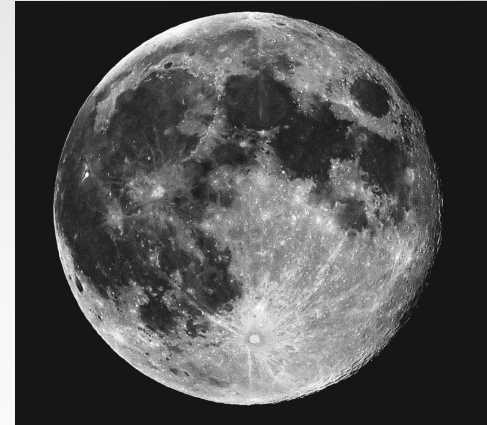# Angles and Astronomy

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# Measuring Angles

- Fist at arms length:

  10 degrees

- Finger:

  1 degree

- Full Moon:

  1/2 degree

- Hubble Ultra Deep Field:

  1/20 degree

What is a galaxy anyway?

# Activity: angular size and distance

- The size that someone or something appears to be is measured as an angle.

- Find a partner a different height from yourself.

- Measure your partner's angular height at different distances.


- Predict: what trends do you expect?

# Discuss with your partner (handout)

1. What trends do you notice in the above apparent angular height measurements?

2. Did the actual heights change?

3. From your graph, predict the apparent angular height of your partner at a distance of 30 tiles (feet). Check your predictions by doing the measurement.

# Relationship between distance, size, and angular size

- What relationships did we notice in the activity?
  - The greater the distance, the ___smaller___ the angle.
  - This is a/an ___inverse___ relationship.
  - Assumption: ___we know the size of the object___ .

- If the distance to the object is large (compared to its size) we can use the small angle formula:

$$a = S/d$$

- If an object is 3 times farther away, it will look ___3 times smaller___ .
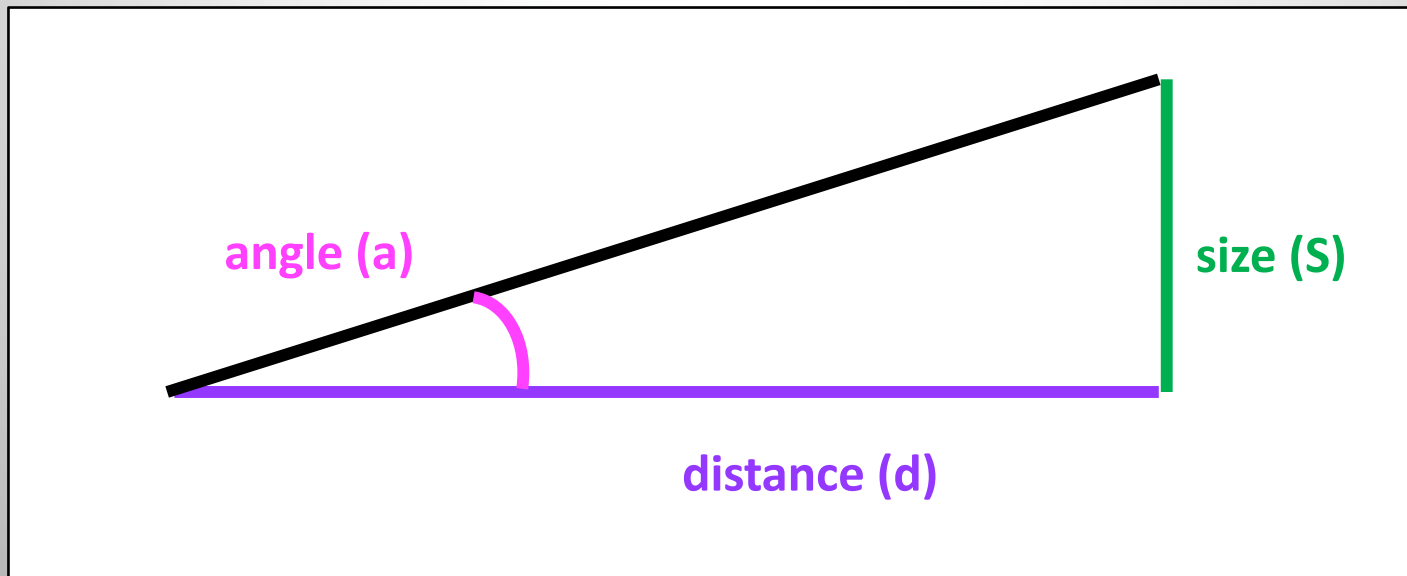
# Determining distance using triangles

If we know the size S and measure the angle a, we can calculate the distance d

tan (a) = S/d

tan (a) ~ a for small angles (large distances)

a = S/d

→ d = S/a

# Discuss with your partner (handout)

1. Suppose that you had a friend the same height as your lab partner. If you see them on the street, how would you figure out how far away they are using this method?

2. Suppose you used five different people at five different distances. How would this change your results?

3. Under what circumstances does this method work for measuring the distances to objects?

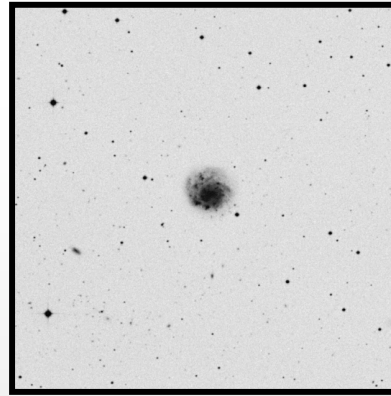# Galaxies

- Below are all large spiral galaxies of the same inherent size.
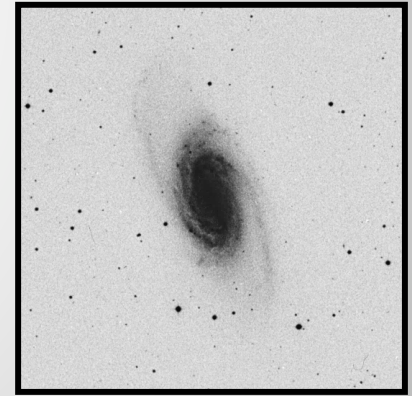
- Rank them by distance from closest to farthest:
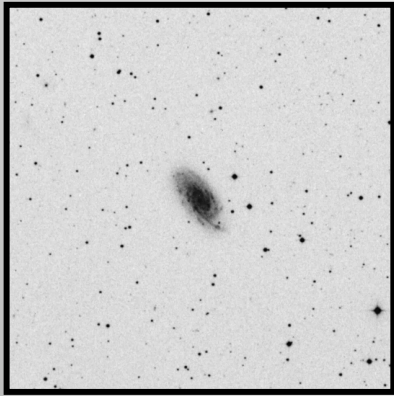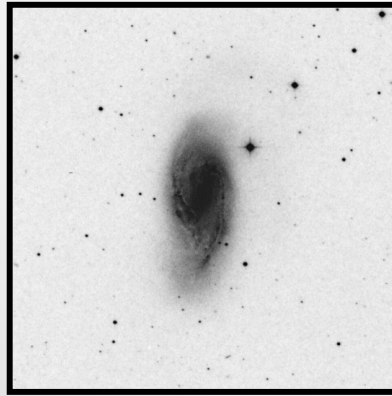


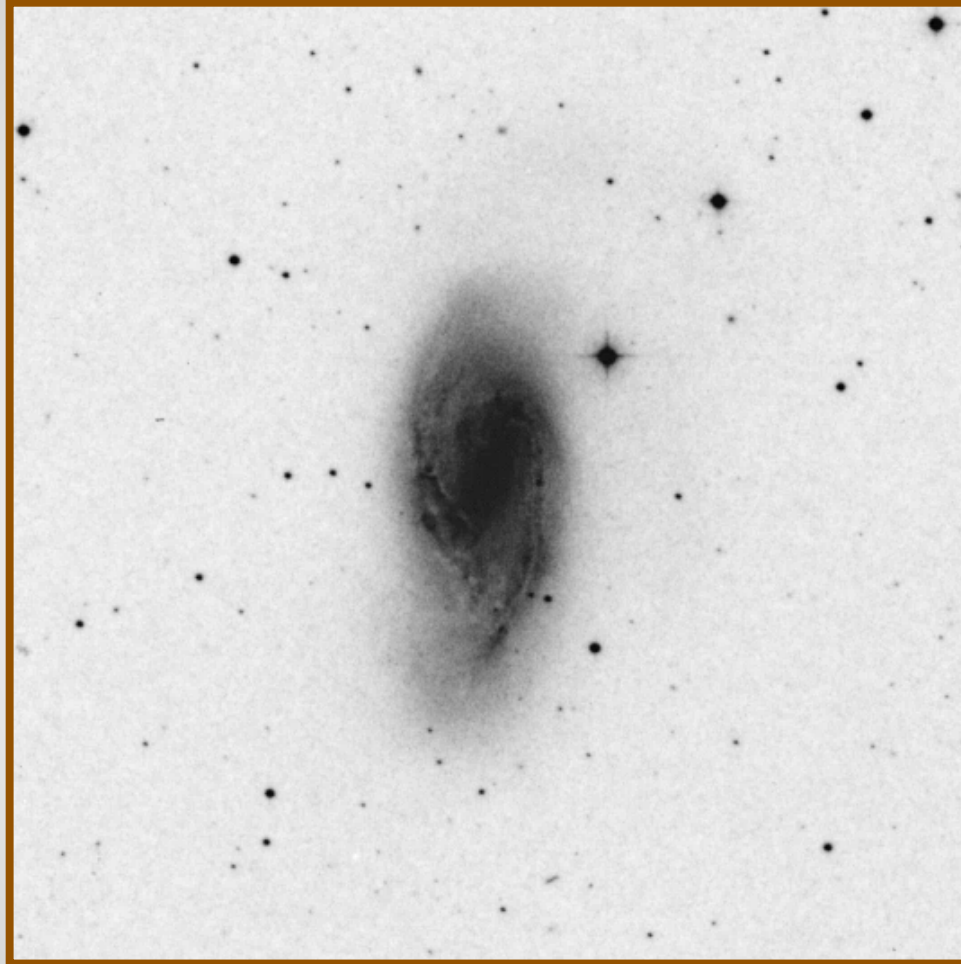A            B            C            D

# Distance to galaxies?

- What if I had different types of galaxies? Would this method work?

# Galaxy NGC 3627

- Pretend we are looking at this galaxy through a window.



- When you look out at the sky you can't tell the distance to an object, you only see it span a certain angle.

- Measure the angular size of galaxy NGC 3627.
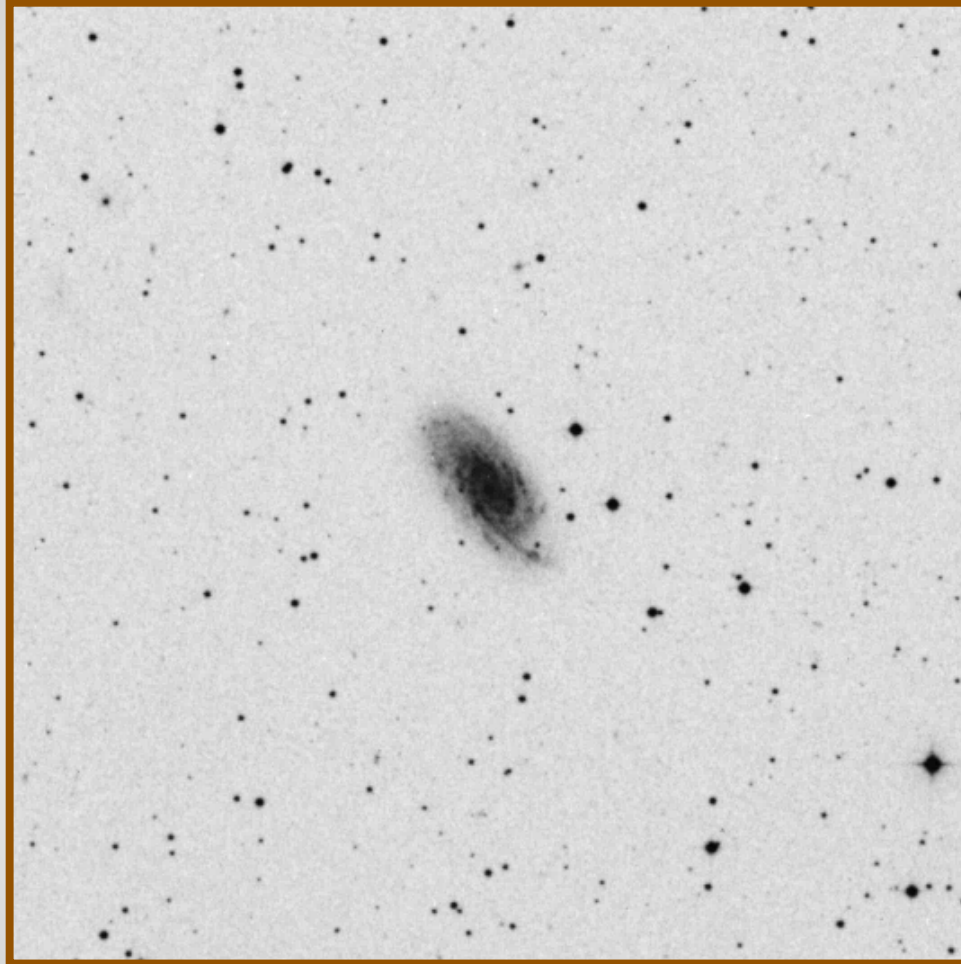
# Galaxy NGC 6643

- Pretend we are looking at this galaxy through a window.



- When you look out at the sky you can't tell the distance to an object, you only see it span a certain angle.

- Measure the angular size of galaxy NGC 6643.

# Finding the distance to a galaxy

- Galaxy NGC 3627 is 36 million light-years away.

- A light-year is ____6 trillion____ miles.

- Galaxy NGC 6643 is the same inherent size as NGC 3627.


- What is the distance to NGC 6643?

# Measurement accuracy and uncertainty

- Accuracy of your measurements with fist?

- Other influences?

- How might we improve upon this?

# Measuring astronomical distances

Can't go out with a tape measure —
have developed other methods:

- Standard Ruler: If we know how big an object is inherently, we can tell how far away it is, because the farther away something is, the _smaller_ it looks.

- Standard Candle: If we know how bright an object is inherently, we can tell how far away it is, because the farther away an object is, the _dimmer_ it looks.

- Parallax: Extension of depth perception.

# Distance ladder

- The chain of measurements that allows us to determine farther and farther distances: