

Arvind Borde

# AST 10: Homework 13 Solutions

1. What is dark matter? How much of the Universe is dark matter? **Invisible matter. About 27%.**
2. What is dark energy? How much of the Universe is dark energy? **Invisible energy. About 68%.**
3. What is the evidence for dark matter? **Exerts a measurable gravitational influence on rotations of stars in galaxies, gravitational lensing, etc.**
4. What is the evidence for dark energy? **Exerts a measurable repulsive gravitational influence on the expansion of the Universe.**
5. Which of dark matter or energy can perhaps be explained by a cosmological constant? How? **Dark energy. If  $\Lambda$  is positive, it can make  $\ddot{a}(t) > 0$ .**
6. Does dark matter change the shape of the graph of the scale factor from concave down to up? **No.**
7. Does dark energy change the shape of the graph of the scale factor from concave down to up? **Yes.**
8. What are some things that dark matter is not? **Thin clouds of gas and dust, antimatter, galaxy-size black holes.**
9. What are some things that dark matter might be? **MACHOS, WIMPS, small black holes.**
10. What standard candles were used by the teams that found the accelerating expansion of the Universe? **Type 1a supernovae.**
11. What are Type 1a supernovae? **Supernovae from a white dwarf that accretes matter from a companion till it crosses  $1.4M_{\odot}$ , becomes unstable, and explodes.**