120 Intermediate Philosophy of Physics: Special Relativity Reading List (HT/TT25)

Prof. Samuel C. Fletcher (sam.fletcher@merton.ox.ac.uk)

This reading list suggests entrees into the following eight topics:

- Newton's Laws
- Symmetry and the derivation of the Lorentz transformations
- Lorentzian relativity
- Dynamical and geometrical approaches to spacetime theories
- The conventionality of simultaneity
- Presentism and relativity
- Frame-dependence and reality
- Mass-energy equivalence

We will proceed in order, with one topic per week, for your tutorial essays. For up to two topics, instead of writing a new essay, you may opt to revise a previous tutorial essay based on the comments you received on it. You also have the option to write an essay responding to a question pertaining to but not listed under a topic below; in this case you should write to me for approval with the proposed question at least 48 hours in advance of your tutorial.

For each topic, in addition to primary sources, I will suggest secondary source reviews from a variety of textbooks and course notes, especially the following:

- James Read (2023). *Special Relativity*. Cambridge University Press. [JR]
- Tim Maudlin (2012). *Philosophy of Physics, Vol. I: Space and Time*. Princeton University Press. [TM]
- Harvey R. Brown (2005). *Physical Relativity: Spacetime Structure from a Dynamical Perspective* Oxford University Press. [HB]
- Roberto Torretti (1996). *Relativity and Geometry*, 2nd ed. Dover. [RT]
- Michael Friedman (1983). *Foundations of Space-Time Theories*. Princeton University Press. [MF]
- Hans Reichenbach (1957). *The Philosophy of Space and Time*. Dover. [HR]

Below, I will refer to these using the respective bracketed abbreviations. I recommend reading (at least some of) the secondary sources on a topic before the primary sources. These secondary sources will also often have additional suggested reading that you may explore based on your own interests.

1. Newton's Laws

State Newton's laws of motion and define all terms therein. How (if at all) do the laws depend upon one another? Are any merely definitions or conventions?

Primary Reading

- JR, Ch. 1
- TM, pp. 12-24
- HB, Chs. 2.2, 3.2
- MF, Ch. III.7
- RT, Ch. 1.1-1.6

Secondary Reading

- Daniel Hoek (2023). Forced changes only: A new take on the law of inertia. *Philosophy of Science* 90: 60–76.
- John Earman and Michael Friedman (1973). The meaning and status of Newton's law of
- inertia and the nature of gravitational forces. *Philosophy of Science* 40(3): 329-359.
- James L. Anderson (1990). Newton's first two laws are not definitions. *American Journal of Physics* 58(12): 1192-5.
- Herbert Pfister and Markus King (2015). *Inertia and Gravitation*. Springer, §§1.1-1.3.

2. Symmetry and the derivation of the Lorentz transformations

Outline Einstein's 1905 derivation of the Lorentz transformations. Which of its assumptions are empirical facts, and which are conventions?

Primary Reading

- JR, Ch. 4.
- RT, Ch. 3
- HB, Chs. 2.3, 5, 6.4.
- MF, Ch. IV.2, 5, 6

Secondary Reading

- Albert Einstein (1952/1923/1905). On the electrodynamics of moving bodies. In *The Principle of Relativity*. Dover, 35-65.
- Marton Gomori and Laszlo E. Szabo (2015). Formal statement of the special principle of relativity. *Synthese* 192(7): 1-24.

- Judit X. Madarász, Gergely Székely, and Mike Stannett (2017). Three different formalisations of Einstein's relativity principle. *Review of Symbolic Logic* 10(3): 530-548.
- Judit X. Madarász, Mike Stannett, and Gergely Székely (2022). Investigations of isotropy and homogeneity of spacetime in first-order logic. *Annals of Pure and Applied Logic* 173(9): 103-153.

3. Lorentzian Relativity

What theoretical virtues, if any, does special relativistic electrodynamics have over Lorentz's aether theory?

Primary Reading

- JR, Ch. 3
- RT, Ch. 2
- HB, Ch. 4

Secondary Reading

- Elie Zahar (1973). Why did Einstein's programme supersede Lorentz's? *British Journal for the Philosophy of Science* 24: 95–123, 223–262.
- Michel Janssen (2002). Reconsidering a scientific revolution: The case of Einstein versus Lorentz. *Physics in Perspective* 4: 421–446.
- Pablo Acuña (2014). On the empirical equivalence between special relativity and Lorentz's ether theory. *Studies in History and Philosophy of Modern Physics* 46(2): 283-302.
- Clara Bradley (2021). The Non-equivalence of Einstein and Lorentz. *British Journal for the Philosophy of Science* 72(4): 1039-1059.

4. The "Dynamical approach" to special relativity

What is the "dynamical approach" to special relativity, and what is the best argument in favor of it, or against it?

Primary Reading

- JR, Ch. 7.
- Harvey R. Brown and Oliver Pooley (2006). Minkowski space-time: A glorious non-entity. In D. Dieks (ed.), *The Ontology of Spacetime.* Elsevier, 67-89.

Secondary Reading

- John D. Norton. (2008). Why constructive relativity fails. *British Journal for the Philosophy of Science* 59: 821-834.

- Michel Janssen (2009). Drawing the line between kinematics and dynamics in special relativity. *Studies in History and Philosophy of Modern Physics* 40: 26-52.
- Pablo Acuña (2016). Minkowski spacetime and Lorentz invariance: The cart and the horse or two sides of a single coin? *Studies in History and Philosophy of Modern Physics* 55: 1-12.
- Harvey R. Brown and James Read (2022). The dynamical approach to spacetime. In E. Knox and A. Wilson (eds.), *The Routledge Companion to Philosophy of Physics.* Routledge, 70-85.

5. The Conventionality of Simultaneity

In what sense, if any, is simultaneity conventional in special relativity?

Primary Reading

- JR, Ch. 8
- HB, Ch. 6.3
- RT, Ch. 7.1
- HR, §§19-20
- MF, Ch. IV.7, VII.4
- David B. Malament (1977). Causal theories of time and the conventionality of simultaneity. *Nous* 11: 293-300.

Secondary Reading

- Allen Janis (2018). Conventionality of simultaneity. In Edward N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy,* Fall ed. https://plato.stanford.edu/archives/fall2018/entries/spacetime-convensimul/.
- Wesley C. Salmon (1977). The Philosophical Significance of the One-Way Speed of Light. *Nous* 11(3): 253-292.
- Tim Budden (1998). Geometric simultaneity and the continuity of special relativity. *Foundations of Physics Letters* 11: 343-357.
- Ettore Minguzzi (2002). On the conventionality of simultaneity. *Foundations of Physics Letters* 15: 153-169.

6. Presentism and relativity

Is there a viable theory presentism compatible with relativity? Why or why not?

Primary Reading

- Hilary Putnam (1967). Time and physical geometry. *The Journal of Philosophy* 64(8): 240–247.
- Howard Stein (1968). On Einstein-Minkowski space-time. *The Journal of Philosophy* 65(1): 5–23.

- Howard Stein (1991). On relativity theory and openness of the future. *Philosophy of Science* 58: 147-167.
- Simon Saunders (2002). How relativity contradicts presentism. In C. Callender (ed.), *Time, Reality & Experience*. Cambridge University Press, 277-292.
- Yuri Balashov and Michel Janssen (2003). Presentism and relativity. *British Journal for the Philosophy of Science* 54: 327-346.

Secondary Reading

- Oliver Pooley (2013). Relativity, the open future, and the passage of time. *Proceedings of the Aristotelian Society* 113: 321-363.
- Dean Zimmerman (2011). Presentism and the space-time manifold. In C. Callender (ed.), *The Oxford Handbook of Philosophy of Time*. Oxford University Press, Ch. 7.
- Steven Savitt (2011). Time in the special theory of relativity. In C. Callender (ed.), *The Oxford Handbook of Philosophy of Time*. Oxford University Press, Ch. 18.

7. Frame-dependence and reality

Are frame-dependent phenomena or properties real?

Primary Readings

- JR, Ch. 9.
- TM, Chs. 4-5
- HB, Ch. 7.5
- John S. Bell (2004). How to teach special relativity. In *Speakable and Unspeakable in Quantum Mechanics*, 2nd ed. Cambridge University Press, pp. 67-80.

Secondary Readings: The reality of frame-dependent quantities

- Richard Healey (2004). Change without change, and how to observe it in general relativity. *Synthese* 141(3): 381-415. [Read only through section 2.]
- Alastair Wilson (2009). Disposition-manifestations and reference-frames. *Dialectica* 63(4): 591-601.

Secondary Readings: Fragmentalism

- Thomas Hofweber and Marc Lange (2017). Fine's fragmentalist interpretation of special relativity. *Nous* 51(4): 871-883.
- Martin A. Lipman (2020). On the fragmentalist interpretation of special relativity. *Philosophical Studies* 117: 21-37.
- James Read (2022). Geometric objects and perspectivalism. In J. Read and N. Teh (eds.), *The Philosophy and Physics of Noether's Theorems.* Cambridge University Press, Ch. 10.

8. Mass-energy equivalence

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Primary Readings

- RT, Ch. 4.4
- Francisco Fernflores (2019). The equivalence of mass and energy. In Edward N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy* (Fall ed.). https://plato.stanford.edu/archives/fall2019/entries/equivME/.
- Hermann Bondi and C. B. Spurgin (1987). Energy has mass: A common misunderstanding is re-examined. *Physics Bulletin* 38: 62–63.
- Marc Lange (2001). The most famous equation. *Journal of Philosophy* 98: 219–238.

Secondary Reading: Historical sources in energy-mass relations

- Albert Einstein (1935). Elementary derivation of the equivalence of mass and energy. *Bulletin of the American Mathematical Society* 41: 223–230.
- Max Jammer (1961). *Concepts of Mass in Classical and Modern Physics*. Harvard University Press, Chs. 12-13.
- Max Jammer (2000). *Concepts of Mass in Contemporary Physics and Philosophy*. Princeton University Press, Chs. 2-3.

Secondary Reading: Incommensurability of mass concepts

- Okun, L. B. (1989). The concept of mass. *Physics Today, 42*(6), 31–36.
- Samuel C. Fletcher (2024). On the alleged incommensurability of Newtonian and relativistic mass. *Erkenntnis* (forthcoming): 1-22.
- TBA