

Astronomy 350 Fall 2006
Homework #11: The Final Frontier

Due in class: Friday, Dec. 2

1. *The Planck Epoch*

- (a) **[5 points]**. What is the Planck epoch? Why is it of interest?
- (b) **[5 points]**. What is quantum gravity? How would a theory of quantum gravity be useful in addressing the question of what happened at the big bang ($t = 0$)?

2. *Particle Dark Matter*

- (a) **[5 points]**. What is a WIMP? How might they originate in the Early Universe? Why are these good candidates for dark matter?
- (b) **[5 points]**. What are examples of experiments to detect WIMPs? Why are they located underground (or under mountains)? What signal would the dark matter create in a WIMP detector?
- (c) **[5 points]**. What is the current status of WIMP experiments? That is, what results do we already have? What controversies exist among the competing experiments?

3. *Antimatter in the Universe.*

- (a) **[5 points]**. What is antimatter? How is it similar to and different from ordinary matter?
- (b) **[5 points]**. What is the evidence that our Solar System is entirely made of matter and not any antimatter? What about our Galaxy?
- (c) **[5 bonus points]**. In fact, all available evidence suggests that the universe is entirely made of matter and not antimatter. What are the two logical explanations for this—i.e., what are the two possible kinds of initial matter/antimatter ratios which one could imagine? In each scenario, how is the present dominance of matter understood?

4. *Inflation*

- (a) **[5 points]**. Why is it puzzling that the observed CMB temperature is almost exactly the same on opposite sides of the sky? How would this result be explained in cosmology theories that do *not* include inflation?
- (b) **[5 points]**. What is the cosmic epoch of inflation in the early universe? How is this different from the usual expansion of the universe? What similarities and differences are there between inflation and dark energy?
- (c) **[5 points]**. How does inflation answer the puzzle from part (a)? What other properties of the *homogeneous* universe does inflation explain?