

1. The present distance to Hoag's Object is 300 Mpc, and its speed is 18,000 km/s. For Hubble's constant, use the value 60 km/s/Mpc, which is equal to 0.061/Byr. A Mpc is 3.1×10^{19} km. A billion years is 3×10^{16} s.
 - a. (3 pts.) Three billion years ago, Hoag's Object was moving away from us at about the same speed. What is the reason for that?
 - b. (3 pts.) How far from us was Hoag's Object at that time?
 - c. (3 pts.) What was the value of Hubble's constant at that time?
2. Simplicio reasons, "The universe is expanding. Hoag's object and the solar system, being part of the universe, are expanding too. Therefore the earth is steadily moving away from the sun, and Hoag's object is steadily moving away from us, and Hoag's object is getting bigger."
 - a. (4 pts.) Modify Simplicio's statement so that it is correct.
 - b. (4 pts.) What is the root cause of Simplicio's misconception?
3. Demonstration that Hubble's Law implies a Big Bang. Hubble's Law is $v = H D$, and $H = 0.061/\text{Byr}$. Consider galaxy A at distance 300 Mpc and galaxy B at distance 600 Mpc.
 - a. (2 pts.) What is the speed of galaxy A? Express the speed in Mpc/Byr.
 - b. (2 pts.) At what time was galaxy A very near us? Is galaxy B near us at the same instant?
 - c. (2 pts.) What can you conclude from part (b)?
 - d. (6 pts.) Use an alternative law for the motion of galaxies, $v = h D^2$, where $h = 0.061/\text{Byr}/(300\text{Mpc})$. Repeat parts (a) – (c).