Philosophy 395S: Space and Time
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Final Exam

This is really a "second exam", not a "final exam", since it is only on the second half of the course. You must do four essay questions in all: one from each part of the exam and then one more. Essays should be succinct and complete, typically about two pages for each question, double-spaced. You may use the readings to review the topics of the essays, but be sure to put the answers in your own words so that I know that you understand them. Exams should be e-mailed to me by Wednesday, December 16 at 11:59 PM. If you have special circumstances that would justify an extension, you should request it by e-mail prior to the deadline.

Part 1. *Theory of Relativity*. Answer *at least one* of the following questions:

1. State clearly the thesis of the relativity of simultaneity. Use the following variant on Einstein's train example to argue for the relativity of simultaneity. Instead of two lightning flashes reaching the ground observer at the same time, there are two light flashes coming from two light bulbs at either end of the train reaching the train observer at the same time. Be sure to identify all assumptions used in your argument for the relativity of simultaneity. Finally draw a space-time diagram.

2. State clearly what is meant by "time dilation" in the theory of relativity. Carefully present an argument concluding that, if A is moving at a constant velocity with respect to B, then, according to B, A's clocks are running slow. The argument need not be quantitative, but you must identify all assumptions. Explain why it also follows that, according to A, B's clocks are running slow. Finally, respond to the following confusion: "If A's clock runs, say, five minutes slow relative to B's, and B's clock runs five minutes slow relative to A's, then A's clock runs ten minutes slow relative to itself, which is impossible!"

3. Hermann Minkowski famously said: "Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality." Discuss and illustrate this quote. You will need to introduce the notion of the spacetime interval, and discuss its significance.

4. Present the paradox of the twins, and explain in detail how the paradox is resolved in special relativity (using spacetime diagrams to illustrate). Could a relationist about space and time accept this solution? How might Mach, for example, respond to the paradox?

Part 2. *Conventionality of Simultaneity and Clock Synchronization*. Do *at least one* of the following questions:

5. State clearly the thesis of the conventionality of simultaneity. Present an argument for this thesis, noting clearly the role that verificationist (or positivist) principles play. Explain clearly what Salmon means when he suggests that "the conventionality of simultaneity makes it possible to erase the relativity of simultaneity"? Illustrate with an example.

6. First, say how one could synchronize spatially separated clocks within the framework of Newtonian mechanics without relying on the assumption that epsilon is one-half? Now consider the following method of synchronization which can (in principle) be used within the framework of relativity:

> A rapidly rotating searchlight is moved farther and farther from the clocks so that its beam of light sweeps from one clock to the other faster and faster without limit. If the clocks are set so that the beam arrives at each clock at the same time, the "error" can be made smaller and smaller without limit.

Can this method of synchronization eliminate the need to assume that epsilon equals one-half?

Part 3. *Backwards Causation and Time Travel.* Do *at least one* of the following questions:

7. Suppose some physicist claims to have discovered particles that travel, say, at twice the speed of light. Explain why, if one does not also change the basic assumptions of the theory of relativity (including the structure of Minkowski spacetime), such particles would lead to "causal anomalies." Present an example. Would it be possible to accept such particles but avoid the "causal anomalies" by modifying the theory (and the structure of spacetime)?

8. Present Dummett's case of the Dancing Chief (from Horwich, ch. 6). Present the "bilking argument," whose conclusion is that backwards causation is logically (or analytically) impossible. Explain clearly why the bilking argument fails. What, if anything, do considerations of bilking show about backwards causation?

9. Suppose first that time is one-dimensional and doesn't branch. Consider the following claim: "Time travel into the past is incompatible with the view that the past is fixed and cannot change. For as soon as the time traveler enters the past he has changed it." Explain what is wrong with this statement, making use of the distinction between "changing" the past and "influencing" the past? Now suppose that time branches when the time traveler goes back in time. Would this allow the time traveler to change the past? Discuss.

10. Present the Grandfather paradox and David Lewis's resolution. Why does Lewis see the Grandfather Paradox as analogous to the standard argument for fatalism? Explain how Lewis's response to the Grandfather paradox can be applied to the argument for fatalism.