Introduction to Philosophy of Physics   Homework 1

Natural motion, inertia, laws, determinism   Due: 5 March 2023

1. The 'shipmast experiment' compares a ship firmly moored to the landings in a harbour with one smoothly afloat in the open sea and considers the motion of a cannonball dropped from its masthead. Intuition suggested that in the ship firmly at anchor, the ball would land right next to the mast from which it was dropped, while in the ship under canvass, it would fall aft, i.e., toward the stern of the ship, as the ship itself would move forward while the ball was falling. In other words, merely from observing the landing point of the cannonball, one could infer whether or not the ship was moving: if the ball lands next to the mast, the ship is not in motion; if the ball falls behind, the ship is moving forward. Or so intuitions seems to suggest.

   This was thought to have implications for the terrestrial physics on a moving Earth. Instead of from a masthead, imagine the ball being dropped from a tower: if the ball lands next to the foot of the tower, Earth does not move; if the ball falls away from the tower, then Earth moves. In fact, rough estimates at the time suggested that Earth's proposed diurnal revolution alone would cause the cannonball to fall behind hundreds of metres even for a tower of moderate height.

   (a) Suppose we were just interested in estimating the effect of the tangential velocity of Earth's daily motion on the cannonball's fall. This velocity depends on the position of the tower on Earth's surface, and in particular on its latitude. At a latitude of $45°$ (i.e., roughly at the latitude of Turin or Piacenza) it is roughly a third of a kilometre per second. Following this intuitive reasoning, if the cannonball were in free fall for three seconds (which is the case if dropped from a height of around 44m), it should be left behind by a kilometre. Still following this reasoning, by how far should the ball be left behind if it were dropped from the most beautiful tower in your native city? For a fixed height of the tower, should the effect be larger or smaller toward the equator? Let me emphasize that this reasoning is now considered erroneous, as Earth's rotation need not result in the cannonball 'falling behind'. [2 points]

   (b) Explain what is erroneous in the above reasoning, using the analysis by Bruno and Galileo. What is the correct analysis of the shipmast experiment? [2 points]

2. John Carroll (and others) have complained that the Humean approach to laws of nature is in trouble because Humean supervenience is false, as there could be worlds which differ but in their laws. Explain this argument and sketch a response a Humean could give. [2 points]

3. Explain how a Leibnizian can use the idea of static and kinematic shifts to articulate an objection to substantivalism. [2 points]

4. How is Huggett's analogy with a game of chess on an infinite board supposed to help relationalism against Newton's bucket thought experiment? [2 points]