

Biographical and Scientific Information about Characters in *Copenhagen* (a play by Michael Frayn)

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<http://www.chem.yorku.ca/NAMED/>

Main Characters:

Niels Hendrik David Bohr

7 October 1885 - 16 November 1962

Danish, b. Copenhagen, Denmark

Ph.D. 1911 Copenhagen (C. Christiansen)

Physics Nobel Prize 1922

"for his services in the investigation of the structure of atoms and of the radiation emanating from them."

Bohr theory, model of atom

Bohr, N., *Phil. Mag.* **1913**, 26, 1; 476

Bohr, N., *Phil. Mag.* **1913**, 26, 857

Bohr's laws of line spectra of gases

Bohr, N. *Phil. Mag.* **1913**, 26, 1; 476; 857

Concept of complementarity

Bohr, N. *Phys. Rev.* **1935**, 48, 696

Aufbau principle (electron configuration of atoms)

Bohr, N. *Z. Physik* **1922**, 2, 1

Biographical references:

Rosenfeld, L. in *Dictionary of Scientific Biography* (Charles Gillispie, ed.), Charles Scribner's Sons: New York, 1970, Vol. 2, pp. 238 - 254

Daintith, J.; Mitchell, S.; Tootill, E.; Gjersten, D., *Biographical Encyclopedia of Scientists*, Institute of Physics Publishing: Bristol, UK, 1994

Cockcroft, Sir J., *Biog. Memoirs Fellows Roy. Soc.* **1963**, 2, 37

Current Biography 1945

Nobel Academy, <http://www.nobel.se>

Margrethe Bohr

1890 - 1984

Danish, b. Slagesle, Denmark

Biographical references:

Lustig, Harry *Biographies of Persons in Copenhagen*

<http://web.gc.cuny.edu/sciart/copenhagen/nyc/CopenhagenCharacters.doc>

(accessed February 2004)

Werner Karl Heisenberg

5 December 1901 - 1 February 1976

German, b. Würzburg, Germany

Ph.D. 1923 Munich (Arnold Sommerfeld)

Physics Nobel Prize 1933

"for the creation of quantum mechanics, the application of which has, inter alia, led to the discovery of the allotropic forms of hydrogen."

Heisenberg uncertainty principle

Heisenberg, W., *Z. Physik* **1927**, 43, 172

Biographical references:

Cassidy, D.C. in *Dictionary of Scientific Biography* (Charles Gillispie, ed.), Charles Scribner's Sons: New York, 1990, Supplement II, pp. 394 - 403.

Mott, Sir N.; Peierls, Sir R., *Biog. Memoirs Fellows Roy. Soc.* **1977**, 23, 213

Current Biography 1957

Nobel Academy, <http://www.nobel.se>

Other Scientists Mentioned in Script:

Max Born

11 December 1882 - 5 January 1970

German, b. Breslau, Germany, now Wroclaw, Poland

Ph.D. 1907 Göttingen (Christian Felix Klein)

Physics Nobel Prize 1954

"for this fundamental research in quantum mechanics, especially for this statistical interpretation of the wavefunction."

Born-Oppenheimer approximation

Born, M.; Oppenheimer, R., *Ann. Physik (Leipzig)* **1927**, 84, 457

Born postulate, Born-Haber cycle

Born, M., *Verhandl. Deut. Physik Ges.* **1919**, 21, 13

Haber, F. *Verhandl. Deut. Physik Ges.* **1919**, 21, 750

Biographical references:

Kemmer, N.; Schlapp, R., *Biog. Memoirs Fellows Roy. Soc.* **1971**, 17, 17

Nobel Academy, <http://www.nobel.se>

Prince Louis Victor de Broglie

15 August 1892 - 19 March 1987

French, b. Dieppe, France

D.Sc. 1924 Sorbonne (Maurice de Broglie)

Physics Nobel Prize 1929

"for his discovery of the wave nature of the electron."

de Broglie's law, de Broglie wavelength
 de Broglie, L., *Ann. Physik* **1925**, 3, 22
 de Broglie, L., *Nature* **1923**, 112, 540
 de Broglie, L., *Ann. Phys.* **1925**, 3, 22
 de Broglie, L., *Compt. Rend.* **1923**, 177, 517; 548; 630

Biographical references:

Abragam, A., *Biog. Memoirs Fellows Roy. Soc.* **1988**, 34, 21
 Millar, D.; Millar, I.; Millar, J.; Millar, M., *Chambers Concise Dictionary of Scientists*, W. & R. Chambers: Edinburgh, 1989
 Nobel Academy, <http://www.nobel.se>

Hendrick Brugt Gerhard Casimir

15 July 1909 - 2000
 Dutch, b. (Den Haag) The Hague, Netherlands
 D.Sc. 1931 Leiden
 PD Copenhagen (Niels Bohr)

Casimir effect

Casimir, H.B.G.; Polder, D. *Phys. Rev.* **1948**, 73, 360
 Casimir, H.B.G. *Proc. K. Ned. Akad. Wetensch.* **1948**, 60, 793

Casimir operator

Casimir, H.B.G. *Proc. Roy. Acad. Amsterdam* **1931**, 34, 844

Biographical references:

Debus, Allen G. (ed.) *World Who's Who in Science: A Biographical Dictionary of Notable Scientists from Antiquity to the Present*, 1st ed., Marquis-Who's Who, Inc.: Hannibal: Missouri, 1968, p. 308

Sir James Chadwick

20 October 1874 - 24 July 1974
 British, b. Bollington, England
 Ph.D. 1921 Cambridge (Ernest Rutherford)
 Physics Nobel Prize 1935
 "for the discovery of the neutron."

Discovery of neutron

Chadwick, J. *Nature* **1932**, 129, 312
 Chadwick, J. *Proc. Roy. Soc. London A* **1932**, 136, 692
 Chadwick, J. *Z. Elektrochem.* **1932**, 38, 546
 Chadwick, J. *Brit. J. Radiol.* **1933**, 6, 24
 Chadwick, J. *Proc. Roy. Soc. London A* **1933**, 142, 1

Biographical references:

Hendry, J. in Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1990, Vol. 17, Supplement II, 143
 Massey, Sir H.; Feather, N., *Biog. Memoirs Fellows Roy. Soc.* **1976**, 22, 11
 Current Biography 1945

Nobel Academy, <http://www.nobel.se>

Kurt Diebner

Biographical references:

Paul Adrien Maurice Dirac

8 August 1902 - 20 October 1984

British, b. Bristol, England

Ph.D. 1926 Cambridge (Ralph H. Fowler)

Physics Nobel Prize 1933 (shared with Erwin Schrödinger)

"for the discovery of new productive forms of atomic theory."

Quantum theory of electron, Dirac equation

Dirac, P.A.M. *Proc. Roy. Soc.* **1927**, 117A, 610

Dirac, P.A.M. *Proc. Roy. Soc.* **1928**, 118A, 351

Dirac, P.A.M., *The Principles of Quantum Mechanics*, Clarendon Press: Oxford, 1958

Dirac bra-ket ("bra" and "ket") notation

Dirac, P.A.M., *The Principles of Quantum Mechanics*, Clarendon Press: Oxford, 1958

Fermi-Dirac distribution

Dirac, P.A.M., *Proc. Roy. Soc. London Ser. A.*, **1926**, 112, 661

Fermi, E., *Z. Physik* **1926**, 36, 902

Dirac $h = h/2\pi = 1.054 \times 10^{-34}$ J s

Biographical references:

Dalitz, R.H.; Peierls, Sir R. *Biog. Memoirs Fellows Roy. Soc.* **1986**, 32, 137

Nobel Academy, <http://www.nobel.se>

Albert Einstein

14 March 1879 - 18 April 1955

German-Swiss-American, b. Ulm, Bavaria, Germany

Ph.D. 1905 Zurich (Alfred Kleiner, Heinrich Burkhardt)

Physics Nobel Prize 1921

"for his service to theoretical physics, and especially for his discovery of the law of the photoelectric effect."

Photoelectric effect

Einstein, A. *Ann. Physik* **1905**, 17, 132

General theory of relativity

Einstein, A. *Berl. Sitz.* **1915**, 778; 799; 831; 844

Einstein, A. *Ann. Physik* **1916**, 49, 769

Special theory of relativity

Einstein, A. *Ann. Physik* **1905**, 17, 891

Light quanta; photons concept

Einstein, A. *Ann. Physik* **1905**, 17, 132

Einstein, A. *Ann. Physik* **1906**, 20, 199

Bose-Einstein statistics

Bose, S.N., *Z. Physik* **1924**, 26, 178

Einstein, A., *Berliner Ber.* **1924**, 261

Einstein, A., *Berliner Ber.* **1925**, 3

Einstein mass-energy equation

Einstein, A., *Ann. Physik* **1905**, 17, 891

Einstein, A., *Ann. Physik* **1916**, 49, 769

Einstein, A., *Berlin Sitzber.* **1915**, 778; 799; 831; 844

Einstein equation for specific heat, Einstein law, Einstein temperature

Einstein, A., *Ann. Physik* **1907**, 22, 180

Einstein-Smoluchowski equation

Einstein, A., *Z. Elektrochem.* **1908**, 14, 235

Smoluchowski, M., *Ann. Physik* **1908**, 25, 205

Biographical references:

Wheeler, J.A., *Biog. Memoirs Natl. Acad. Sci.* **1980**, 51, 97

Whittaker, Sir E., *Biog. Memoirs Fellows Roy. Soc.* **1955**, 1, 37

Current Biography 1953

Nobel Academy, <http://www.nobel.se>

Enrico Fermi

29 September 1901 - 30 November 1954

Italian-American, b. Rome, Italy

Ph.D. 1922 Pisa (Luigi Puccianti)

Physics Nobel Prize 1938

"for his demonstration of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons."

Synthesis of new radioactive elements using slow neutrons

Fermi, E. *Nature* **1934**, 133, 757; 898

Fermi, E.; Pontecorvo, B.; Rasetti, F. *Ricerca Sci.* **1934**, 5(II), 380

Fermi, E.; Amaldi, E.; D'Agostino, O.; Rasetti, F.; Segre, E. *Proc. Roy. Soc. London* **1934**, 146A, 483

Amaldi, E.; Fermi, E. *Ricerca Sci.* **1935**, 6, 344; 443

Amaldi, E.; D'Agostino, O.; Fermi, E.; Pontecorvo, B.; Rasetti, F.; Segre, E. *Proc. Roy. Soc. London* **1935**, 149A, 522

Fermi, E.; Amaldi, E. *Phys. Rev.* **1936**, 50, 899

Amaldi, E.; Fermi, E. *Ricerca Sci.* **1936**, 7(I), 310; 393

Amaldi, E.; Fermi, E.; Rasetti, F. *Ricerca Sci.* **1937**, 8(II), 40

Fermi, E.; Amaldi, E.; Wick, G.C. *Phys. Rev.* **1938**, 53, 493

Fermi, E.; Amaldi, E. *Phys. Rev.* **1938**, 53, 493

Anderson, H.L.; Fermi, E.; Hanstein, H.B. *Phys. Rev.* **1939**, 55, 797

Anderson, H.L.; Fermi, E.; Szilard, L. *Phys. Rev.* **1939**, 56, 284

Fermi, E. *Science* **1940**, 92, 269

Fermi, E. *Nature* **1940**, 146, 640

Chain reacting atomic pile

Fermi, E.; Segre, E. *Phys. Rev.* **1941**, 59, 680

Fermi, E. *Proc. Am. Phil. Soc.* **1946**, 90, 20

Biographical references:

Bretscher, E.; Cockcroft, Sir J. *Biog. Memoirs Fellows Roy. Soc.* **1955**, 1, 69

Allison, S.K. *Biog. Memoirs Natl. Acad. Sci.* **1957**, 30, 125

Nobel Academy, <http://www.nobel.se>

Siegfried Flügge

16 March 1912 - 15 December 1997

German, b. Dresden, Germany

Ph.D. 1933 Göttingen

Flügge, S. *Naturwiss.* **1939**, 27, 451

"Kann der Energieinhalt der Atomkerne technisch nutzbar gemacht werden?"

Biographical references:

Pogg. 7A(2), 77; 8(2), 1223

Schlögl, F. *Physics Today* **1998**, 51(8), 77

Schlögl, F.; Klar, H. *Physik. Bl.* **1998**, 54, 448

Otto Robert Frisch

1 October 1904 - 22 September 1979

Austrian, b. Vienna, Austria

Ph.D. 1926 Vienna (Karl Przibram)

Meitner, L.; Frisch, O.R. *Nature* **1939**, 143, 239; 471

Frisch, O.R. *Annual Reports on the Progress of Chemistry* **1939**, 36, 7

Biographical references:

Peierls, Sir R. *Biog. Memoirs Fellows Roy. Soc.* **1981**, 27, 283

George Gamow

4 March 1904 - 20 August 1968

Russian, b. Odessa, Ukraine

Ph.D. 1928 Petrograd (St. Petersburg)

Hypothesis of existence of neutrino

Gamow, G. *Physik. Blaetter* **1949**, 5, 108

Gamow-Condon-Gurney law

Gamow, G. *Z. Physik* **1928**, 51, 204

Condon, E.U.; Gurney, R.W. *Phys. Rev.* **1929**, 33, 127

Gamow-Teller selection rule

Gamow, G.; Teller, E. *Phys. Rev.* **1936**, 49, 895

Biographical references:

Stuewer, R.H. in Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1972, Vol. 5, 271

Walther Gerlach

1 August 1899 - 10 August 1979

German, b. Bieberich, Germany

Ph.D. 1912 Tübingen (Friedrich Paschen)

Stern-Gerlach experiment

Stern, O.; Gerlach, W. *Z. Physik* **1922**, 8, 110

Biographical references:

Debus, Allen G. (ed.) *World Who's Who in Science* 1st ed., Marquis-Who's Who, Inc.: Hannibal: Missouri, 1968

Pogg. 5, 420

<http://www1.physik.tu-muenchen.de/~kressier/Bios/Gerlach.html>

(accessed February 2004)

Samuel Abraham Goudsmit

11 July 1902 - 4 December 1978

Dutch-American, b. The Hague, Netherlands

Ph.D. Leiden 1927 (Paul Ehrenfest)

Spin concept

Uhlenbeck, G.; Goudsmit, S.A. *Naturwiss.* **1925**, 13, 953

Uhlenbeck, G.; Goudsmit, S.A. *Nature* **1926**, 117, 264

Biographical references:

Goldberg, S. in Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1990, Vol. 17, Supplement II, 362

Current Biography 1954

Otto Hahn

8 March 1879 - 28 July 1968

German, b. Frankfurt-am-Main, Germany

Ph.D. 1901 Marburg (Theodore Zincke)

Chemistry Nobel Prize 1944

"for his discovery of the fission of heavy nuclei."

Nuclear fission

Meitner, L. *Naturwissenschaften* **1934**, 22, 759

Hahn, O.; Meitner, L. *Naturwissenschaften* **1935**, 23, 37; 230; 320

Hahn, O.; Meitner, L.; Strassmann, F. *Naturwissenschaften* **1935**, 23, 544

Hahn, O.; Meitner, L.; Strassmann, F. *Chem. Ber.* **1936**, 69B, 905

Meitner, L.; Hahn, O. *Naturwissenschaften* **1936**, 24, 158

Hahn, O.; Meitner, L.; Strassmann, F. *Chem. Ber.* **1937**, 70B, 1374

Meitner, L.; Hahn, O.; Strassmann, F. *Z. Physik* **1937**, 106, 249

Hahn, O.; Meitner, L.; Strassmann, F. *Naturwissenschaften* **1938**, 26, 475

Hahn, O.; Meitner, L. *Scientia* **1938**, 63, 12

Hahn, O. *Ann. Chem. Physik* **1939**, 36, 368

Hahn, O.; Strassmann, F. *Naturwissenschaften* **1939**, 27, 11; 89; 163

Hahn, O.; Strassmann, F. *Physik. Z.* **1939**, 40, 673

Meitner, L.; Frisch, O.R. *Nature* **1939**, 143, 239; 471

Bohr, N.; Wheeler, J. *Phys. Rev.* **1939**, 56, 426
 Hahn, O.; Strassmann, F. *Naturwissenschaften* **1940**, 28, 455
 Hahn, O.; Strassmann, F. *Forschungen u. Fortschr.* **1940**, 16, 31
 Hahn, O. *Scientia* **1941**, 68, 8
 Hahn, O. *Chem. Ztg.* **1942**, 66, 317

Biographical references:

Badash, L. in Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1981, Vol. 6, 14
 Spence, R. *Biog. Memoirs Fellows Roy. Soc.* **1970**, 16, 279
 Current Biography 1951
 Nobel Academy, <http://www.nobel.se>

Paul Harteck

20 July 1902 - 1985
 Austrian, b. Vienna, Austria
 Ph.D. 1926 Berlin (Max Bodenstein)

Discovery of parahydrogen

Bonhoeffer, K.F.; Harteck, P. *Naturwiss.* **1929**, 17, 182

Biographical references:

Pogg. 6(2), 1032; 7A(2), 381

Fritz Georg Houtermans

22 January 1903 - 1 March 1966
 German, b. Danzig (now Gdansk), Poland
 Ph.D. 1927 Göttingen (James Franck)

Biographical references:

Pogg. 7A(2), 558; 8(2), 1560
 Khriplovich, I.B. *Physics Today* **1992**, xx(7), 29

Peter Jensen

Biographical references:

Frédéric Joliot-Curie

19 March 1900 - 14 August 1958
 French, b. Paris, France
 D.Sc. 1920s Radium Institute Paris (Marie Curie, Paul Langevin)
 Chemistry Nobel Prize 1935 (shared with Irène Joliot-Curie)
"in recognition of their synthesis of new radioactive elements."

Synthesis of radioactive elements

Joliot, F.; Joliot-Curie, I. *Compt. Rend. Acad. Sci.* **1934**, 198, 254
 Joliot-Curie, I.; von Halban, H.; Prieswerk, P. *J. Phys. Radium (France)* **1925**, 6

Biographical references:

Blackett, P.M.S. *Biog. Memoirs Fellows Roy. Soc.* **1960**, 6, 87
 Nobel Academy, <http://www.nobel.se>

Ernst Pascual Jordan

18 October 1902 -

German, b. Hannover, Germany

Ph.D. 1924 Göttingen (Max Born)

Born, M.; Jordan, P. *Zeitschrift fuer Physik* **1925**, 33, 479-505.

Born, M.; Jordan, P.; Nordheim, L. *Naturwissenschaften* **1925**, 13, 969-70.

Born, M.; Jordan, P. *Zeitschrift fuer Physik* **1925**, 34, 858-88

Born, M.; Heisenberg, W.; Jordan, P. *Zeitschrift fuer Physik* **1926**, 35, 557-615

Born, Max; Jordan, Pascual. *Elementare Quantenmechanik*. J. Springer: Berlin, 1930

Biographical references:

Pogg. 6(2), 1254; 7A(2), 648

Oskar Benjamin Klein

15 September 1894 - 1977

Swedish, b. Mörby, Stockholm, Sweden

Ph.D. 1921 Stockholm Högskola

Biographical references:

Pogg. 6(2), 1330; 7B(4), 2492

Hendrik Antony Kramers

17 December 1894 - 24 April 1952

Dutch, b. Rotterdam, Netherlands

Ph.D. 1916 Leiden (Paul Ehrenfest)

WKB (Wentzel-Kramers-Brillouin) or JWKB (Jeffreys- Wentzel-Kramers-Brillouin) method

Wentzel, G., *Z. Physik* **1926**, 38, 519

Brillouin, L., *Compt. Rend.* **1926**, 183, 24

Kramers, H.A., *Z. Physik* **1926**, 39, 828

Jeffreys, H., *Proc. London Math. Soc.* **1925**, 23, 428

Biographical references:

Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1973, Vol. 7, p. 491

Lev Davidovich Landau

28 January 1908 - 1 April 1970

Russian, b. Baku, USSR (now Azerbaidzhan)

Ph.D. 1934 Leningrad (St. Petersburg) (Niels Bohr in Copenhagen)

Physics Nobel Prize 1962

"for his pioneering theories for condensed matter, especially liquid helium."

Concept of density matrix for energy

Concepts in condensed matter physics

Landau, L.D. *Phys. Z. Sowjet.* **1937**, 11, 26; 129; 545

Landau, L.D.; Pomeranchuk, I. *Phys. Z. Sowjet.* **1936**, 10, 649

Landau, L.D. *J. Phys. USSR* **1941**, 5, 71

Landau, L.D. *J. Phys. USSR* **1946**, 11, 91

Landau, L.D. *J. Phys. USSR* **1943**, 7, 99
 Landau, L.D. *J. Phys. USSR* **1944**, 8, 1
 Landau, L.D.; Khalatnikov, I.M. *JETP* **1949**, 19, 637; 709
 Landau, L.D.; Ginzburg, V.L. *JETP* **1950**, 20, 1064
 Landau, L.D. *JETP* **1956**, 30, 1058
 Landau, L.D. *JETP* **1957**, 32, 59
 Landau, L.D. *JETP* **1958**, 35, 97

Biographical references:

Physics Today **1962**, 15(12), 56
Physics Today **1968**, 21(6), 103
 Ryndina, E. *Physics Today* **2004**, 57(2), 53
 Nobel Academy, <http://www.nobel.se>

Max Theodore von Laue

9 October 1879 - 24 April 1960
 German, b. Pfaffendorf, Koblenz, Germany
 Ph.D. 1903 Berlin (Max Planck)
 Physics Nobel Prize 1914
"for his discovery of the diffraction of X-rays by crystals."

Laue symmetry groups

Friedrich, W.; Knipping, P.; v. Laue, M., *Sitzber. Math.-Phys. Klasse Bayer. Akad. Wissen. Munchen* **1912**, 303

Discovery of diffraction of X-rays by crystals

Friedrich, W.; Knipping, P.; Laue, M. *Sitzungsber. Bayer. Akad. Wiss. (Math. Phys. Klasse)* **1912**, 303
 Friedrich, W.; Knipping, P.; Laue, M. *Ann. Physik* **1913**, 41, 971

Biographical references:

Ewald, P.P. *Biog. Memoirs Fellows Roy. Soc.* **1960**, 6, 135
 Nobel Academy, <http://www.nobel.se>

Lise Meitner

7 November 1878 - 27 October 1968
 Austrian, b. Vienna, Austria
 Ph.D. 1906 Vienna (Franz Exner)

Discovery of proactinium (element 91)

Hahn, O.; Meitner, L. *Physik. Z.* **1918**, 19, 208
 Hahn, O.; Meitner, L. *Chem. Ber.* **1919**, 52B, 1812
 Hahn, O.; Meitner, L. *Chem. Ber.* **1921**, 54B, 69
 Hahn, O.; Meitner, L. *Z. Physik* **1922**, 8, 202

Nuclear fission

Meitner, L. *Naturwissenschaften* **1934**, 22, 759
 Hahn, O.; Meitner, L. *Naturwissenschaften* **1935**, 23, 37; 230; 320
 Hahn, O.; Meitner, L.; Strassmann, F. *Naturwissenschaften* **1935**, 23, 544
 Hahn, O.; Meitner, L.; Strassmann, F. *Chem. Ber.* **1936**, 69B, 905
 Meitner, L.; Hahn, O. *Naturwissenschaften* **1936**, 24, 158

Hahn, O.; Meitner, L.; Strassmann, F. *Chem. Ber.* **1937**, 70B, 1374
 Meitner, L.; Hahn, O.; Strassmann, F. *Z. Physik* **1937**, 106, 249
 Hahn, O.; Meitner, L.; Strassmann, F. *Naturwissenschaften* **1938**, 26, 475
 Hahn, O.; Meitner, L. *Scientia* **1938**, 63, 12
 Hahn, O. *Ann. Physik* **1939**, 36, 368
 Hahn, O.; Strassmann, F. *Naturwissenschaften* **1939**, 27, 11; 89; 163
 Hahn, O.; Strassmann, F. *Physik. Z.* **1939**, 40, 673
 Meitner, L.; Frisch, O.R. *Nature* **1939**, 143, 239; 471
 Hahn, O.; Strassmann, F. *Naturwissenschaften* **1940**, 28, 455
 Hahn, O.; Strassmann, F. *Forschungen u. Fortschr.* **1940**, 16, 31
 Hahn, O. *Scientia* **1941**, 68, 8
 Hahn, O. *Chem. Ztg.* **1942**, 66, 317
 Hahn, O.; Strassmann, F. *Naturwissenschaften* **1943**, 31, 499
 Meitner, L. *Rev. Modern Phys.* **1945**, 17, 287

Biographical references:

Frisch, O.R. *Biog. Memoirs Fellows Roy. Soc.* **1970**, 16, 405
 Sime, R.L. *J. Chem. Educ.* **1989**, 66, 373
 Current Biography 1945

Christian Møller

22 December 1904 - 1980
 Danish, b. Notmark, Denmark

Møller-Plesset single point energy calculation

Møller, C.; Plesset, M.S., *Phys. Rev.* **1934**, 46, 618

Biographical references:

Turkevich, John; Turkevich, Ludmilla B. *Prominent Scientists of Continental Europe*, Elsevier: New York, 1968
 World Biographical Index, K.G. Saur Publishing,
http://www.biblio.tu-bs.de/acwww25u/wbi_en/
 Kay, E. (ed.) *Dictionary of Scandinavian Biography*, 2nd ed., International Biographical Center: Cambridge, 1976

Julius Robert Oppenheimer

22 April 1904 - 18 February 1967
 American, b. New York City, New York, USA
 Ph.D. 1927 Göttingen (Max Born)

Biographical references:

Bethe, H.A. *Biog. Memoirs Fellows Roy. Soc.* **1968**, 14, 391
 Bethe, H.A. *Biog. Memoirs Natl. Acad. Sci.* **1997**, 71, 175

Wolfgang Pauli

25 April 1900 - 14 December 1958
 Austrian-American, b. Vienna, Austria
 Physics Nobel Prize 1945

"for the discovery of the exclusion principle, also called the Pauli principle."

Pauli exclusion principle

Pauli, W., *Naturwiss.* **1924**, 12, 741

Pauli principle

Pauli, W., *Phys. Rev.* **1940**, 58, 716

Biographical references:

Valko, E.I., *J. Chem. Educ.* **1950**, 27, 2

Nobel Academy, <http://www.nobel.se>

Sir Rudolf Ernst Peierls

5 June 1907 - 1995

German-British, b. Berlin, Germany

Ph.D. 1929 Leipzig (Wolfgang Pauli)

Biographical references:

Pogg. 6(3), 1973; 7A(3), 522

Chem. Intelliger 2000, 6(April), 54

Francis Perrin

17 August 1901 - 1992

French, b. Paris, France

D.Sc. Paris (Jean-Baptiste Perrin)

Concept of critical mass

Perrin, F. *Compt. Rend.* **1939**, 208, 1394; 1573

Biographical references:

Pogg. 6(3), 1986

Aage Petersen

Biographical references:

Stefan Rozentel

1903 - 1994

Polish, b. Lodz, Poland

Ph.D. 1928 Cracow

PD Leipzig (Werner Heisenberg)

PD Copenhagen (Niels Bohr)

Biographical references:

<http://www.nbi.dk/NBA/icos/rozen.html>, Felicity Pors, 1998

(accessed February 2004)

Erwin Schrödinger

12 August 1887 - 4 January 1961

Austrian, b. Vienna, Austria

Ph.D. 1910 Vienna (Friedrich Hasenohrl)

Physics Nobel Prize 1933 (shared Paul A.M. Dirac)

"for the discovery of new productive forms of atomic theory."

Schrödinger equation

Schrödinger, E., *Ann. Physik* **1926**, 79, 361

Schrödinger, E., *Ann. Physik* **1926**, 79, 489

Schrödinger, E., *Ann. Physik* **1926**, 80, 437

Schrödinger, E., *Ann. Physik* **1926**, 81, 109

Biographical references:

Gillispie, Charles Coulston (ed.), *Dictionary of Scientific Biography*, Charles Scribner & Sons: New York, 1975, Vol. 12, p. 217

Daintith, J.; Mitchell, S.; Tootill, E.; Gjersten, D., *Biographical Encyclopedia of Scientists*, Institute of Physics Publishing: Bristol, UK, 1994

Nobel Academy, <http://www.nobel.se>

Arnold Johannes Wilhelm Sommerfeld

5 December 1868 - 26 March 1951

German, b. Königsberg, Prussia, now Kaliningrad, Lithuania

Ph.D. 1891 Königsberg (Carl Louis Ferdinand Lindemann)

Sommerfeld model of atom

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Flügge, S., *Angew. Chem.* **1952**, 64, 37

Eckert, M. *Hist. Stud. Phys. Biol. Sci.* **1987**, 17, 191

Fritz Strassmann

22 February 1902 - 22 April 1980

German, b. Boppard, Germany

Ph.D. 1929 TU Hannover (H. Braune)

Biographical references:

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Edward Teller

15 January 1908 - 9 September 2003

Hungarian, b. Budapest, Hungary

Ph.D. Göttingen (Werner Heisenberg)

BET method

Brunauer, S.; Emmett, P.H.; Teller, E. *J. Am. Chem. Soc.* **1938**, 60, 309

Teller, E. *ACS Symp. Ser.* **1983**, 222, 227

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Schulz, W. *Chem. Eng. News* **2003**, 81(37), 9

Current Biography 1983

George Eugene Uhlenbeck

6 December 1900 - 31 October 1988

Dutch-American, b. Batavia (now Djakarta), Java, Indonesia

Ph.D. Leiden (Paul Ehrenfest)

Spin concept

Uhlenbeck, G.; Goutsmit, S.A. *Naturwiss.* **1925**, 13, 953

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<http://physics.rug.ac.be/Fysica/Geschiedenis/Mathematicians/Uhlenbeck.html>

Carl Freidrich Freiherr von Weizäcker

28 June 1912 -

German, b. Kiel, Germany

Ph.D. 1933 Leipzig (Werner Heisenberg)

Biographical references:

Die Zeit **1957**, 12(19), 2

Pogg. 7A(5), 920

Current Biography 1965

John Archibald Wheeler

9 July 1911 -

American, b. Jacksonville, Florida, USA

Ph.D. 1933 Johns Hopkins (Niels Bohr at Copenhagen)

Coining of "Black hole"

Wheeler, J.A. in *Atti Conv. Mendeleeviano Period. Simmetrie Struttura Elem. Mater.* (M. Verde, ed.) **1971**, 189 - 233

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Coining of "Particle physics"

Wheeler, J.A. *Am. Scientist* **1947**, 35, 177

Biographical references:

Current Biography 1970

Karl Eugen Julius Wirtz

24 April 1910 -

German, b. Köln, Germany

Ph.D. 1934 Breslau (Wroclaw, Poland) (Clemens Schaefer)

PD Leipzig (K.F. Bonhoeffer)

PD KWI-Physik (Peter Debye, Werner Heisenberg)

Biographical references:

Pogg. 7A(5), 1037

Scientists Mentioned in Postscript:

Manfred von Ardenne

20 January 1907 - 26 May 1997

German, b. Hamburg, Germany

Studied in Berlin 1930s

First patent on multiple electron tube, 1923

First broadband amplifier, 1925

Flying spot scanner, 1930

First transmission of television pictures, 1933

High resolution universal electron microscopy, 1940

Development of Russian atomic weapons program, 1946 - 1954

Establishment of Research Institute Manfred von Ardenne in Dresden, Germany (1955 - 1991)

Biographical references:

<http://www.dhm.de/lemo/html/biografien/ArdenneManfred>

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Reball, S. *Elektrie* **1987**, 41, 84

Jeremy Bernstein

31 December 1929 -

American, b. Rochester, New York, USA

Ph.D. 1955 Harvard

Biographical references:

American Men and Women of Science, 21st ed.

Hans Albrecht Bethe

2 July 1902 -

German, b. Strassburg, Alsace-Lorraine (now Strasbourg, France)

Ph.D. 1928 Munich (Arnold Sommerfeld)

Physics Nobel Prize 1967

"for his contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production in stars."

Biographical references:

Current Biography 1950

Nobel Academy, <http://www.nobel.se>

Aage Bohr

19 June 1922 -

Danish, b. Copenhagen, Denmark

Ph.D. 1954 Copenhagen (Benjamin Mottelson)

Physics Nobel Prize 1975 (shared with Benjamin Mottelson and James Rainwater)

"for the discovery of the connection between collective motion and particle motion in atomic nuclei and the development of the theory of the structure of the atomic nucleus based on this connection."

Biographical references:

Nobel Academy, <http://www.nobel.se>

Karl Clusius

19 March 1903 - 1963

German, b. Breslau (now Wroclaw, Poland)

Ph.D. 1928 Breslau (Wroclaw, Poland) (Arnold Eucken)

PD Oxford (Cyril N. Hinshelwood)

PD Leiden (W.H. Keesom)

Clusius-Dickel thermal diffusion column

Clusius, K.; Staveley, L.; Dickel, G. *Z. Physik. Chem.* **1941**, 50B, 403

Clusius, K.; Dickel, G. *Naturwiss.* **1940**, 28, 711

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Biographical references:

Pogg. 7A, 351

Oesper, R. *J. Chem. Educ.* **1951**, 28, 321

Gerhard Dickel

28 October 1913 -

German, b. Augsburg, Germany

Ph.D. 1939 Munich (Karl Clusius)

Clusius-Dickel thermal diffusion column (separation of isotopes)

See references under Karl Clusius

Biographical references:
Pogg. 7A(1), 403; 8(2), 838

Hugh Everett III

11 November 1930 - 19 July 1982
 American, b. Washington, DC, USA
 Ph.D. 1957 Princeton (John A. Wheeler)

Biographical references:
<http://www.hep.upenn.edu/~max/everett/everettbio.pdf>
 (accessed February 2004)

Murray Gell-Mann

15 September 1929 -
 American, b. New York City, New York, USA
 Ph.D. 1951 MIT (Victor Weisskopf)
 Physics Nobel Prize 1969
"for his contributions and discoveries concerning the classification of elementary particles and their interactions."

Biographical references:
 Nobel Academy, <http://www.nobel.se>

Balazs Laszlo Gyorffy (physicist consultant for Michael Frayn at U. Bristol)

1938 -
 Hungarian-British, b. ?
 Ph.D. Yale 1966 (Willis E. Lamb, Jr.)

Biographical references:
Who's Who in Science in Europe, 9th ed., Catermill International Ltd.: London, 1995, Vol. 1, p. 666

Gustav Ludwig Hertz

22 July 1887 - 1975
 German, b. Hamburg, Germany
 Ph.D. 1911 Berlin (James Franck)
 Physics Nobel Prize 1925
"for their discovery of the laws governing the impact of an electron upon an atom."

Franck-Condon transition, Franck-Condon factor,
 Franck-Condon principle
 Franck, J., *Trans. Faraday Soc.* **1925**, 21, 536

Biographical references:
 Nobel Academy, <http://www.nobel.se>

Igor Vasil'evich Kurchatov

1903 - 7 February 1960
 Russian, b. Russia
 Ph.D. 1925 Baku Polytechnik

Biographical references:
Current Biography 1957

Rudolf Ladenburg

6 June 1882 - 6 April 1952
German, b. Kiel, Germany
Ph.D. 1906 Munich (Wilhelm C. Roentgen)

Biographical references:
Pogg. 6(3), 1444; 7A(3), 4
Kopfermann, H. *Naturwiss.* **1952**, 39, 289

Yuval Ne'elma

14 May 1925 -
Israeli, b. Tel-Aviv, Israel
Ph.D. Imp. Coll. London 1961 (Abdus Salam)

Biographical references:
<http://www-obs.tau.ac.il/judaism>
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John von Neumann

28 December 1903 - 8 February 1957
Hungarian-American, b. Budapest Hungary
Ph.D. 1926 Budapest

Biographical references:
Bochner, S. *Biog. Memoirs Natl. Acad. Sci.* **1953**, 32, 438
Current Biography 1955

Roger Penrose

8 August 1931 -
British, b. Colchester, England
Ph.D. 1957 London (John Arthur Todd)

Penrose impossible figures
Penrose, L.S.; Penrose, R. *Brit. J. Psychology* **1958**, 49, 31

Biographical references:
Index of Biographies, University of St. Andrews, Mathematical Chronology <http://www-groups.dcs.st-and.ac.uk/~history/BioIndex.html>

Leo Szilard

11 February 1898 - 30 May 1964
Hungarian, b. Budapest, Hungary
Ph.D. 1922 Berlin (Max von Laue)

Szilard-Chalmers effect
Szilard, L.; Chalmers, T.A. *Nature* **1934**, 134, 494; 462
Szilard, L.; Chalmers, T.A. *Nature* **1935**, 135, 98

Biographical references:

Wigner, E. *Biog. Memoirs Natl. Acad. Sci.* **1994**, 40, 337

Current Biography 1947

Spencer Richard Weart

8 March 1942 -

American, b. Detroit, Michigan, USA

Ph.D. 1968 (Colorado at Boulder)

PD Cal Tech

Biographical references:

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American Men and Women in Science, 21st ed.

Victor Weisskopf

19 September 1908 - 22 April 2002

Austrian-American, b. Vienna, Austria

Ph.D. 1931 Göttingen (Max Born)

PD Leipzig (Werner Heisenberg)

PD Berlin (Erwin Schrodinger)

PD Copenhagen (Niels Bohr)

PD Cambridge (Paul A.M. Dirac)

PD Zurich (Wolfgang Pauli)

Biographical references:

Current Biography 1976

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<http://web.gc.cuny.edu/sciart/copenhagen/nyc/CopenhagenCharacters.doc> (accessed February 2004)