

Dark Matter and Dark Energy

Pre-Class Questions

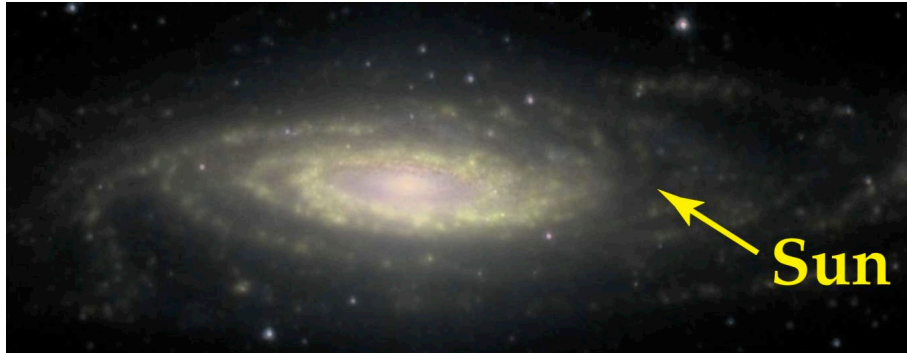
Problem Set (due next time)

Dark – 1, 2, 3, 4

Lecture Outline

1. Dark Matter and the Orbit of the Sun
2. Gravitational Lensing
3. Dark Energy and the Expansion of the Universe

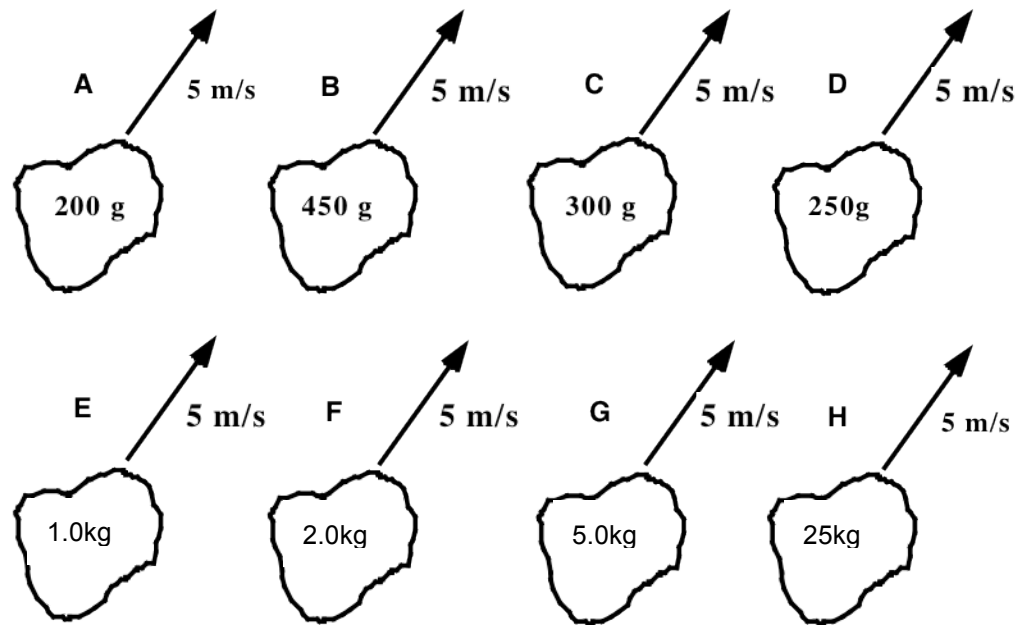




Example 1: We are 27,200 light-years from the center of the Milky Way that contains about 100 billion stars. Our best estimates indicate the sun is an average star and about half the stars in the galaxy are closer to the center than the sun. Find the orbital speed of the sun.

Shown below are eight rocks that have been thrown into the air. The rocks all have the same shape, but they have different masses. The rocks are all thrown at the same angle, height, and initial speed. The masses and speeds are given in the figures. Assume air resistance can be ignored.

Rank these rocks from greatest to least on the basis of the maximum heights they reach.

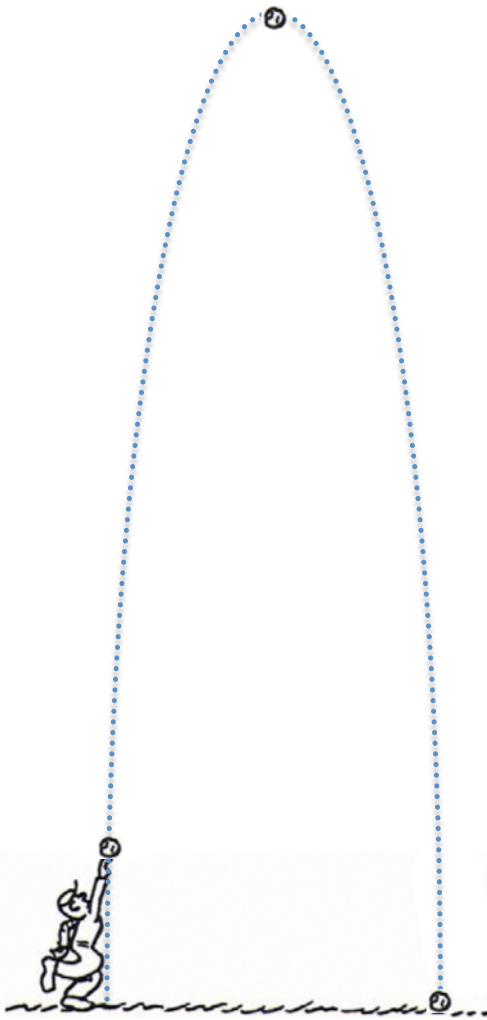


Highest 1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ 8 _____ Lowest

Or, all rocks reach the same height. _____

Please carefully explain your reasoning.



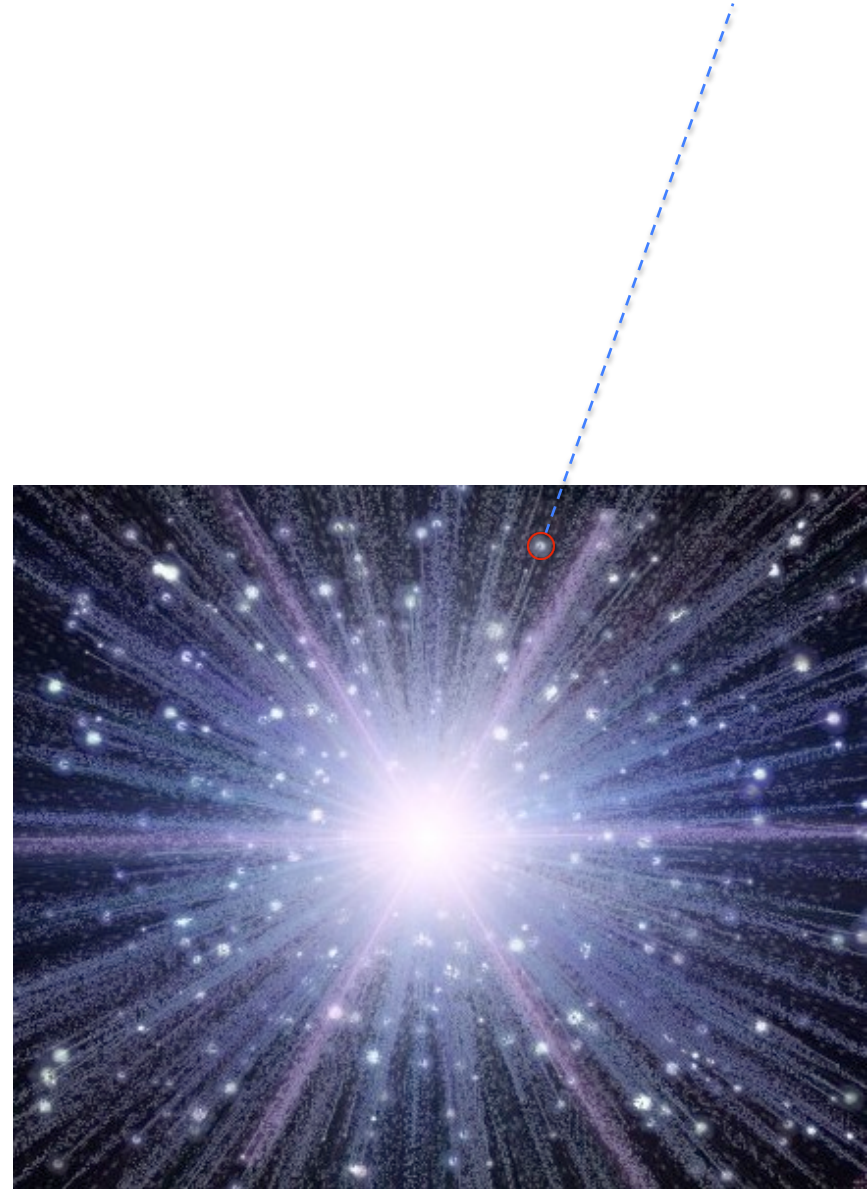


A baseball player throws a ball upward along the trajectory shown.

1. Draw three additional images of the ball on the way up. The images should be equally spaced in time.
2. Is the ball speeding up, slowing down or moving at a constant speed?
3. What is causing the ball to behave this way?
4. How does your sketch reflect your answer to part 2?

Here is an artist's conception of the Big Bang. The trajectory of the galaxy circled in red is shown.

1. Draw three additional images of the galaxy on the way out. The images should be equally spaced in time.
2. Is the galaxy speeding up, slowing down or moving at a constant speed?
3. What is causing the galaxy to behave this way?
4. How does your sketch reflect your answer to part 2?



Example 2: The most distant galaxies are about thirteen billion light-years away. Assume such a galaxy has the same mass as the Milky Way (100 billion stars) and that the universe contains about 10^{23} stars. On average each star has the mass of the sun. Estimate the minimum size of the mysterious force causing a distant galaxy to accelerate.

Lecture 15- Summary

Dark Matter is the name of the problem associated with the orbital motion of stars within a galaxy.

Evidence is from:

- The orbital motion of stars with galaxies
- Gravitational Lensing

Dark Matter is the name associated with the accelerating expansion of our universe.

