

# “Metaphysical Problems of Physics”

## Schedule of Lectures

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<http://strangebeautiful.com/lmu/2021-summer-metaphys-phys.html>

Summer, 2021

Tuesdays, 14:00–16:00 *C.T.*

ONLINE

(contact Dr. Curiel for Zoom coordinates; eventually perhaps in person  
at Geschw.-Scholl-Pl. 1 - C 022)

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## Notes on the Readings, Discussion Sessions, and Caveats

### Readings

When there are more than one required readings, they are to be read in the order in which they appear in the list.

The only book I suggest you purchase (if you like having physical copies of important books) is:

James Clerk Maxwell, *Matter and Motion*

A paperback reprint from Dover Publishers costs 12€. Every serious philosopher of science, philosopher of physics and physicist should have it.

Some of the required and suggested readings are available online at the course’s webpage, though they may not be listed as such in the bibliography:

<http://strangebeautiful.com/lmu/2021-summer-metaphys-phys.html>

Many of the required and suggested readings are available in the course’s shared Dropbox folder. Contact Dr. Curiel to get access to it.

Journal articles that are available through LMU’s online library system do not appear in either place. Many of the books are available through LMU’s electronic resources, especially those made available to us during the coronavirus pandemic, such as [ProQuest Ebook Central](#). As many of these latter won’t be available for long, make sure to try to find all the relevant readings on them sooner rather than later. Some of the books are also available on the [Internet Archive](#).

## Suggested Readings

I neither expect nor request that you try to read all or indeed any of the suggested reading. I give extensive lists for each lecture only so you can delve more deeply into particular facets of the topic or topics closely related if you are both interested and fired up. For most lectures, I divide the suggested readings into those that reflect my own sympathies and those that reflect the sympathies of others. That does not mean I agree with all the claims, arguments or conclusions of those in the former list, or disagree with all those in the latter. It has more to do with temperament, style and attitude, although, to be sure, something to do with conclusions as well.<sup>1</sup>

## Discussion Sessions

Weekly discussion sessions will be led by Alex Mathie ([alex.mathie@lmu.de](mailto:alex.mathie@lmu.de), [https://www.mcmp.philosophie.uni-muenchen.de/people/doct\\_fellows/mathie\\_alex/index.html](https://www.mcmp.philosophie.uni-muenchen.de/people/doct_fellows/mathie_alex/index.html)). He will set up a day and time for the sessions after consulting with y'all. We cannot require your attendance, but I urge you in the strongest terms to attend.

Thus the view is expressed [in Plato's Seventh Letter] that the whole apparatus of what we might call “object-semantics,” involving both linguistic signs and ordinary things (Plato's “images”), cannot suffice to determine meaning and truth, without some essential involvement of the *language users* and their *conceptions and beliefs*; and the writer goes on to assert that this determination can occur reliably only in *discussion*, with questioning and answering “free from envy”—and that, indeed, over a long time: a process which, in favorable conditions, can lead to a shining forth of the light of understanding and intelligence (φρόνησις and νοῦς).

Howard Stein

“How Does Physics Bear Upon Metaphysics; and Why Did  
Plato Hold that Philosophy Cannot Be Written Down?”

## Caveats

I will be making changes to this document from time to time, as I decide to change some required reading, find new suggested reading I think is good, change the schedule of lectures to reflect the facts on the ground, *etc.* Please check it on the course's webpage periodically, as that will always be the most up-to-date version.

## Lectures 1–3: Introduction; Maxwell's *Matter and Motion* (13. Apr – 4. May)

What is metaphysics? I'm not sure. Some potential answers will be displayed and examined.

Maxwell was the most philosophically sophisticated physicist who ever lived. We will do well to begin thinking about the relationship between physics and metaphysics by studying his exposition

1. “Brotherhood of men comes not from community of thought but from consanguinity of mind.” – Proust, *Within a Budding Grove*.

of the grounds and contents of basic physics. This will provide a touchstone against which to test all philosophical principles, arguments and claims we encounter in the course.

Maxwell’s *Matter and Motion* is deceptively simple, but philosophically rich and deep. Read it with thoughtfulness and care, stopping from time to time to reflect on seemingly innocuous, perhaps even banal, remarks—you will come to see how, under the illumination of your contemplation, they blossom into a garden of philosophical delights.

## Lecture 1: Introduction; *Matter and Motion* I, Kinematics (13.–27. Apr)

### Required Reading

1. Curiel (2011), “Notes on Learning Philosophy”
2. Maxwell (1877), *Matter and Motion*: “Preface (1877)”; ch. I–II (§§1–35)

### Suggested Reading: Introduction

1. Callender (2011), “Philosophy of Science and Metaphysics”
2. Carnap (1966), *Philosophical Foundations of Physics*: part I
3. Chakravartty (2007), *A Metaphysics for Scientific Realism*: chs. 1–3
4. Einstein (1918), “Principles of Research”
5. Feynman (1965), *The Character of Physical Law*: chs. 1–2
6. Geroch (1985), *Mathematical Physics*: ch. 1
7. Hempel (1966), *Philosophy of Natural Science*: chs. 1–3, 5–6
8. Kincaid (2013), “Introduction: Pursuing a Naturalized Metaphysics”
9. Ladyman and Ross (2007), *Every Thing Must Go*: ch. 1
10. Maudlin (2007), *The Metaphysics within Physics*: “Epilogue”
11. Mumford and Tugby (2013b), “What Is the Metaphysics of Science?”
12. Poincaré (1913), *Science and Hypothesis*: part IV, ch. 9
13. Sider (2020), *The Tools of Metaphysics and the Metaphysics of Science*: ch. 1

### Suggested Reading: Maxwell on Kinematics

1. Barbour (2001), *The Discovery of Dynamics*: ch. 1
2. Cohen (2004), “Newton’s Concepts of Force and Mass, with Notes on the Laws of Motion”
3. Einstein (1931), “Maxwell’s Influence on the Evolution of the Idea of Physical Reality”
4. Maxwell (1870), “Address to the Mathematical and Physical Sections of the British Association”
5. Maxwell (1871), “Introductory Lecture on Experimental Physics”
6. Maxwell (1876a), “General Considerations Concerning Scientific Apparatus”
7. Newton (unpublished), “De Gravitatione et Æquipondio Fluidorum”
8. Newton (1726[1999]), *Philosophiæ Naturalis Principia Mathematica*: Author’s Preface (pp. 381–383); Definitions (pp. 403–408); Scholium to the Definitions (pp. 408–415); Axioms, or the Laws of Motion and Scholium (pp. 416–430); Rules for the Study of Natural Philosophy (pp. 794–796)
9. Sklar (2013), *Philosophy and the Foundations of Dynamics*: chs. 4–7
10. Stein (1967), “Newtonian Space-Time”

**Lecture 2: *Matter and Motion* II, Dynamics (27. Apr)**Required Reading

1. Maxwell (1877), *Matter and Motion*: ch. III–IV (§§36–71); ch. VI, §§98–106
2. Maxwell (1879), “Thomson and Tait’s *Natural Philosophy* (A Review)”

Suggested Reading

1. Einstein (1927), “The Mechanics of Newton and Their Influence on the Development of Theoretical Physics”
2. Feynman, Leighton, and Sands (1963), *The Feynman Lectures on Physics*, Volume 1: chs. 12, 52
3. Harman (1982), *Energy, Force and Matter*
4. Hertz (1899), *The Principles of Mechanics Presented in a New Form*: “Author’s Preface”; “Introduction”
5. Hoffman (1977), *The Concept of Energy*
6. Mach (1911), *History and Root of the Principle of the Conservation of Energy*
7. Maxwell (1876b), “On the Proof of the Equations of Motion of a Connected System”
8. Maxwell (1878), “*Paradoxical Philosophy* (A Review)”
9. Maxwell (1891), *Theory of Heat*: ch. IV
10. Poincaré (1913), *Science and Hypothesis*: part III
11. Sklar (2013), *Philosophy and the Foundations of Dynamics*: chs. 8–9, 13, 16

**Lecture 3: *Matter and Motion* III, Energy (4. May)**

We expand our collection of touchstones, in preparation for contact with overt philosophy, by a detailed study of one fundamental—and fundamentally weird—physical quantity, as it appears in all its exuberantly variegated glory across physics. We begin to come to grips with the idea of “metaphysics”.

Required Reading

1. Maxwell (1877), *Matter and Motion*: ch. V (§§72–97); ch. VI, §§107–112
2. Maxwell (1869), “Remarks on the Mathematical Classification of Physical Quantities”

Suggested Reading

1. Boltzmann (1871), “Einige allgemeine Sätze über Wärmegleichgewicht”
2. Boltzmann (1877), “Über die Beziehung zwischen dem zweiten Hauptsatze der mechanischen Wärmetheorie und der Wahrscheinlichkeitsrechnung resp. den Sätzen über das Wärmegleichgewicht”
3. Boltzmann (1896), *Vorlesungen über Gastheorie*, Volume 1: forward, introduction, ch. I, §§3–9 chs. III, VII
4. Carnot (1824), *Réflexions sur la Puissance Motrice du Feu et sur les Machines Propres à Développer Cette Puissance*
5. Curiel (2000), “The Constraints General Relativity Places on Physicalist Accounts of Causality”

6. Ehrenfest-Afanassjewa (1956), *Die Grundlagen der Thermodynamik*: chs. I–III
7. Emden (1938), “Why Do We Have Winter Heating?”
8. Elkana (1974), *The Discovery of the Conservation of Energy*
9. Fermi (1937), *Thermodynamics*: Introduction; chs. I–III; ch. IV, §§11–14
10. Feynman (1965), *The Character of Physical Law*: chs. 3, 5
11. von Helmholtz (1853), “On the Conservation of Force; A Physical Memoir”
12. Thomson (Lord Kelvin) (1852), “On a Universal Tendency in Nature to the Dissipation of Mechanical Energy”
13. Thomson (Lord Kelvin) (1857), “2. On a Universal Tendency in Nature to the Dissipation of Mechanical Energy”
14. Kreuzer and Payne (2011), “Thermodynamics of Heating a Room”
15. Maxwell (1891), *Theory of Heat*: chs. IV–V, VIII–IX, XII
16. Planck (1926), *Treatise on Thermodynamics*: Prefaces to the first through fifth editions; Parts I–III
17. Sommerfeld (1964), *Thermodynamics and Statistical Mechanics*: Author’s Preface; ch. I, §§1–8, 11
18. Truesdell (1980), *The Tragicomical History of Thermodynamics: 1822–1854*

## Lectures 4–5: Quantities, Kinds (11. May – 1. Jun)

### Lecture 4: Quantities (11.–18. May)

Can this tell us what is metaphysics?

#### Required Reading

1. Wolff (2020), *The Metaphysics of Quantities*: chs. 1, 6–10

#### Suggested Reading: My Sympathies

1. Carnap (1956c), “The Methodological Character of Theoretical Concepts”
2. Carnap (1966), *Philosophical Foundations of Physics*: chs. 7–12
3. Curiel (2017b), “Kinematics, Dynamics, and the Structure of Physical Theory”
4. Curiel (2017c), “On Newton’s Third Rule of Reasoning in Philosophy, ‘the Universal Qualities of All Bodies Whatsoever’, and the Taxonomy of Physical Systems”
5. Krantz et al. (1971), *Foundations of Measurement: Additive and Polynomial Representations*: chs. 1, 10
6. Malament (1982), “*Science without Numbers: A Defense of Nominalism*, by Hartry H. Field (Book Review)”
7. Stein (1990), “On Locke, “the Great Huygenius, and the Incomparable Mr. Newton””
8. Stein (2004), “The Enterprise of Understanding and the Enterprise of Knowledge—For Isaac Levi’s Seventieth Birthday”
9. Suppes (1969a), “Models of Data”
10. Suppes (1974), “The Structure of Theories and the Analysis of Data”
11. Suppes and Scott (1969), “Foundational Aspects of Theories of Measurement”

Suggested Reading: Those of Others

1. Baker (2020), “Some Consequences of Physics for the Comparative Metaphysics of Quantity”
2. Bird (2007), *Nature’s Metaphysics*: chs. 1–2; ch. 4, §§1–2; ch. 7
3. Chakravartty (2007), *A Metaphysics for Scientific Realism*: ch. 5
4. Chang (2008), *Inventing Temperature*: chs. 1–3
5. Chang (2012), *Is Water H<sub>2</sub>O?*: ch. 4
6. Dasgupta (2013), “Absolutism vs Comparativism about Quantity”
7. Eddon (2013), “Quantitative Properties”
8. Field (2016), *Science without Numbers*
9. Lewis (1970), “How to Define Theoretical Terms”
10. Martens (2021), “The (Un)detectability of Absolute Newtonian Masses”
11. Mundy (1987), “The Metaphysics of Quantity”
12. Shoemaker (1980), “Causality and Properties”
13. Sider (2020), *The Tools of Metaphysics and the Metaphysics of Science*: ch. 4
14. Wolff (2020), *The Metaphysics of Quantities*: chs. 2–5
15. Tal (2019), “Individuating Quantities”

**25. MAY: NO LECTURE (PFINGSTDIENSTAG)**

Yes, in the Great and Most Holy, Most Sacred and Most Devout Catholic State of Reverential and Saintly Bayern of the Dutiful Dulia, Pfingstdienstag in its apotheosis as Feiertag has metaphysical indubitability. Because we all need to be told by our governments what to worship and when.

**Lecture 5: Kinds (1. Jun)**

Natural and unnatural. *En passant*, you will learn why the idea of the rigidity of reference is not hep to the jive. It does not, as it were, let the light of metaphysics shine through.

Required Reading

1. Beebee (2013), “How to Carve across the Joints in Nature without Abandoning Kripke-Putnam Semantics”
2. Curiel (2016), “Why Rigid Designation Cannot Stand on Scientific Ground”

Suggested Reading: My Sympathies

1. Curiel (2017b), “Kinematics, Dynamics, and the Structure of Physical Theory”
2. Curiel (2017c), “On Newton’s Third Rule of Reasoning in Philosophy, ‘the Universal Qualities of All Bodies Whatsoever’, and the Taxonomy of Physical Systems”
3. Goodman (1983), *Fact, Fiction and Forecast*
4. Putnam (1975), “The Meaning of ‘Meaning’”
5. Quine (1969a), “Natural Kinds”<sup>2</sup>

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2. For those who know me: don’t drop dead of shock at my claim of sympathy with Quine. Not *everything* the dude said was total crap.

Suggested Reading: Those of Others

1. Beebe and Sabbarton-Leary (2012), *The Semantics and Metaphysics of Natural Kinds*: chs. 1–3, 6–7, 9–11
2. Chakravartty (2007), *A Metaphysics for Scientific Realism*
3. Ellis (2013), “Essentialism and Natural Kinds”
4. Khalidi (2013), *Natural Categories and Human Kinds*
5. Kripke (1980), *Naming and Necessity*
6. LaPorte (2003), *Natural Kinds and Conceptual Change*

## Lecture 6: Interlude on Under-Determination *à la* the Hole Argument (8. Jun)

Dr. Curiel will be giving lectures at the Urbino International School in Philosophy of Physics XXIV “Black Holes and the Information-Loss Paradox” this week. (Check out <https://sites.google.com/view/xxivurbinosummerschool/home> to see recordings of my lectures.) This course lecture will be given by Alex Mathie. He may or may not tell you what metaphysics is. I hope he does.

Required Reading

1. Pooley (2020), “The Hole Argument”

Suggested Reading

1. Bueno, French, and Ladyman (2003), “On Representing the Relationship between the Mathematical and the Empirical”
2. Butterfield (1989), “The Hole Truth”
3. Chakravartty (2003), “The Structuralist Conception of Objects”
4. Curiel (2018), “On the Existence of Spacetime Structure”
5. Dasgupta (2011), “The Bare Necessities”
6. Dasgupta (2020), “How to Be a Relationalist”
7. Dainton (2010), *Time and Space*: ch. 21
8. Earman (1989), *World Enough and Space-Time: Absolute versus Relational Theories of Space and Time*: ch. 9
9. Earman and Norton (1987), “What Price Spacetime Substantivalism? The Hole Story”
10. French (2009), “Metaphysical Underdetermination: Why Worry?”
11. Hofer (1996), “The Metaphysics of Space-Time Substantivalism”
12. Pooley (2013), “Substantivalist and Relationalist Approaches to Spacetime”
13. Rynasiewicz (1994), “The Lessons of the Hole Argument”
14. Stachel (2014), “The Hole Argument and Some Physical and Philosophical Implications”
15. Weatherall (2018), “Regarding the ‘Hole Argument’”



## Lectures 7–9: Modality (15.–29. Jun)

### Lecture 7: Counterfactuals (15. Jun)

Dr. Curiel will be presenting at and attending the conference “Singularity theorems, causality, and all that: A tribute to Roger Penrose”. (Check out <https://sites.google.com/unifi.it/scr21> to see a recording of my talk.) This course lecture will be given by Dr. Neil Dewar. He may or may not address the following questions.

If counterfactuals could show us metaphysical truths, could we nonetheless evaluate them empirically? Could they, nonetheless, tell us something of empirical and practical import?

I hope he does.

#### Required Reading

1. Lewis (1973), *Counterfactuals*: chs. 1–4

#### Suggested Reading: My Sympathies

1. Adams (1975), *The Logic of Conditionals*
2. Butterfield (2004), “Some Aspects of Modality in Analytical Mechanics”
3. Bennett (2003), *A Philosophical Guide to Conditionals*: chs. 1, 10–15, 19, 21
4. Curiel (2017a), “If Metrical Structure Were Not Dynamical, Counterfactuals in General Relativity Would Be Easy”
5. Fletcher (2019), “Counterfactual Reasoning within Physical Theories”
6. Gibbard (1981), “Two Recent Theories of Conditionals”
7. Goodman (1983), *Fact, Fiction and Forecast*
8. Goodman (1972), “Seven Strictures on Similarity”
9. Harper (1981), “A Sketch of Some Recent Developments in the Theory of Conditionals”
10. Montague (1974), *Formal Philosophy: Selected Papers of Richard Montague*: chs. 3–4, 6–7
11. Stalnaker (1981), “A Theory of Conditionals”
12. Stalnaker (1984), *Inquiry*: chs. 3, 7–8
13. Stalnaker (2003b), *Ways a World Might Be: Metaphysical and Anti-Metaphysical Essays*: chs. 1–2, 10
14. Stalnaker (2019), “Counterfactuals and Humean Reduction”

#### Suggested Reading: Those of Others

1. Eagle (2009), “Causal Structuralism, Dispositional Actualism, and Counterfactual Conditionals”
2. Ellis, Jackson, and Pargetter (1977), “An Objection to Possible-World Semantics for Counterfactual Logics”
3. Fine (1975), “Critical Notice: *Counterfactuals* by D. Lewis”
4. Fine (2012), “Counterfactuals without Possible Worlds”
5. Lange (2009), *Laws and Lawmakers*: ch. 1
6. Lewis (1973), *Counterfactuals*: chs. 5–6
7. Maudlin (2007), *The Metaphysics within Physics*: chs. 1, 5
8. Roberts (2013), “Measurements, Laws, and Counterfactuals”
9. Sellars (1958), “Counterfactuals, Dispositions and the Causal Modalities”

**Lecture 8: Possibility (22. Jun)**

It may be that there are many ways to understand the idea of “metaphysics”, or that it bears many different relationships to physics. Or none and none. That is also a possibility.

Required Reading

1. Williamson (2018), “Spaces of Possibility”
2. Gyenis (2020), “Determinism, Physical Possibility, and Laws of Nature”

Suggested Reading: My Sympathies

1. Carnap (1956a), “Empiricism, Semantics and Ontology”
2. Carnap (1962), *Logical Foundations of Probability*: chs. I—III, especially §§18–20
3. Fletcher (2020), “Modality in Physics”
4. Lyon and Colyvan (2008), “The Explanatory Power of Phase Spaces”
5. Malament (1982), “*Science without Numbers: A Defense of Nominalism*, by Hartry H. Field (Book Review)”
6. Manchak (2018), “General Relativity as a Collection of Collections of Models”
7. Stalnaker (2003a), “The Interaction of Modality with Quantification and Identity”
8. Ruetsche (2011), *Interpreting Quantum Theories*: especially ch. 1, ch. 6–§1, ch. 12–§4, and ch. 15
9. Stalnaker (2012), *Mere Possibilities*: chs. 1–2
10. Stein (1992), “Was Carnap Entirely Wrong, After All?”

Suggested Reading: Those of Others

1. Belot (2011), *Geometric Possibility*
2. Bird (2007), *Nature’s Metaphysics*: chs. 5, 8
3. Field (2016), *Science without Numbers*
4. French (2017), “Building Bridges with the Right Tools: Modality and the Standard Model”
5. Lewis (1968), “Counterpart Theory and Quantified Modal Logic”
6. Lewis (1983b), “Postscripts to “Counterpart Theory and Quantified Modal Logic””
7. Lewis (1986), *On the Plurality of Worlds*: chs. 1–2
8. Vetter (2011), “Recent Work: Modality without Possible Worlds”
9. Vetter (2015), *Potentiality*
10. Williamson (1998), “Bare Possibilia”
11. Williamson (2013), *Modal Logic as Metaphysics*: chs. 1–4

**Lecture 9: Necessity and Causality (29. Jun)**

If something must be true, must it also be metaphysics?

Required Reading

1. Chakravartty (2007), *A Metaphysics for Scientific Realism*: chs. 4–5
2. Peirce (1892a), “The Doctrine of Necessity Examined”

Strongly Suggested Reading

1. Chakravartty (2007), *A Metaphysics for Scientific Realism*: Preface, chs. 1–3
2. Russell (1919), “On the Notion of Cause, with Applications to the Problem of Free Will”

Suggested Reading: My Sympathies

1. Anscombe (1971), “Causality and Determination”
2. Carnap (1956b), *Meaning and Necessity: A Study in Semantics and Modal Logic*
3. Carnap (1966), *Philosophical Foundations of Physics*: chs. 19–21
4. Curiel (2000), “The Constraints General Relativity Places on Physicalist Accounts of Causality”
5. Curiel (2020a), “Lecture Notes on an Introduction to the Philosophy of Charles Sanders Peirce, and a Survey of the Idea of “Pragmatism””
6. Doboszewski (2019), “Relativistic Spacetimes and Definitions of Determinism”
7. Earman (1986), *A Primer on Determinism*: chs. I–III, V
8. Earman, Roberts, and Smith (2002), “Ceteris Paribus Lost”
9. Haack (1979), “Fallibilism and Necessity”
10. Halvorson and Manchak (2021), “What Hole Argument?”
11. Legg and Misak (2016), “Charles Sanders Peirce on Necessity”
12. Norton (2003), “Causation as Folk Science”
13. Nozick (2001), *Invariances*: ch. 3
14. Peirce (1898), *Reasoning and the Logic of Things*: Lecture 6
15. Popper (1979), “Of Clouds and Clocks: An Approach to the Problem of Rationality and the Freedom of Man”
16. Skyrms (1980), *Causal Necessity*
17. Suppes (1993b), “The Transcendental Character of Determinism”

Suggested Reading: Those of Others

1. Bird (2007), *Nature’s Metaphysics*: ch. 3; ch. 4, §§3–5; ch. 9
2. Dowe (2000), *Physical Causation*
3. Fine (1994), “Essence and Modality: The Second Philosophical Perspectives Lecture”
4. Fine (2002), “The Varieties of Necessity”
5. Hildebrand (2020), “Non-Humean Theories of Natural Necessity”
6. Mackie (1980), *The Cement of the Universe*
7. Lange (2009), *Laws and Lawmakers*: ch. 2
8. Salmon (1994), “Causality without Counterfactuals”
9. Sider (2020), *The Tools of Metaphysics and the Metaphysics of Science*: ch. 2
10. Williamson (2013), *Modal Logic as Metaphysics*: chs. 6–8
11. Williamson (2016), “Modal Science”

## Lectures 10–11: Ontology and Metaphysics (6.–13. Jul)

### Lecture 10: Ontology (6. Jul)

Does metaphysics exist? If not, this course should have ended long ago.

#### Required Reading

1. Fine (1984), “The Natural Ontological Attitude”
2. Curiel (2019a), “How Can Physics Bear on Ontology? Or, The Dialectical Dance of Realism and Instrumentalism”

#### Suggested Reading: My Sympathies

1. Carnap (1956a), “Empiricism, Semantics and Ontology”
2. Curiel (2018), “On the Existence of Spacetime Structure”
3. Curiel (2019b), “What Can It Mean to Ask, Why Is There Something Rather Than Nothing?”
4. Curiel (2020c), “Schematizing the Observer and the Epistemic Content of Theories”
5. Halvorson (2019), “To Be a Realist about Quantum Theory”
6. Humphreys (2013), “Scientific Ontology and Speculative Ontology”

#### Suggested Reading: Those of Others

1. Azzouni (1998), “On ‘On What There Is’”
2. Azzouni (2004), *Deflating Existential Consequence*
3. Chakravartty (2017), *Scientific Ontology*: chs. 1–5
4. Field (2016), *Science without Numbers*
5. Fine (2009), “The Question of Ontology”
6. Lewis (1970), “How to Define Theoretical Terms”
7. Maddy (2007), *Second Philosophy*: Part IV, §§1, 5
8. Maudlin (2007), *The Metaphysics within Physics*: chs. 2, 6
9. Quine (1948), “On What There Is”
10. Quine (1951), “On Carnap’s Views on Ontology”
11. Quine (1969b), “Ontological Relativity”

### Lecture 11: Metaphysics and Methodology (13. Jul)

There may be more to metaphysics after all than the instrumentalist or empiricist admits, and less than the realist. But the pragmatist?

#### Required Reading

1. Stein (1995), “How Does Physics Bear Upon Metaphysics; and Why Did Plato Hold that Philosophy Cannot Be Written Down?”

#### Suggested Reading: My Sympathies

1. Carnap (1966), *Philosophical Foundations of Physics*: chs. 23–28

2. Hertz (1899), *The Principles of Mechanics Presented in a New Form*: “Author’s Preface”; “Introduction”
3. Peirce (1992), “What Is a Sign?” (also, Curiel 2020b, “Lecture Notes on Peirce’s ‘What Is a Sign?’ and Two Other Manuscripts on Semiotic”)
4. Putnam (1981), *Reason, Truth and History*: chs. 5–8
5. Smith and Seth (2020), *Brownian Motion and Molecular Reality*: ch. 7; “Postscript”
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7. Stein (1972), “On the Conceptual Structure of Quantum Mechanics”
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10. Stein (unpublished[a]), “On Metaphysics and Method in Newton”
11. Stein (unpublished[b]), “Further Considerations on Newton’s Method”
12. Stein (2021), “Physics and Philosophy Meet: The Strange Case of Poincaré”
13. Suppes (1993a), “The Role of Formal Methods in the Philosophy of Science”
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Suggested Reading: Those of Others

1. Bird (2007), *Nature’s Metaphysics*: ch. 10
2. Boyd (2012), “Realism, Natural Kinds, and Philosophical Methods”
3. Chakravartty (2007), *A Metaphysics for Scientific Realism*: chs. 7–8
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8. French and McKenzie (2012), “Thinking outside the Toolbox: Towards a More Productive Engagement between Metaphysics and Philosophy of Physics”
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**FINAL PAPER DUE: 27. SEP**

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