
The seminar will review the history of quantum theory in the first quarter of this century. It will cover the emergence of the old quantum theory and its development into modern quantum theory in the 1920s.

The fine print. Participants in this seminar are expected to attend regularly, read the assigned readings and take their turn in presenting material. The final grade is based on these presentations and on an essay to be submitted on Friday December 18 in 1017CL by 4:45 pm. My policy is NOT to issue incomplete grades, excepting in extraordinary circumstances. I really do want your essays completed and submitted by the end of term. I do not want them to linger on like an overdue dental checkup, filling your lives with unnecessary worry and guilt. In return for the rigidity of the deadline, the seminar will not meet in the final week of term (Tuesday December 15). The essay may be on any subject of relevance to the seminar. To assist you in commencing work, I ask you submit an essay proposal to me by November 17. The proposal need only be brief. It should contain a short paragraph describing the topic to be investigated and give a brief indication of the sources you intend to use. Feel free to talk to me about possible topics!

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Collections of Original Papers

- D. ter Haar, The Old Quantum Theory. Pergamon, 1967.
- G. Ludwig, Wave Mechanics. Pergamon, 1968.
- W. R. Hindmarsh, Atomic Spectra. Pergamon, 1967.
- B. L. van der Waerden, Sources of Quantum Mechanics. Dover, 1968.
- J. Stachel et al. Collected Papers of Albert Einstein. Vol. 2 Princeton Univ. Press.
Companion English Translation Volume, trans. A. Beck.
- A. I. Miller, Early Quantum Electrodynamics: A Source Book. Cambridge Univ. Press, 1994.

Topics

Black Body Radiation: Planck's Theory

- M. Planck, "On an Improvement of Wien's Equation for the Spectrum." (1900) (Ter Haar)
- M. Planck, "On the Theory of the Energy Distribution of the Normal Spectrum." (1900) (ter Haar)
- Rayleigh, "Remarks upon the Law of Complete Radiation," Phil. Mag. 1901; "The Dynamical Theory of Gases and of Radiation," Nature 1905.
- J. Jeans, "On the Partition of Energy between Matter and Aether," Phil. Mag. 1905.

Planck's Second Theory

- M. Planck, Theory of Heat Radiation. 2nd ed.

Einstein and the Light Quantum

- A. Einstein, "On a Heuristic Point of View about the Creation and Conversion of Light." (1905) (Ter Haar)
- A. Einstein, "On the Present Status of the Radiation Problem, (1906) (Einstein Papers Vol.2); "On the Development of our Views Concerning the Nature and Constitution of Radiation," (1909) (Einstein Papers Vol. 2)

Specific Heats and the Quantum Hypothesis

A. Einstein "Planck's Theory of Radiation and the Theory of Specific Heat," (1906)
(Einstein Papers Vol.2)

Emission and Absorption: A and B Coefficients

A. Einstein, "On the Quantum Theory of Radiation." (1917) (van der Waerden, Ter Haar)

Bohr's Model of the Atom

E. Rutherford, "The Scattering of Alpha and Beta Particles by Matter and the Structure of the Atom." (1911) (Ter Haar)

N. Bohr, "On the Constitution of Atoms and Molecules" (1913) (Ter Haar)

N. Bohr, "On the Quantum Theory of Line Spectra." (1918) (van der Waerden)

The Adiabatic Principle

P. Ehrenfest, "Adiabatic Invariants and the Theory of Quanta." (1917) (van der Waerden)

The Necessity of Quantum Discontinuity

J. Jeans, "On Non-Newtonian Mechanical Systems and Planck's Theory of Radiation,"
Phil. Mag. 1910

J. Jeans, Report on Radiation and the Quantum Theory 1st ed. 1914
Papers by Ehrenfest (1911) and Poincare (1912)

The Compton Effect

A. H. Compton, "The Spectrum of Scattered X Rays." Physical Review, 22 (1923), 409.
reprinted in M. H. Shamos (ed.) Great Experiments in Physics. (Dover?)

The BKS Proposal

N. Bohr, H. A. Kramers and J. C. Slater, "The Quantum Theory of Radiation." (1924)
(van der Waerden)

Preview of Revolution

A. Sommerfeld, Atombau und Spektrallinien (1923/24)

M. Born, Atommechanik (1924?)

"Histories" of quantum theory from the early 1920s

Scattering and Dispersion

H. A. Kramers, "The Law of Dispersion and Bohr's Theory of Spectra." (1924) (van der Waerden)

M. Born, "Quantum Mechanics" (1924) (van der Waerden)

H. A. Kramers, "The Quantum Theory of Dispersion." (1924) (van der Waerden)

J. H. van Vleck, "The Absorption of Radiation by Multiply Periodic Orbits, and its Relation to the Correspondence Principle and the Rayleigh-Jeans Law." (1924)
(van der Waerden)

- H. A. Kramers and W. Heisenberg, "On the Dispersion of Radiation by Atoms," (1925)
(van der Waerden)
W. Kuhn, "On the Total Intensity of Absorption Lines Emanating from a Given State."
(1925) (van der Waerden)

Heisenberg's Theory of Observables

- W. Heisenberg, "Quantum-Theoretical Re-Interpretation of Kinematic and Mechanical Relations." (1925) (van der Waerden)

Matrix Mechanics

- M. Born and P. Jordan, "On Quantum Mechanics I." (1925) (van der Waerden)
M. Born, W. Heisenberg and P. Jordan, "On Quantum Mechanics II." (1926) (van der Waerden)

De Broglie Waves

- L. de Broglie, "Investigations on Quantum Theory." (1924/5) (Ludwig)

Schroedinger and Wave Mechanics

- E. Schroedinger, "Quantization as an Eigenvalue Problem." 1st and 2nd
Communication. (1926) (Ludwig)
E. Schroedinger, "Quantization as an Eigenvalue Problem." 4th Communication. (1926)
(Ludwig)
E. Schroedinger, Collected Papers on Wave Mechanics. Chelsea.

Dirac: c-numbers and q-numbers

- P. Dirac, "The Fundamental Equations of Quantum Mechanics." (1926) (van der Waerden)
P. Dirac, "Quantum Mechanics and a Preliminary Investigation of the Hydrogen Atom."
(1926) (van der Waerden)

Consolidation of the various approaches

- E. Schroedinger, "On the Relationship of the Heisenberg-Born-Jordan Quantum Mechanics to Mine." (1926) (Ludwig)

Bose Einstein Statistics

The Aufbau Construction of the Elements

- W. Pauli, "On the Connexion between the Completion of Electron Groups in an Atom with the Complex Structure of Spectra." (1925) (Ter Haar)

Electron Spin

- G. E. Oulenberg and S. Goudsmit, "Spinning Electrons and the Structure of Spectra."
(1926) (Hindmarsh)

Some Useful Secondary Sources

Introductory sections of collections of original papers listed above.

Surveys

- E. Segre, From X-Rays to Quarks: Modern Physicists and Their Discoveries. San Francisco: Freeman, 1980. A good introductory survey.
- A. Hermann, The Genesis of the Quantum Theory (1899-1913) MIT Press, 1971. Short, but to the point.
- F. Hund, The History of Quantum Theory. Harper and Row, 1974. Short, but to the point.
- M. Jammer, Conceptual Development of Quantum Mechanics. McGraw-Hill, 1966. A standard survey. Synoptic but telegraphic.
- E. T. Whittaker, A History of Theories of Aether and Electricity. New York Harper, 1960. An old standard.
- O. Darrigol, From c-Numbers to q-Numbers: The Classical Analogy in History of Quantum Theory. Univ. of CA Press, 1992. New and interesting.
- P. Stehle, Order, Chaos, Order: The Transition from Classical to Quantum Physics. Oxford Univ. Press, 1994. Pitt author!
- C. Jungnickel and R. McCormmach, Intellectual Mastery of Nature. Vol. II: The Now Mighty Theoretical Physics 1870-1925. Univ. of Chicago. Attempt to merge internal and external history.
- J. Mehra and H. Rechenberg, The Historical Development of Quantum Theory. Springer. Multivolume attempt to say everything.
- V. V. Ezhela et al., Particle Physics: One Hundred Years of Discovery: An Annotated Chronological Bibliography. Springer 1996.
- H. H. Stroke (ed.), The Physical Review: The First Hundred Years: A Selection of Seminar Papers and Commentaries. (With CD) AIP Press, 1996.

Specialized Topics

- J. L. Heilbron, Historical Studies in the Theory of Atomic Structure. Arno Press, 1981. Good source for the Bohr model.
- H. Kangro, Early History of Planck's Radiation Law. London: Taylor & Francis, 1976. Detailed, heavy going.
- M. Klein, Paul Ehrenfest: Vol.1 The Making of a Theoretical Physicist. North Holland, 1985. Best source on Ehrenfest. Also good general introduction to early period.
- T. S. Kuhn, Black Body Theory and the Quantum Discontinuity 1894-1912. Oxford Univ. Press, 1978. Thorough study. Urges that Einstein not Planck really introduced quantum discontinuity.
- W. Moore, Schroedinger: Life and Thought. Cambridge Univ. Press, 1989.
- A. Pais, Subtle is the Lord...: The Science and Life of Albert Einstein. Oxford: Clarendon, 1982. Best survey of Einstein's scientific corpus.
- A. Pais, Niels Bohr's Times: In Physics, Philosophy and Polity. Oxford: Clarendon, 1991.
- A. Pais, Inward Bound: Of Matter and Forces in the Physical World. Oxford: Clarendon Press, 1986.