

**Part I: SNe Ia as Standard Candles**

1) Explain what measurements are needed to measure the distance and redshift to supernova Ia.

2) In his Nobel Prize acceptance speech, Adam Riess mentions that the distant supernova were a thousand times further away than nearby supernova, and thus a million times harder to observe. Explain this statement.

3) What are two types of corrections that were made to “standardize” SNe Ia as standard candles.

## Part II: Hubble Diagrams and Expanding Universe

Below are two diagrams. The left is a traditional Hubble diagram, while the right is the diagram you saw on the slides.

4) On the diagram on the left, sketch what a constant expansion rate of the Universe looks like (start your line at 0,0 in the bottom left hand corner). On the right hand plot, this is the dotted line – the “expected distance” is the distance based on the expansion rate observed in nearby galaxies.

5) Now consider a “heavy weight” matter dominated universe that is deaccelerating over time. Would more distant galaxies be moving faster or slower than in a constant expansion universe? Draw a line for a deaccelerating universe and label it in the left hand diagram

5a) Now draw a deaccelerating universe in the right hand diagram. Consider whether the distance at a given redshift would be larger or smaller than expected based on constant expansion. Would a supernova at high redshift appear brighter or fainter than in a universe with constant expansion?

6) Now draw an accelerating universe in both diagrams. Would a supernova with at high redshift appear brighter or fainter than in a universe with constant expansion?

