Space: Its Light , Its Shape.

Cosmology Part III: The Dance of Redshifts

Assignment: For Monday, April 4

- Read Harrison's *Cosmology* chapter 15. It is available on eReserves.
- Please feel free to bring up other issues you find interesting or puzzling. If at all possible send an email before seminar to me. I will present this topic as my assignment or open it up to discussion by the whole seminar.
- Some of these require additional reading for the presenting team. If I don't explicitly give the reference then the additional information is easy to find on the internet.
- Though everyone is responsible for reading all of the material and for working out all of the exercises, teams have been specific material and exercises for which they are responsible in class presentations. You may want to come to class early to firm up and smooth out the exercises with your teammates.

If you would like to review any of the material from last week, much of it is in Chapter 14.

Team 4: Use figure 15.1 to explain expansion redshift and equations 15.1 and 15.4.

Team 1: Sketch a cosmological model (R vs. t) which looks roughly like $R = 1/t$. What are the possible redshifts or z's? Where on the sketch are these redshifts?

Team 2: A redshift 5.9 quasar is annouced. How much has the universe expanded since the light that we see was emitted from the quasar?

Team 3: Derive 15.6 for us. In quantum mechanics the energy of a photon is given by $E = hf$ where h is Planck's constant and f is the frequency. Use this relation to answer the question that came up at dinner on Thursday, "How do you explain the redshift for light [expansion redshift], in terms of photons?"

Team 4: Explain how equation 15.7 comes about.

Team 1: Expound on what the following could mean, "At the frontier of the observable universe, where the redshift rises to infinity, nothing seems to change; everything is apparently frozen in a static state."

Team 2: Sketch figure 15.5 for us. Sketch the plot of a cosmological model (R vs. t) which matches this figure. Explain what is going on in terms of space, expansion, light cones, redshift, etc.

Team 3: Justify the triad of equations 15.8-10.

Team 4: Derive the relation for density in terms of redshift and explain why the big bang model predicts high densities for small R.

Seth: Explain the gravitational redshift.

Team 1: Tell us the relativistic form of the Doppler shift, why it is important for cosmology and how it reduces to the familiar form when v/c is small.

Team 2: The confusion over expansion and velocity redshifts came up at dinner on Thursday. How would you clarify these redshifts now?

Team 3: Why can we not combine the two basic laws of cosmology to derive a redshift-distance relation?

Team 4: Follow light from a distant galaxy to us explaining the dance of redshifts.

Team 1: Why is emission distance not the same as reception distance in figure 15.6?

Team 2: Use figure 15.7 or 8 to argue that at small redshift you cannot distinguish Einstein-de Sitter from a simple linear expansion with $q = 0$.

Team 3: Summarize the two pitfalls that Harrison identifies.

Read the redshift curiosities for pleasure, if you like. It is optional. For a bit further depth on several topics, see the notes.