Book Recommendations

Michael Astwood

February 2019

Classical Mechanics

1. *Classical Mechanics* - Taylor. The cover is hilarious. Also the book is good.
2. *Classical Dynamics of Particles and Systems* - Thornton and Marion. Also a solid class mech book.
3. *Classical Mechanics* - Morin. A bit harder and higher level than Taylor or Thornton. Good for advanced study
4. *Classical Mechanics* - Goldstein. Standard graduate classical mechanics book. Study this because the university doesn't have a course in it.
5. *Analytical Mechanics for Relativity and Quantum Mechanics* - Oliver. Fantastic grad book in classical mechanics.
6. *LL 1: Mechanics* - Landau & Lifshitz. One of the legendary LL books. Short, concise, and Russian as fuck.
7. *Mathematical Methods of Classical Mechanics* - Arnold. This book introduces the modern mathematics behind classical mechanics (it's even higher level than LL!)
8. *Symplectic Geometry and Analytical Mechanics* - Libermann and Marle. Supposedly a good book on modern analytical mechanics.

Note: isn't it unfortunate that in our whole UWaterloo education we only get 2/3 books into this list?

Electricity and Magnetism

1. *Introduction to Electrodynamics* - Griffiths. Absolutely incredible book. Reads like an actual novel. Not very mathematical though.

2. *Electricity and Magnetism* - Purcell. This one is supposed to be a more mathematical sequel to Griffiths.

3. *Modern Electrodynamics* - Zangwill. You will notice a pattern of intro grad books starting with "modern". This book is like Jackson but wont make you want to die.

4. *Classical Electrodynamics* - Jackson. Absolutely insane. Standard graduate E&M book if that tells you anything.

5. *LL 2: Classical Theory of Fields* - Landau & Lifshitz. This one is more mathematical and Russian. Pretty much a primer for a course in QFT. The second installment in Landau and Lifshitz' theoretical mechanics series.

Thermal and Statistical Physics

1. *An Introduction to Thermal Physics* - Schroeder. Standard undergraduate book. You should probably read one of these if you want to call yourself a physicist. That said, the cool stuff starts later on the page.
2. *Thermal Physics* - Kittel. It's blue!
3. *Statistical Physics* - Mandl. Another stat mech book! This one is the one I own. So I like it.
4. *Fundamentals of Statistical Physics* - Reif. This ones a bit more advanced.
5. *Statistical Mechanics* - Huang. Good graduate book in stat mech. Pretty readable for someone with little stat mech background, despite obviously requiring undergrad prereqs. I own this one and it's shiny.

Solid State & Condensed Matter Physics

1. *Solid State Physics* - Kittel. It's green!
2. *Solid State Physics* - Ashcroft & Mermin. Industry standard grad condensed book.
3. *Quantum Theory of Many-Particle Systems* - Fetter & Wallecka. This one is supposed to be pretty decent. Probably a good idea to read before the next two.
4. *Condensed Matter Field Theory* - Atland & Simmons. A path integral approach to CMP. Wow!
5. *Methods of Quantum Field Theory in Statistical Physics* - Abrikosov. This one's Russian.

You can probably tell I don't know a lot about CMP and stat mech. These are suggestions I have compiled from people more qualified than I am.

Optics

1. *Introduction to Modern Optics* - Fowles. Supposedly this is the only good undergrad optics book. Someone please confirm. You should probably read it for a good foundation in all the big fields of physics.

Astrophysics and Astronomy

1. *Foundations of Astrophysics* - Ryden. This is what we used in PHYS275/375. It's pretty solid, but hard to find online.

2. *Stellar Spectral Classification* - Gray and Corbally. "It's grey's anatomy for stellar physics!" - Brody.

3. *Modern Astrophysics* - Caroll and Ostlie. No, not that Caroll. This book is supposed to be pretty good.

4. *Galaxies in the Universe* - Sparke and Gallagher. I think this is what they use in galaxies.

5. *Introduction to Cosmology* - Ryden. This book is extremely readable. Not too advanced.

6. *Cosmology* - Weinberg. Yep, that Weinberg. This book is a grad book in cosmology.

7. *Principles of Stellar Structure* - Cox and Guili. This book is supposedly the best reference book for stellar physics. If you want to overkill PHYS375, go here.

Backup Reading

1. *Quantitative Finance for Physicists* - Schmidt. Haha

Quantum Mechanics

1. *Quantum Mechanics: A Paradigms Approach* - McIntyre. Standard undergraduate text in quantum mechanics at UW. Far superior to most intro quantum mechanics books. It's the Griffiths of QM.
2. *Principles of Quantum Mechanics* - Shankar. This book is more mathematical than McIntyre and more detailed. It covers many topics that you won't see in depth in undergraduate, such as the path integral, in an intuitive and well written way.
3. *Quantum Mechanics* - Zettili. For some reason Crystal Senko swears by this book. It seems pretty good for applications, I'll give it that.
4. *Modern Quantum Mechanics* - Sakurai. This is the standard graduate quantum mechanics book. Pretty plain and American.
5. *LL 3: Quantum Mechanics, The Non-Relativistic Theory* - Landau & Lifshitz. You know the drill. Russian.
6. *LL 4: Relativistic Quantum Theory* - Landau & Lifshitz. This is basically an introduction to quantum electrodynamics.

Quantum Field Theory (String theory sneaks up on you here)

1. *An Introduction to Quantum Field Theory* - Peskin and Schroeder. The standard book in quantum field theory for any 4th/5th/6th year student.
2. *Physics From Symmetry* - Schwichtenberg. This is what PHYS444 uses. It's actually a pretty awesome point of view on quantum field theory.
3. *Quantum Field Theory In A Nutshell* - Zee. Handwavy/intuitive introduction. Pretty solid as a supplementary text.
4. *Undergraduate Lecture Notes in Topological Quantum Field Theory* - Ivancevic and Ivancevic. Who knew they could teach this to undergrads?
5. *Differential Topology and Quantum Field Theory* - Nash. Probably written in the heyday of string theory. Still pretty relevant.
6. *Introduction to Cohomological Field Theory* - Witten. There are two different types of TQFT, and this covers the Witten type.
7. *Gauge Fields, Knots and Gravity* - Baez. Some more topological quantum field theory. This covers the Schwartz-type TQFTs. By now you're getting into string theory!

Please note that I have a very small understanding of quantum field theory at this time. These are compiled recommendations by people more qualified than I am (stack exchange, Atmn, etc).

Analysis

1. *Calculus* - Spivak. This book is a good gentle introduction to analysis for someone who took MATH127/128 and hasn't really been exposed to sequences, series, or the definitions of continuity before

2. *Real Analysis With Real Applications* - Donsig. Donsig is the perfect book for a first look at analysis as a physicist. It has many applications to numerical methods, mathematical physics, and signal processing. Plus one co-author is from UWaterloo!

3. *Introduction to Analysis* - Wade. This is the book Stephen New bases his real analysis course (PMATH333) on. I haven't read it though, but I'm sure its better than Rudin...

4. *Understanding Analysis* - Abbott. Good intuitive intro to real analysis. Often recommended for first year analysis courses.

5. *Visual Complex Analysis* - Needham. Good intuitive look at complex analysis. All you need to get through PMATH332.

6. *Complex Analysis* - Ahlfors. Excellent introductory text in complex analysis. More suited for PMATH352. Not too advanced.

7. *Principles of Mathematical Analysis* - Rudin. Hardcore and brutally difficult. You can't deny that the exercises aren't good though. They really drill the methods of analysis into your head.

8. *Real and Complex Analysis* - Rudin. This one is a grad book, so it's even more dense and difficult than PMA.

9. *Real Analysis* - Lang. This is the true grad book in real analysis. It's pretty good and very in depth. Covers lots of good topics.

10. *Functional Analysis* - Kolmogorov. Industry standard in functional analysis for pure mathematicians. Very Russian. Grad book

11. *Functional Analysis* - Einseidler. Newer book in funky anal. Probably less Russian than Kolmogorov. Grad book.

12. *Functional Analysis: A Primer* - Baggett. Shorter and more introductory overview of functional analysis.

13. *Functional Analysis* - Rudin. Grandpa Rudin.

14. *Methods of Modern Mathematical Physics* - Reed & Simon. This is the big book of analysis in mathematical physics. It comes in volumes! Covers functional analysis and operator theory.

Algebra

1. *Linear Algebra Done Right* - Axler. This book is a good abstract look at linear algebra. Unfortunately it takes a strange approach to determinants, but in general it's pretty good.

2. *Linear Algebra Done Wrong* - Treill. Perfect complement to Axler's book. This one matches the content required of a physicist moreso, but isn't a full published book but a sort of shorter "book" put out by a prof at a university.

3. *Linear Algebra* - Freidberg et al. This book is alright. It's kind of a generic "high level" lin alg book that covers everything you will need in much of a lin alg course.

4. *MIT 18.952 Coursenotes, Chapter 1* - This is a good resource for multilinear algebra that is taught in MATH245 as well as in the first month of PMATH365. It appears that much of PMATH365 is based on this MIT course. http://math.mit.edu/classes/18.952/2014SP/index.html

5. *Principles of Quantum Mechanics, Chapter 1* - Shankar. This is the physicist's interpretation of linear algebra as far as undergrad quantum goes. Very helpful for PHYS234/334/434/454

6. *A Book of Abstract Algebra* - Pinter. This book is amazing for an intuitive understanding of the abstract algebra of groups, rings, and fields. It, however, doesn't go into as much depth as is required for an entire undergraduate education in algebra.

7. *Abstract Algebra* - Dummit & Foote. This book is the ultimate reference for abstract algebra 1 and 2. It even covers the algebra of tensor spaces and modules. It covers everything you might see in PMATH347/348 besides Noetherian rings.

8. *Undergraduate Commutative Algebra* - Reid. This is what many recommend for a better look at rings and modules. Chapters 1-3 were covered in PMATH347 (when taught by Satriano).

9. *An Introduction to Commutative Algebra* - Atiyah and MacDonald. This book is the standard grad text in commutative algebra.

10. *Homological Algebra* - Weibel. Secretly a book in algebraic topology. Industry standard for that field.

Topology

1. *Set Theory and Metric Spaces* - Kaplansky. Good short overview of the foundations of sets and metric spaces without delving too far into point-set topology. Good way to refresh on concepts before diving into topology.
2. *Topology*- Munkres. This is the standard undergrad topology book. Pretty good, but expensive. Spends a lot of time on "classical" (point-set) topology, which is only really useful in fields that aren't pure topology.
3. *Topology* - Hocking. Very dense look at topology. Decent for undergrads. This one goes through lots of algebraic topology which is good.
4. *Topology for Physicists* - Schwarz. A good book in topology for physicists. Covers the main useful parts of topology (homological algebra, fibrations, etc).
5. *Algebraic Topology* - Vanessa Robins. A good and short overview of algebraic topology written for mathematical physicists. Published as chapter 5 in Wiley's *Mathematical Tools for Physicists*.
6. *Geometry, Topology, and Physics* - Nakahara. Ultimate book on all things geometry and topology in physics. Superb book overall.

Differential Geometry

1. *Differential Forms* - Darling. This is an okay look at differential forms
2. *Introduction to Smooth Manifolds* - Lee. Good intro to diff geo from the manifold point of view rather than the differential forms point of view.
3. *MIT 18.952 Coursenotes* - Covers a lot of what is done in PMATH365. Mainly focuses on the foundations and theory of differential forms and exterior calculus. http://math.mit.edu/classes/18.952/2014SP/index.html
4. *Analysis on Manifolds* - Munkres. A good look at smooth manifolds from an analytic point of view. Recommended for 365.
5. *Calculus on Manifolds* - Spivak. Similar to above. A short and concise overview of manifolds from a calculation point of view - good for physics.
6. *Differential Forms and Integration* - Tao. Short but good overview of the concepts of integration in differential geometry.
7. *Geometry, Topology, and Physics* - Nakahara. [repeat for emphasis] Ultimate book on all things geometry and topology in physics. Superb book overall.
8. *Geometrical Methods of Mathematical Physics* - Schutz. Covers lots of Lie theory.

Other Topics

Measure Theory

1. *The Elements of Integration and Lebegue Measure* - Useful overview of measure theory from a historical standpoint. Useful in various fields of mathematical physics (functional analysis in particular).

2. *Abstract Analysis* - Conway. Supposedly a good book for if you want to utilize measure theory in functional analysis.

Probability and Statistics

1. *STAT230 Coursenotes* - Honestly the best resource for introductory probability theory. Not mathematically rigourous.

2. *Probability in Physics* - Ben-Menahem and Hemmo. Fantastic overview of advanced probability theory in physics. Requires some analysis knowledge.

3. *STAT231 Coursenotes* - Just use them. They're solid.

4. *The Advanced Theory of Statistics* - Kendall and Stuart. Fine, you wanted a "real" stats book. Here you go, good luck.

5. *Statistics and Data Analysis for Physicists* - Bohm and Zech. Okay okay, here's something less intense.

Mathematical Methods Books

1. *Mathematical Methods* - Boas. A fantastic overview of all the things you should learn from 1st to 3rd year in your AMATH courses. Read and take notes on this whole book at some point between 2nd and 3rd year.

2. *Mathematical Physics* - Hassani. Good primer for advanced mathematical physics. Written around a 4th year level (if you have some PMATH background). Introduces topics such as Lie theory, Clifford algebras, the theory of Green's functions, operator theory, etc. Basically most of the tools of regular-old theoretical physics. Can probably be started in 3rd year or earlier with effort.

Comprehensive Notes

1. *An Infinitely Large Napkin* - Evan Chen. This book goes through the basic concepts of much of pure mathematics at a 1st year level. Fantastic if you want to know what each field is "about". http://web.evanchen.cc/napkin.html

2. *Cambridge Notes* - Dexter Chua. This guy took notes on like 30 Cambridge pure math and physics courses during his part 1/2/3 of the tripos. Absolutely legendary. http://dec41.user.srcf.net/notes/

Not Books

1. *Essence of Linear Algebra* - 3Blue1Brown. Watch these!
2. *Imaginary Numbers Are Real* - Welch Labs. Watch these too!
3. *Mathematical Methods of Quantum Information Theory* - Tobias Osborne (youtube)
4. *Symplectic Geometry* - Tobias Osborne (youtube). This is a field of differential geometry which forms the basis for advanced analytical methods in quantum theory and classical mechanics. Problem sets can be found on his blog.
5. *Quantum Field Theory & Advanced Quantum Field Theory* - Tobias Osborne. Fairly approachable with a good foundation in quantum theory.