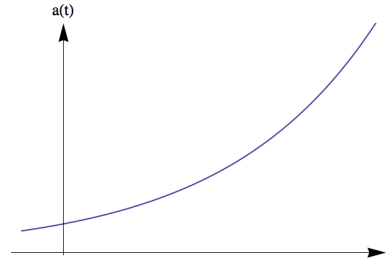
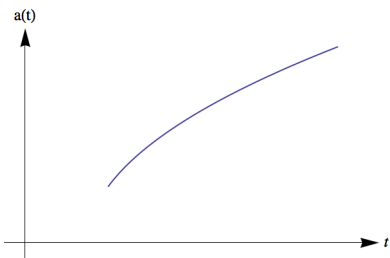


Arvind Borde

# Physics: Homework on Relativity

1. According to the theory of relativity, gravity is not a true force. What is it?
2. What attribute of an object is connected to the curvature of spacetime that it causes? (Color? Shape? Charge? Mass?)
3. What are the three effects explained (or predicted) by Einstein when he proposed the final version of the theory of relativity?
4. Below are graphs of two possible scale factors of the Universe. The one on the left is the type before Alan Guth introduced the idea of cosmic inflation. The one on the right is an exponential scale factor of the type used in inflation.



- a) Is the graph on the left concave up or down?
  - b) Does that mean that the expansion of the Universe accelerates or decelerates?
  - c) What does that tell us about whether gravity is attractive or repulsive?
  - d) Is the graph on the right concave up or down?
  - e) Does that mean that the expansion of the Universe accelerates or decelerates during inflation?
  - f) What does that tell us about whether gravity is attractive or repulsive during inflation?
5. What new form of gravity did Einstein introduce for a while and why? Given what we now believe of inflation, was Einstein really so wrong in doing so?
  6. If we look at a galaxy 13 billion light-years away, that means that light has taken 13-billion years to get to us from it. Are we seeing that galaxy as it is or as it was? How far back in time are we looking? Are there nearby objects that we also see as they were, not as they are?
  7. A typical baby doubles his or her weight in about 6 months. Rounding off your age to the nearest half year, how much would you weigh today if you continued this rate (doubling every 6 months)? If you do not know your birth-weight, assume that you were a robust 10 lbs at birth.
  8. The formation on the right is known as the Einstein cross. It shows a nearer central galaxy and four distant objects around it, *all now believed to be images of the same object behind the central one*. What phenomenon is responsible for this effect?
  9. As we said in class, a supernova that was seen in 2014 seemed to have been seen before in 1995 and 1964, and we expect to see it again by 2020. Why is this supernova flaring up again and again, and how is that even possible, or is something else happening?

