Appendix A of the text gives a brief chronology of modern physics. This online version is a more extensive version of the same chronology.

- We include here all the events listed in Appendix A, but add many more.
- We also cite here, whenever possible, the paper where each breakthrough was first published.

Although this list is still by no means comprehensive, it should give you a good sense of the overall timeline. We begin with just a few important pre-modern milestones that are important to the 20th-century narrative.

When we cite a discovery as "online" that means we discuss that topic in an online section. All such sections are available at:

felderbooks.com/modernphysics/contents

1632	Galileo's *Dialogo sopra i due massimi sistemi del mondo* (*Dialogue Concerning the Two Chief World Systems*) contains the principle that we today call Galilean (or classical) relativity. This principle will become one of the cornerstones of Einstein's relativity.	Section 1.1
1687	Isaac Newton's *Philosophiæ Naturalis Principia Mathematica* (*The Mathematical Principles of Natural Philosophy*) lays out his laws of motion. (Fun fact: Newton wrote $F = p'$, not $F = ma$.)	
1804	Thomas Young's paper "Experiments and Calculations Relative to Physical Optics" describes an early form of the double-slit experiment that demonstrates the wave nature of light.	Section 3.2
1861	James Maxwell's paper "On Physical Lines of Force" lays out a set of equations summarizing classical electromagnetism. Maxwell's roughly 20 equations were later combined into 4 by Oliver Heaviside.	
1887	Albert Michelson and Edward Morley's paper "On the Relative Motion of the Earth and the Luminiferous Ether" describes their failed attempt to detect the Earth's motion through the aether.	Section 2.5
1889	Johannes Rydberg's paper "Researches sur la constitution des spectres d'émission des éléments chimiques" ("Research on the Constitution of the Emission Spectra of Chemical Elements") gives a formula for the spectral lines of hydrogen and hydrogen-like atoms.	Section 4.1
1897	In two papers, both entitled "Cathode Rays," J.J. Thomson announces the discovery—and measures the mass and charge—of very light, negatively charged particles that are parts of atoms. (Thomson used the word "corpuscles" for what we now call electrons.)	

1900	Max Planck proposes quantization of cavity radiation to resolve the ultraviolet catastrophe. (He developed the ideas behind this proposal in a series of papers and talks in 1900 and 1901.)	Section 3.4
1905	Albert Einstein's paper "Zur Elektrodynamik bewegter Körper" ("On the Electrodynamics of Moving Bodies") introduces his special theory of relativity. Later that year he publishes "Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?" ("Does the Inertia of a Body Depend Upon Its Energy Content?") which introduces an early form of the relation $E = mc^2$.	Chapters 1–2
1905	Einstein's paper "Über einem die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt" ("On a Heuristic Viewpoint Concerning the Production and Transformation of Light") shows that the quantization of light, earlier proposed by Planck, explains the photoelectric effect.	Section 3.5
1909	G.I. Taylor's paper "Interference Fringes with Feeble Light" describes performing the double-slit experiment with light of such low intensity that non-overlapping incident regions appear on the back wall, eventually forming an interference pattern.	Section 3.3
1911	Ernest Rutherford's paper "The Scattering of α and β Particles by Matter and the Structure of the Atom" proposes a nucleus of positive charge at the core of an atom, based on the gold foil experiments performed by Geiger and Marsden.	Section 4.1 & Section 12.2
1912	Henrietta Swan Leavitt publishes "Periods of 25 Variable Stars in the Small Magellanic Cloud," giving a relationship between the oscillation period of Cepheid variable stars and their intrinsic brightness. This relationship was later used by Edwin Hubble to show that other galaxies exist, and later to discover the expansion of the universe. (Leavitt's paper was signed by her supervisor Edward Pickering, with a note that Leavitt had "prepared" the paper.)	Section 14.2
1913	In a series of papers entitled "On the Constitution of Atoms and Molecules," Niels Bohr proposes his model of the atom, with electrons making discrete jumps between quantized energy levels.	Section 4.1
1913	Henry Moseley's paper "The High-Frequency Spectra of the Elements" suggests a physical meaning to atomic number.	Section 8.4
1914	James Franck and Gustav Hertz's paper "Über Zusammenstöße zwischen Elektronen und Molekülen des Quecksilberdampfes und die Ionisierungsspannung desselben" ("On Collisions Between Electrons and Molecules of Mercury Vapor and the Ionization Potential of the Same") shows evidence for quantized atomic energy levels.	Section 4.1
1914	Robert Millikan's paper "A Direct Determination of h" reports his careful replication of the photoelectric effect in a vacuum—an experiment that, much to Millikan's chagrin, validated Einstein's explanation.	Section 3.5
1915	In the paper "Die Feldgleichungen der Gravitation" ("The Field Equations of Gravitation"), Einstein proposes his general theory of relativity, which incorporates gravity into the theory of relativity.	*online*
1915	Emmy Noether proves that every continuous symmetry of a physical system corresponds to a conservation law. (The proof is not published until three years later.)	Section 13.4
1920	Dyson, Eddington, and Davidson's paper "A Determination of the Deflection of Light by the Sun's Gravitational Field, From Observations Made at the Total Eclipse of 29 May 1919" provides observational verification of Einstein's general theory of relativity.	*online*
1922	Otto Stern and Walther Gerlach demonstrate quantization of angular momentum in the paper "Der experimentelle Nachweis der Richtungsquantelung im Magnetfeld" ("The Experimental Proof of Directional Quantization in the Magnetic Field"). It was later recognized that the angular momentum they had measured was spin.	Section 7.5
1923	Arthur Compton's paper "A Quantum Theory of the Scattering of X-Rays by Light Elements" describes changes in wavelength from light scattering off electrons.	Section 3.6

1923	Edwin Hubble reports in the paper "Cepheids in Spiral Nebulae" measurements of distances to Cepheid variable stars in nebulae. He proves that some nebulae such as Andromeda are outside our galaxy, thus proving for the first time that *anything* exists outside our galaxy.	Section 14.2
1924	Louis de Broglie, in his PhD thesis "Recherches sur la théorie des quanta" ("Research on Quantum Theory"), proposes matter waves.	Section 4.2
1925	Wolfgang Pauli proposes the exclusion principle in the paper "Über den Einfluss der Geschwindigkeitsabhängigkeit der Elektronenmasse auf den Zeemaneffekt" ("On the Connection Between the Termination of the Electron Groups in the Atom and the Complex Structure of the Spectra").	Section 8.1
1925	Goudsmit and Uhlenbeck propose spin (intrinsic angular momentum) to explain the Stern-Gerlach results in "Ersetzung der Hypothese vom unmechanischen Zwang durch eine Forderung bezüglich des inneren Verhaltens jedes einzelnen Elektrons" ("Replacement of the Hypothesis of Nonmechanical Connection by an Internal Degree of Freedom of the Electron").	Section 7.5
1926	Erwin Schrödinger's paper "Quantisierung als Eigenwertproblem" ("Quantization as an Eigenvalue Problem") presents what we now call Schrödinger's equation.	Section 6.6
1926	Max Born proposes the probabilistic interpretation of wavefunctions in "Zur Quantenmechanik der Stoßvorgänge" ("On the Quantum Mechanics of Collision Processes").	Section 4.3
1927	Werner Heisenberg proposes the uncertainty principle in "Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik" ("About the Descriptive Content of Quantum Theoretical Kinematics and Mechanics").	Section 4.4
1927	Davisson and Germer ("Diffraction of Electrons by a Crystal of Nickel") and G.P. Thomson ("Experiments on the Diffraction of Cathode Rays," published in 1928) independently demonstrate electron diffraction.	Section 4.2
1928	Paul Dirac's paper "The Quantum Theory of the Electron" expands the theory of quantum mechanics to be compatible with special relativity.	
1929	In the paper "A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae," Edwin Hubble shows that most galaxies are receding from us at speeds proportional to their distances from us. This is now generally considered the observational discovery of the expansion of the universe.	Section 14.2
1931	Georges Lemaître describes his theory of the "Primeval Atom," now known as the "Big Bang," to explain Hubble's observations: "A Homogeneous Universe of Constant Mass and Increasing Radius Accounting for the Radial Velocity of Extra-Galactic Nebulae."	Section 14.2
1932	James Chadwick's paper "Existence of a Neutron" announces the discovery of the neutron.	Section 12.1
1933	Carl Anderson's paper "The Positive Electron" announces the discovery of the positron (from work performed at the same lab as Chadwick's discovery of the neutron).	Section 12.1
1938-1939	Fission of uranium atoms is observed by Otto Hahn and Fritz Strassman, and explained and confirmed by Lise Meitner and Otto Frisch.	Section 12.5
1949	The first published Feynman diagram appears in the paper "Space-Time Approach to Quantum Electrodynamics." We can't possibly choose a date when "quantum field theory was invented" but this seems like a nice symbolic milestone.	Section 13.5
1957	Chien-Shiung Wu's paper "Experimental Test of Parity Conservation in Beta Decay" demonstrates that parity is not an exact symmetry.	Section 13.4
1961	Claus Jönsson reports a double-slit experiment with electrons in "Elektroneninterferenzen an mehreren künstlich hergestellten Feinspalten" ("Electron Interference at Several Artificially Produced Fine Gaps").	Section 4.2
1964	Murray Gell-Mann ("A Schematic Model of Baryons and Mesons") and George Zweig ("An SU(3) Model for Strong Interaction Symmetry and its Breaking") independently propose the quark model for hadrons, paving the way for the standard model of particle physics.	Section 13.2

1964	John Bell's paper "On the Einstein Podolsky Rosen Paradox" demonstrates that quantum mechanics cannot be reconciled with locality.	*online*
1964	Robert Wilson and Arno Penzias publish "A Measurement Of Excess Antenna Temperature at 4080 Mc/s," reporting measurements of microwave radiation coming to us from all directions. This is now accepted to be the "cosmic micrwave background" radiation left over from the early universe.	Section 14.2
1970-1975	Standard Model of Particle Physics. While there is no one moment when this theory was created, the main pieces that brought it into essentially its current form were developed during this time. Those pieces included a better theoretical understanding of strong forces, and the experimental confirmation of the existence of quarks.	Section 13.2
1980	Vera Rubin and her collaborators publish "Rotational Properties of 21 SC Galaxies With a Large Range of Luminosities and Radii, From NGC 4605 (R=4kpc) to UGC 2885 (R=122kpc)," reporting rotation cureves of 21 galaxies that unambiguously showed the existence of dark matter. This paper was the culmination of work Rubin had published for a number of years before this.	Section 14.5
1981	Alan Guth publishes "Inflationary Universe: A Possible Solution to the Horizon and Flatness Problems," introducing the theory of inflation to explain a number of puzzles in Big Bang cosmology.	Section 14.7
1992	Radio astronomers Aleksander Wolszczan and Dale Frail's paper "A Planetary System Around the Millisecond Pulsar PSR1257 + 12" announces the first definitive detection of planets outside our solar system. (Thirty years later, over 5000 exoplanets have been confirmed.)	
1998	Adam Riess and collaborators ("Observational Evidence From Supernovae for an Accelerating Universe and a Cosmological Constant"), and soon after Saul Perlmutter and collaborators ("Measurements of Omega and Lambda from 42 High Redshift Supernovae" in 1999), independently publish supernova measurements showing that the expansion of the universe is accelerating.	Section 14.5
2012	Detection of the Higgs boson ("Observation of a New Particle in the Search for the Standard Model Higgs Boson with the ATLAS Detector at the LHC") marks experimental validation of the last piece of the standard model. The paper lists approximately 3000 co-authors.	Section 13.2
2016	B. P. Abbott *et al*'s paper "Observation of Gravitational Waves from a Binary Black Hole Merger" announces the 2015 detection of gravitational waves, as predicted by Einstein's general theory of relativity, by the Laser Interferometer Gravitational-Wave Observatory (LIGO).	
2021	In a series of papers, Fermilab announces the results of its "Muon g-2" experiment, showing that the measured gyromagnetic ratio (or "*g*-factor") of the muon differs from theoretical prediction with a significance of 4.2 sigma. If confirmed, this measurement will be the first-ever experimental failure of the standard model of particle physics.	Section 13.2