ASTRONOMY 9: HISTORY OF COSMOLOGY

Assignment #15—Solutions

2000 April 5

1. **Hawley & Holcomb, p. 229, #2**

	Spherical ($k = +1$)	Flat ($k = 0$)	Hyperbolic ($k = -1$)
Size	Finite	Infinite	Infinite
Circle Circum.	$< 2\pi r$	$2\pi r$	$> 2\pi r$
Sum of triangle	$> 180°$	$180°$	$< 180°$
# of parallels	0	1	∞

2. **Hawley & Holcomb, p. 229, #3**

   Two observers are initially at rest with respect to each other, and the first then accelerates away from the second. Newton will say that there is an *absolute space* which defines the non-accelerating frames, so if the pair were initially not accelerating, then the first will feel a force, as he is the one who is accelerating against the backdrop of absolute space.

   Mach will say that it is the overall distribution of mass throughout the universe which defines the non-accelerating frames, and so if the pair were initially not accelerating relative to the distant galaxies, then the first will again feel a force.

   Newton doesn't care if the two are the only objects in the universe; the unchanging background of absolute space is still there. Mach, on the other hand, would say that neither of them will feel a force in this case, because there is no other mass to define the non-accelerating frames.

3. **If a tree falls in a forest with no one around, what happens? Discuss in terms of the ideas presented in the article on Schrodinger's cat in the reader.**

   In the standard Copenhagen interpretation, Schrodinger's cat gets into this superposition state of being both alive and dead at the same time, and the tree might similarly get into a state of being both fallen and not-fallen. (Einstein famously asked another quantum physicist if he really believed the moon wasn't there when he wasn't looking.) Then when an observation is made, the tree picks a definite state to be in. So it hinges on what an "observation" actually is; the reader article discusses evidence that this could simply be any interaction with the environment, and a conscious observer is not required. Since the tree is interacting with lots of things around it, it remains in a boring state of classical normalcy, either fallen or not, but not both. In the many-worlds interpretation, the universe forks when an observation is made: one universe with a dead tree, and one with an alive one.

4. **Which is your favorite interpretation of quantum mechanics? Why?**

   The results of this survey are that many-worlds is the winner with 53% of the vote, standard Copenhagen comes in a close second with 41%, and hidden variables a distant third with 6%. Interestingly, I have heard anecdotally that a poll of leading quantum physicists and cosmologists found that 58% of them chose many-worlds, but among scientists in general, more chose Copenhagen. So you may be closer to Stephen Hawking than you think!