

“Einstein for Everyone”): Suggested Topics for Final Paper

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What bizarre shit?

Thomas Pynchon, *Gravity's Rainbow*

The paper is due by 17:00, Friday, September 19, 2014. Please bring a hard-copy to me in my office or email me a hard copy, preferably as a PDF.

It should be 12–15 pages, double-spaced, with reasonable margins in a reasonable font such as 12 pt. Times New Roman. The paper should clearly state and argue for a thesis; a mere summary of existing literature or lectures will not be rewarded. Students are encouraged to consult with me while preparing the paper. You may write on any topic you like, not necessarily one of the ones I suggest below, so long as you discuss it with me first (if it is not one I suggest). Don't forget to include a complete bibliography listing *all* sources you consulted, whether electronic or non-electronic, while writing your paper.

I will comment on rough drafts provided they are given to me by September 01. A late paper will be penalized 3 points per day, including weekends (maximum 20 points).

Topics

1. Explain what is “real” and what is “not real” about time-dilation and length-contraction in special relativity. To do this, you need to adequately characterize what you mean by “real” (and “not real”), and adequately explain the phenomena of time-dilation and length-contraction themselves. What is the spacetime interval, how does it differ from spatial and temporal lengths, and why is it “real”?
2. What property of the Schwarzschild solution is not determined by the matter distribution? Why did Einstein find this troubling? (To answer this question adequately, you should discuss the Einstein field-equation, what two kinds of structure it sets equal to other and what its physical significance is.)

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3. In 1917, Einstein proposed new field equations for general relativity different from the original field equations in 1915.
 - a. What was different in the 1917 field equations?
 - b. Explain why Einstein changed his field equations.
 - c. What experimental development led Einstein to retract the proposed change, and why?

To answer this question adequately, you should discuss the Einstein field-equation, what two kinds of structure it sets equal to other and what its physical significance is.

4. Explain briefly what a black hole is, and then address the following issues.
 - a. Why does gravitation lead to the formation of black holes, whereas other forces (such as electromagnetic forces) do not?
 - b. What keeps a star from collapsing into a black hole? What keeps a galaxy from collapsing into a supermassive black hole?
 - c. Why do astrophysicists think that black holes exist, despite the fact that we cannot see light or any other signals emanating from within the event horizon? Discuss the type of evidence available for black holes, its apparent reliability and whether it's really convincing.
5. Einstein-Podolsky-Rosen ('EPR') argued that quantum mechanics must be incomplete, based on certain predictions it makes. Explain what they meant by claiming it to be incomplete, making sure to address the following:
 - a. the meaning and reasonableness of their “criteria of reality”
 - b. the meaning and reasonableness of the two fundamental assumptions they made in giving their argument for the incompleteness of QM

You do not have to rehearse the argument in detail; focus instead on explaining the crucial assumptions.