PHYS3021/PHYS3022 Quantum Mechanics/Applied Quantum Mechanics
[Book List for Further Reading]

Suggested Further Reading

Our course should have prepared you well to go deeper into quantum mechanics and its applications. The following list aims to direct students to textbooks at the appropriate undergraduate level on various topics. The selection assumes a good background in our Year 1-3 physics courses, i.e. E&M, quantum physics, mechanics, and thermal and statistical physics. I believe that our students can self-study the books without pain. It is hoped that some of you may find the list useful for pleasure (and leisure) reading in the summer.

Get to know what is happening in the frontiers of physics and science

In this online era, you can register into different websites free of charge to receive weekly highlights in physics and in science. Best places are:

- physicsworld.com [run by Institute of Physics, UK]
- physics.aps.org [run by American Physical Society]
- Science
- Nature

See also daily BBC news items on "Science and Environment".

Serious Reading (by topics)

Quantum Mechanics

A.I.M. Rae, *Quantum Mechanics* (QC174.12. R22 1992 or early editions)
[A clear and precise account of standard QM at the undergraduate level in about 200 pages. Latest edition of the book is much longer, but not as good as the earlier editions.]

D.J. Griffiths, *Introduction to Quantum Mechanics* (QC 174.12. G74 1995 or later editions)
[A good book by a good author who really knows how to teach and write. His book *Introduction to Electrodynamics* is one of the best books in EM theory at the undergraduate level. There is a low-price edition for sale in Mainland.]

W Greiner, *Quantum Mechanics*: *An Introduction*
[An easy to follow but thorough textbook that covers all the standard topics at the undergraduate level in 340 pages.]

R. Shankar, *Principles of Quantum Mechanics* (QC174.12. S52 1994 or later editions)
[A complete textbook that takes you to the graduate level, written with excellent clarity. Good for those who will continue into postgraduate studies.]

A Friedman and L Susskind, *Quantum Mechanics: The Theoretical Minimum*
[A serious book written for the "general public" based on an online course at Stanford. Very good discussion on concepts, but no exercises. There are other titles on Mechanics and Classical Field theory.]
You should have problems finishing the first two books. Shankar is for those who want to learn more formal QM. The last book is a good place to distill what the key concepts in QM are, after learning them seriously from other courses/books.

Atomic and Molecular Physics

M Fox, *A Student's Guide to Atomic Physics*
[A new 2018 book covering atomic physics at undergraduate level with some modern topics such as cold atoms and atomic physics in astronomy. With PHYS3022, you should have known about 70% of the book. The other 30% is an enrichment on applications than basic knowledge.]

C. J. Foot, *Atomic Physics* (Oxford University Press, 2005)
[A 300-page textbook at the final year undergraduate to MSc level, covering many modern topics in a not-too-mathematical way.]

B.H. Brandsden and C.J. Joachain, *Physics of Atoms and Molecules* (QC 173. B677 2002)
[Covers all the standard atomic and molecular physics topics and more, in a serious manner. You could survive about 550 pages of the 1000+ page book. Many topics end at the postgraduate level. The same authors have another book *Introduction to Quantum Mechanics*, which covers all the QM you need as a good physics major. It is not listed in the last section simply because it is much thicker than that by Rae and by Griffiths.]

D. Budker, D.F. Kimball, and D.P. DeMille, *Atomic Physics: An exploration through problems and solutions* (Oxford University Press 2008) (QC 776 B83 2008)
[This book takes you to the postgraduate level of AMO (atomic, molecular, and optical physics) with techniques useful for research. From what we did, you could barely survive two chapters out of nine. The style of the book is to pose questions and then work out the answer. It is for the serious students who want to learn more or go into AMO in the future.]

Nuclear Physics and Particle Physics

[We didn't have time to do much nuclear physics. The boundary between nuclear and particle physics is not that clear. Here are some books on the topics.]

W.N. Cottinghan and D.A. Greenwood, *An Introduction to Nuclear Physics* (QC 776 C63 2001)
[A concise and clear (and traditional) introduction to nuclear physics at the undergraduate level, starting with a short chapter on the modern view of particles.]

W.S.C. Williams, *Nuclear and Particle Physics* (QC776.W55 1990)
[Latest printing in 2001 with updated data. This book is designed as a textbook for final year undergraduates in the British university system, i.e., suitable for you.]

D.J. Griffiths, *Introduction to Elementary Particles* (QC 792.2. G75 1987 or later editions)
[Another book by Griffiths. A well-written book on a topic difficult to cover at the undergraduate level. It assumes some undergraduate QM.]

B.R. Martin and G. Shaw, *Particle Physics* (QC 793.2. M38)
[A book in the Manchester Series – a series of undergraduate textbooks fit to the British curriculum. Needs some undergraduate QM.]

Physical Chemistry

D.A. McQuarrie, *Physical Chemistry: A Molecular Approach* (QD 453.2 .M394 1997)
[An excellent book for standard undergraduate physical chemistry. Physics students should be able to follow the whole book. It covers quantum mechanics, molecular physics, spectroscopy, thermodynamics, statistical mechanics, and chemical kinetics.] See also *Quantum Chemistry*

(QD 462 .M26 2008) by the same author that covers all the undergraduate QM with great clarity, as well as atomic and molecular physics.

P.W. Atkins, *Physical Chemistry* (2002 edition) (QD453.3. A74 2002)
[Your Year 3 quantum mechanics and thermal/statistical physics courses bring you very close to the level of standard physical chemistry at the undergraduate level. All that you need is to learn how to apply your knowledge to chemical systems.]

Physics students should appreciate how quantum mechanics can be applied to chemistry and how the success in chemistry helped establish QM. These Physical Chemistry books serve to illustrate the point. Another point physics students should note is that they can pursue postgraduate studies in physical chemistry.

Quantum/Modern Physics

The following books covered the essential quantum physics, atomic, molecular, solid state, nuclear and particle physics at the level of 2.5 to 3rd year in US universities. The best feature of these books is that the discussions focused more on the physics than on the mathematics. For those preparing for GRE, take a look and get a sense about the basic standard.

J.R. Taylor, C.D. Zafiratos, M. Dubson, *Modern Physics for Scientists and Engineers* (QC 21.2 T393)

R.A. Serway, C.J. Moses, C.A. Moyer, *Modern Physics* (3rd edition or later)

K. Krane, *Modern Physics* (QC 21.2. K7 1996)

R. Eisberg and R. Resnick, *Quantum physics of atoms, molecules, solids, nuclei, and Particles* (QC 174. 12. E34) [A book by the author (Resnick) of your Year 1 textbook. This old book is at a slightly higher level than the other modern physics books, with more formal QM included.]

Leisure/Summer Reading

The books listed here are "popular science" books. They are for fun. It is also a good way to learn and practice English, as well as to learn how to present non-trivial physics ideas to readers/an audience. Many of them actually require a good background in science training at the university level in order to appreciate the contents.

Tony Hey and Patrick Walters, *The Quantum Universe* (QC174.12.H48 1987 and a later 2003 edition).
[A brilliant book on the basic ideas and applications of quantum mechanics (without using much mathematics). It is a book from the Open University in UK. One needs to have a good background in the courses in Year 1,2,3 to understand all the topics. Although not using much mathematics, all the statements and physics are correct and many of them are quite deep (so much so that even if you know how to solve all homework problems, you may not realize what the authors referring to) – a quality not too often found in so-called popular science books.]

Gerald 't Hooft, *In search of the ultimate building blocks* (QC 794.6. S75H66 1996)
[Written by the Nobel Laureate (1999) before winning the prize. An excellent and in-depth account of the theoretical development of particle physics in the past 50 years. Definitely needs some physics background to get through it! The author worked on renormalization problems in quantum field theories.]

G. Milburn, *Quantum Technology* (QC 174.12 M55 1996)
[A non-mathematical account of applications of quantum theory including quantum computing, lithography, tunneling, nanocircuits, quantum cryptography. Although non-mathematical, it can only be understood with a solid background in quantum physics.]

A. Ananthaswamy, *Through two doors at once: The elegant experiment that captures the enigma of our quantum reality*
[A new book that discusses the topics of quantum mechanics that will be used in the second quantum revolution.]

R. Machkintosh, J. Al-Khalili, B. Jonson, and T. Pena, *Nucleus: A trip into the heart of matter* (2nd edition) (Johns Hopkins Univ. Press) [A wonderful account of all of nuclear physics with beautiful pictures. Very serious physics, but no equations.]

B. Cox, *Why does $E=mc^2$?* (QC 173.6 .C68 2009) [By a hot author (who is now Sir Brain for his work in popularizing science) who can explain things to layman. The discussions in some chapters are actually quite difficult, only readers with physics background could possibly follow.]

C. Orzel, *How to teach quantum physics to your dog* [A humorous but serious attempt, even covering topics such as quantum teleportation and encryption. Take a look and it will enhance your understanding of QM (although there are almost no equations)]

D.J. Griffiths, *Revolutions in twentieth-century Physics* (QC 174.12 .G75154 2013) [Finally there is an easier book by the same Griffiths. It is a good survey of the important developments in 20th century physics. It is like a general education textbook to non-physics majors.]

M.D. Fayer, *Absolutely Small: How quantum theory explains our everyday world* (QC 174.12 .F379 2010) [A popular level quantum chemistry book – wonderful discussion on molecules, including fats, soap, alcohol, greenhouse gases.]

Physics Magazines

The CUHK library has subscripted to journals and magazines with articles on the latest developments in physics written by experts. It will be a big step forward if you get into the habit of browsing through them every month.

Physics World (With a monthly magazine as well as physics news pushes published by the Institute of Physics in UK. Each issue of the magazine gives the latest news in physics plus a monthly theme. The website http://www.iop.org/ provides constantly updated physics news.)

Phyiscs Today (A monthly magazine published by the American Physical Society. The format is similar to the Physics World.) The American Physics Society also provides weekly news update free of charge.

WuLi (in Chinese) (A magazine similar in style as the Physics World and Physics Today.)

Scientific American; Newton (in Chinese); Materials Today (it is the counterpart of Physics Today in Materials Science)

Some Additional Topics…

There are interesting topics that we did not have time to discuss. After all, physics is hopeless to be taught in completeness!

Quantum Information/Computing
Quantum Computing Explained by D. McMahon
Quantum Computation and Quantum Information by M.A. Nielsen and I.L. Chuang

Quantum Optics *Introductory Quantum Optics* by C.C. Gerry and P.L. Knight

Quantum Field Theory *Relativistic Quantum Mechanics and Field Theory* by Franz Gross (a good book for students who want to know what QFT is about and how to do calculations)

Quantum Mechanics for Engineers *Essential Quantum Mechanics for Electrical Engineers by Peter Deak; Quantum Phenomena by S Datta*

Nanotechnology [Look up books on nano-optics, nanoscience, nanotechnology, plasmonics]

Physicists' Biographies

I am of the opinion that one's physics education is incomplete without reading some physicists' biographies and/or history of physics books. There are many titles in the library. Einstein is the theme of many books (the one by Abraham Pais is the most popular). D. Stone's (a Yale professor) book on Einstein's contributions to quantum physics is very good. There are very entertaining titles on Planck, Dirac, Schrodinger, Heisenberg, CN Yang, Bohr (also by Pais), Fermi (by his wife), Pauli, Weisskopf, Feynman, Bethe,... There are also titles on the development of quantum mechanics, e.g. the Quantum Men. For a detailed description on how physics was developed (from 17^{th} century to 20^{th} century), see *A Cultural History of Physics* by K. Simonyi. Go to the library stack and you will find many other books on physicists and how physics was developed. It is something important to know as, after all, ***Physics is a human endeavor***.

List updated on 17 April 2019