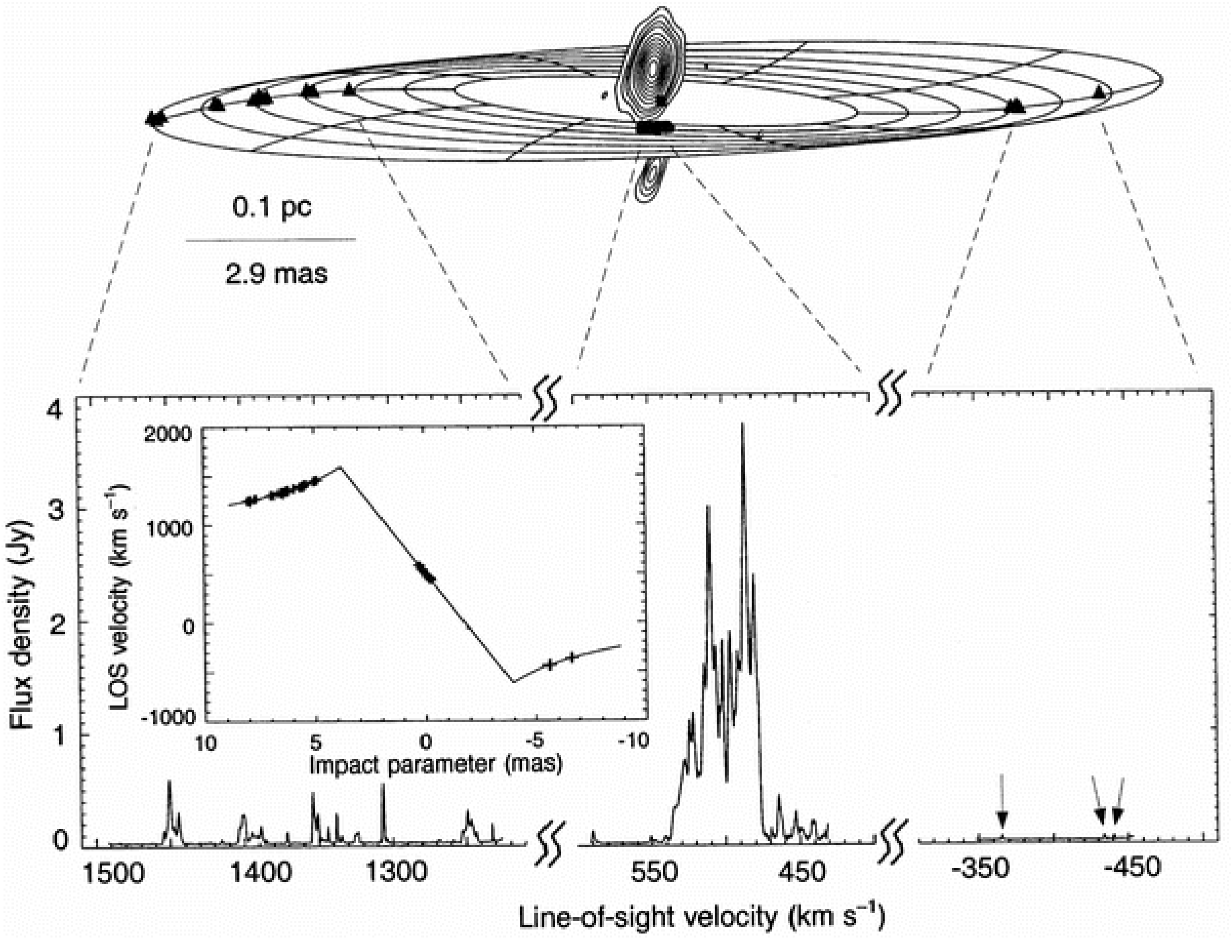
$$F = mv^2/R = GMm/R^2$$

$$v^2 R = GM$$

which is equivalent to Kepler's third law for $v = 2\pi R/T$.

Gas dynamics: a Keplerian example

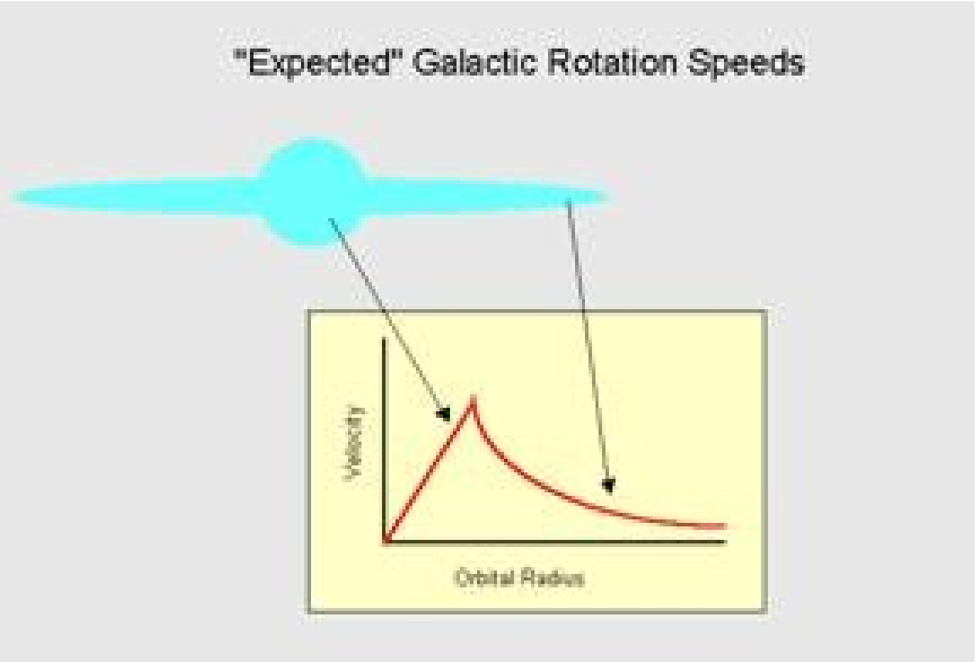
From Herrnstein et al. (1999): water masers tracing orbital motions around the central black hole in NGC4258.



Rotation curves in galaxies: expected

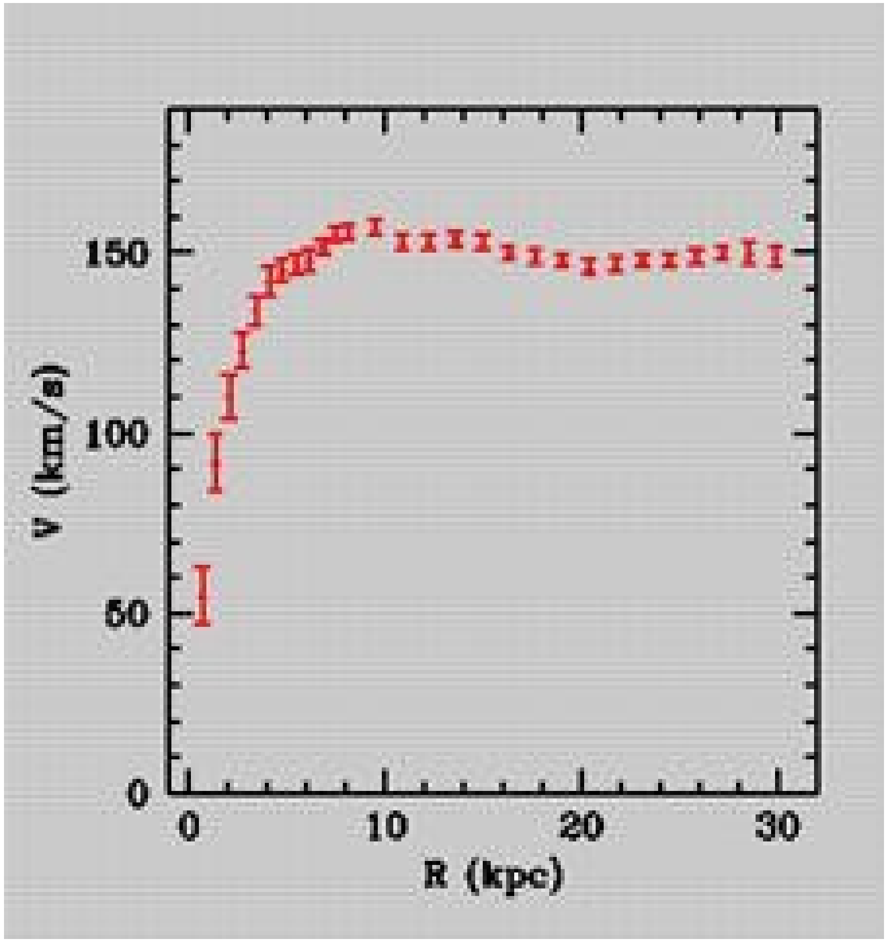
Rotation curves in galaxies are not Keplerian because we must replace M with the "interior mass" $M(<R)$ in the force equation... and $M(<R)$ is not constant as in the case of a central dominant mass.

What we expect, based on the central concentration of luminous matter (stars and gas):



Rotation curves in galaxies: observed

What we observe: flat rotation curves, implying the existence of additional non-luminous matter (i.e., dark matter).



A heretical alternative?

A few bold souls have pointed out that once can just as easily relax the assumption of a universal law of gravitation as the assumption that all matter is luminous.

The idea that gravity might behave differently at low values of acceleration is known as Modified Newtonian Dynamics (MOND). It works well in the context of spiral galaxy rotation curves, but not so well elsewhere.

Inclination and rotation curves

If a galaxy is inclined relative to our line of sight, where

i = 90 means edge-on

i = 0 means face on

then the observed line of sight velocity is related to the intrinsic rotation velocity by $v_{obs} = v_{rot} \sin i$ if we make the assumption of azimuthal symmetry.

Quiz