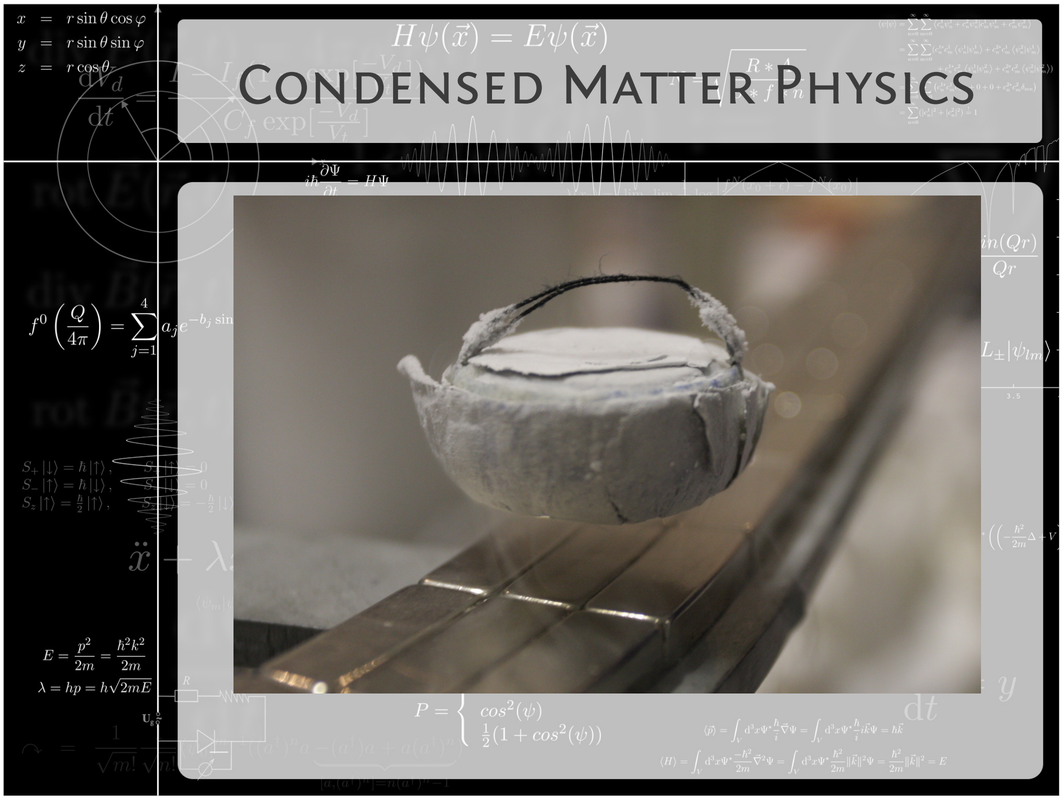
Physics Is A Great Hedge

Or, “How I Stumbled Into The World Of Finance”
(with a brief introduction to the shadow banking system)

$E = m c^2$

Why Are *You* Here?



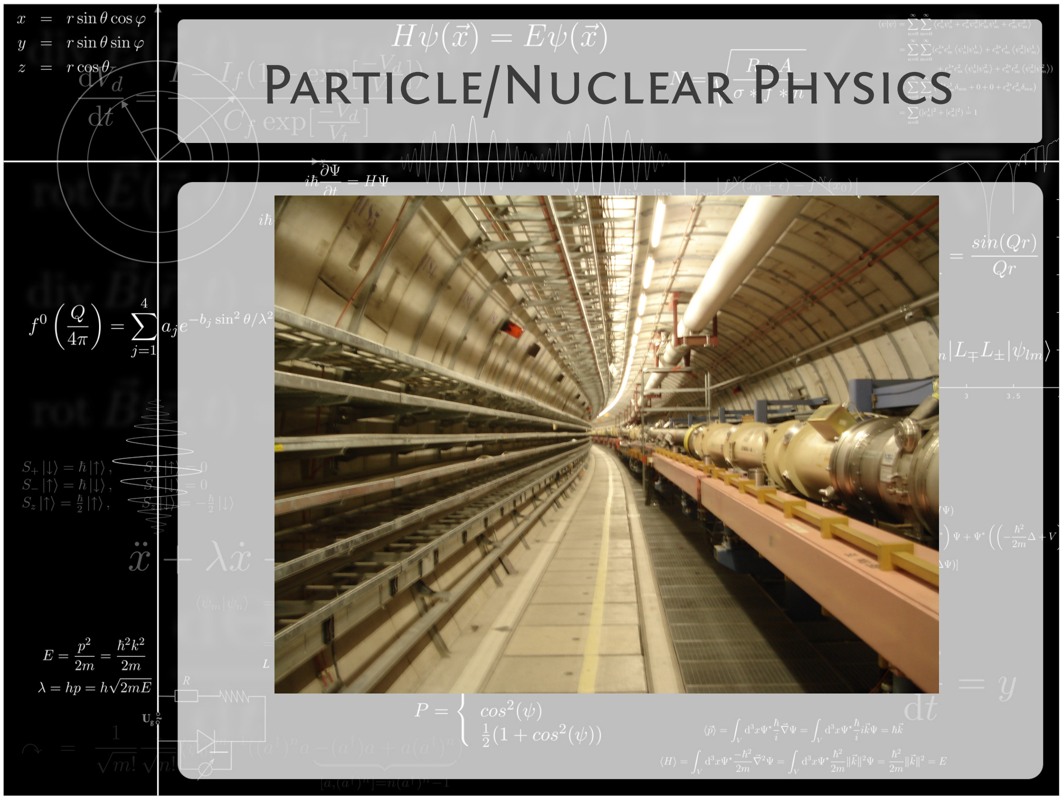
Lots of fantastic areas for research and academic pursuit, and UIUC has a great background in most of them.

Outstanding condensed-matter physics.

Who knows who John Bardeen was?

UIUC professor of EE and Physics from 1951 to 1975. Received the Nobel Prize in '56 for research leading to the transistor and '72 for the theory of superconductivity. Superconductors are used in magnetic levitation and MRIs.

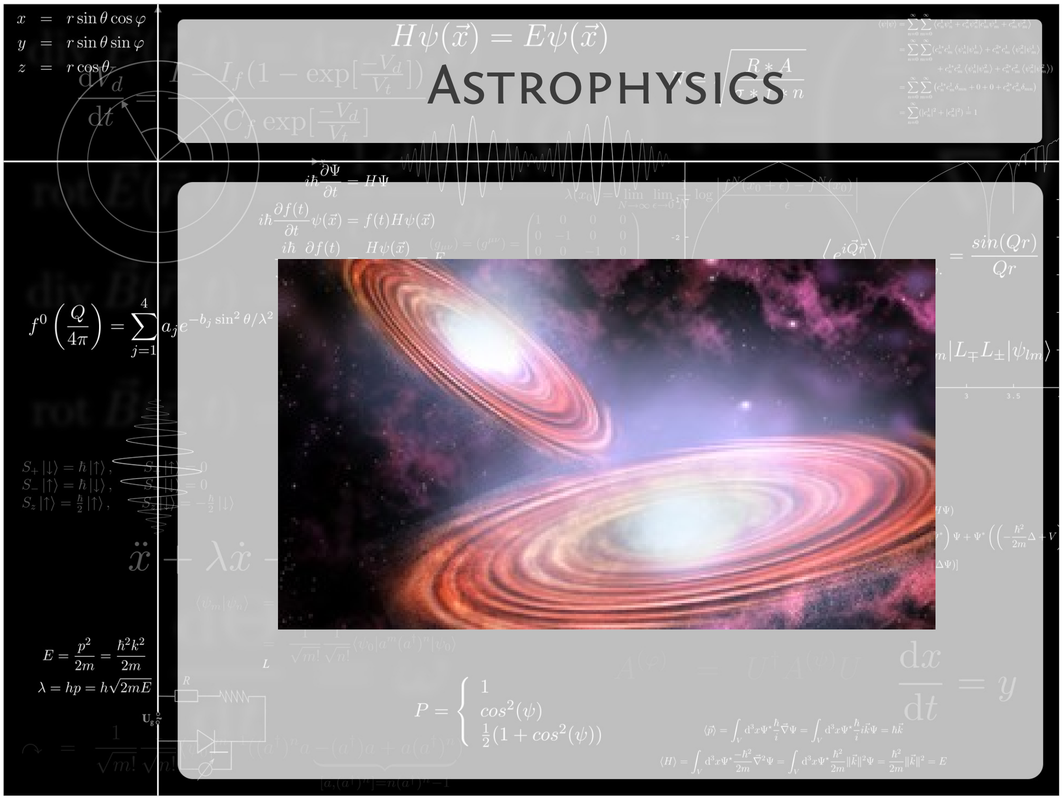
Biggest focus area in the physics dept., including ongoing research in superconductivity and surfaces at the molecular level.



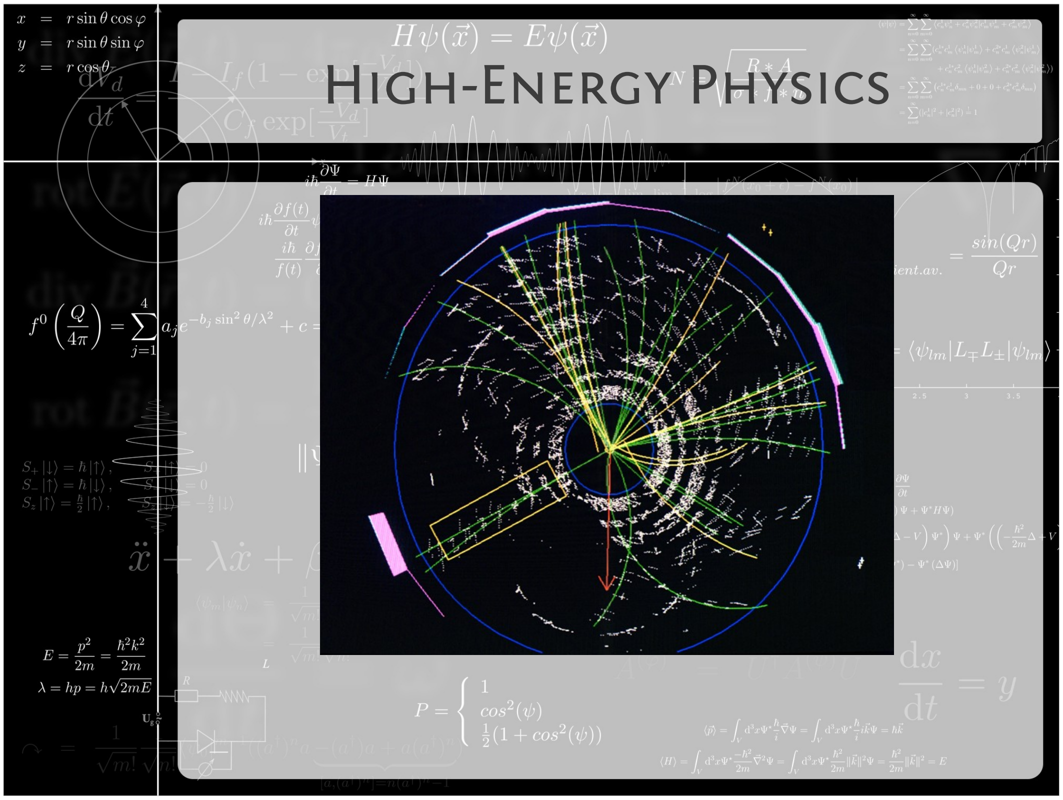
The HERA tunnel at the DESY facility in Hamburg.

The HERMES experiment to determine characteristics about the structure of hadrons (e.g. protons) ran here from 1995 to 2007.

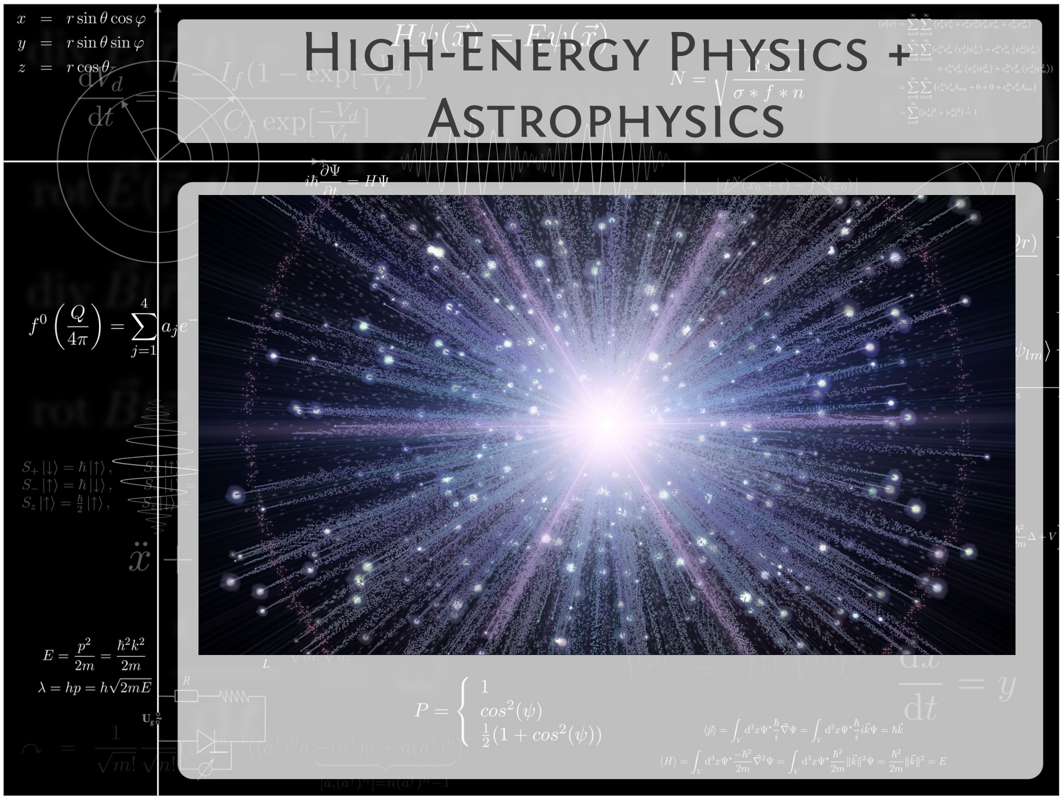
Professor Makins lead the Monte Carlo simulation group for this experiment.



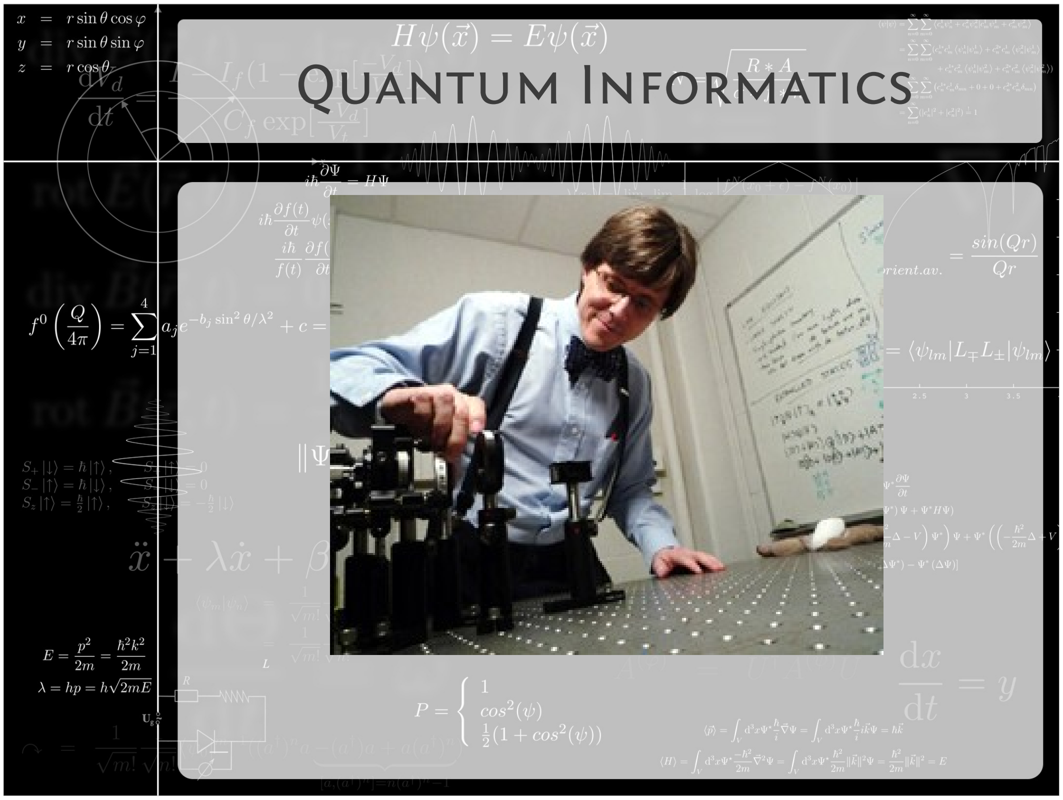
You can study what happens when black holes collide.



You can test the edges of the standard model and the viability of various Theories of Everything.

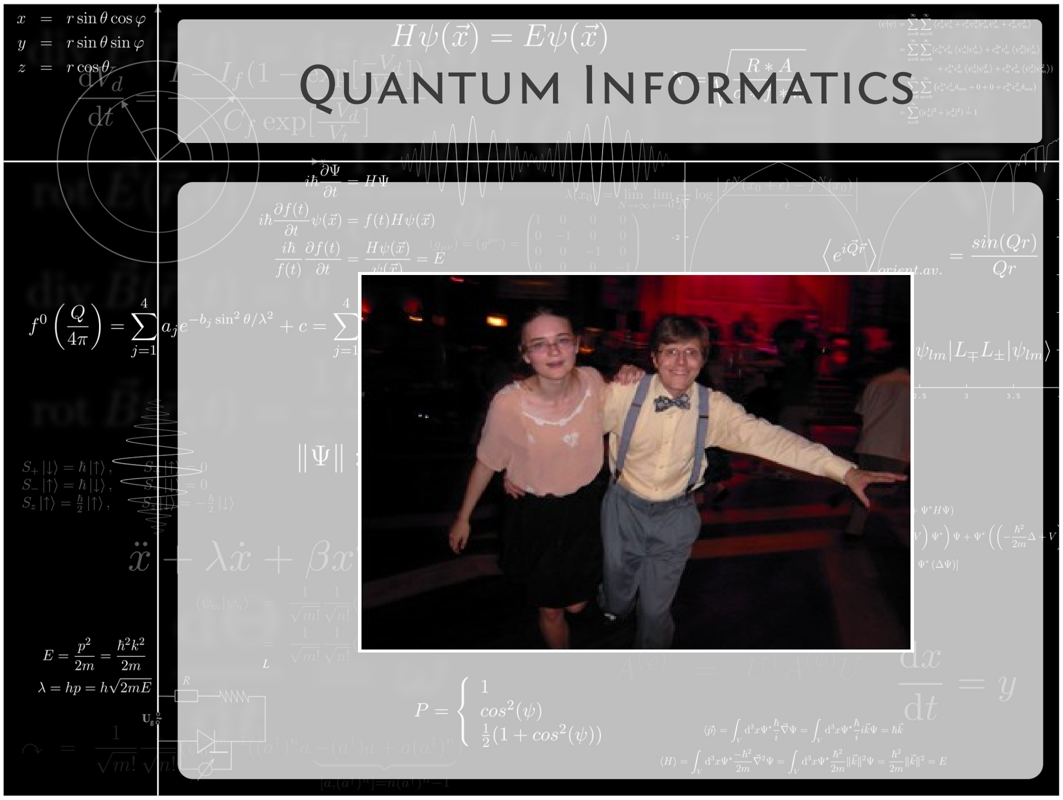


You can study the Big Bang.



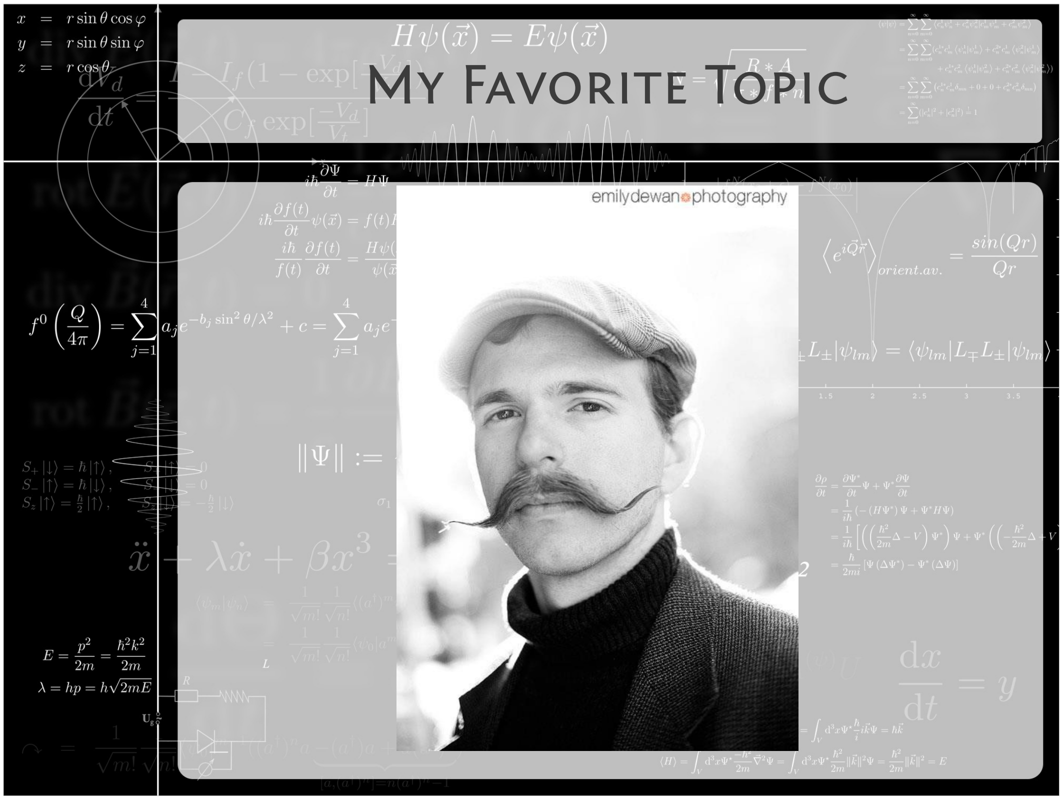
You can study quantum informatics. Quantum computation offers the possibility of radically increasing the speed at which we can solve previously intractable problems and creating new and more secure methods of communication.

Dr. Kwiat here is a pioneer in the field and runs a research group here at UIUC.



He's also an excellent swing dancer. Swing dancing is yet another fantastic subject that you can learn more about here at UIUC.

Anyway, if you're set on pursuing any of these things as a career, this talk may not be directly relevant to you. However, if like me, you don't know exactly what you want to do at 17/18/19 (or 34), or if you decide at some point that you'd like to explore outside of the world of academia, I hope that this provides an example of what a physics degree can prepare you for.

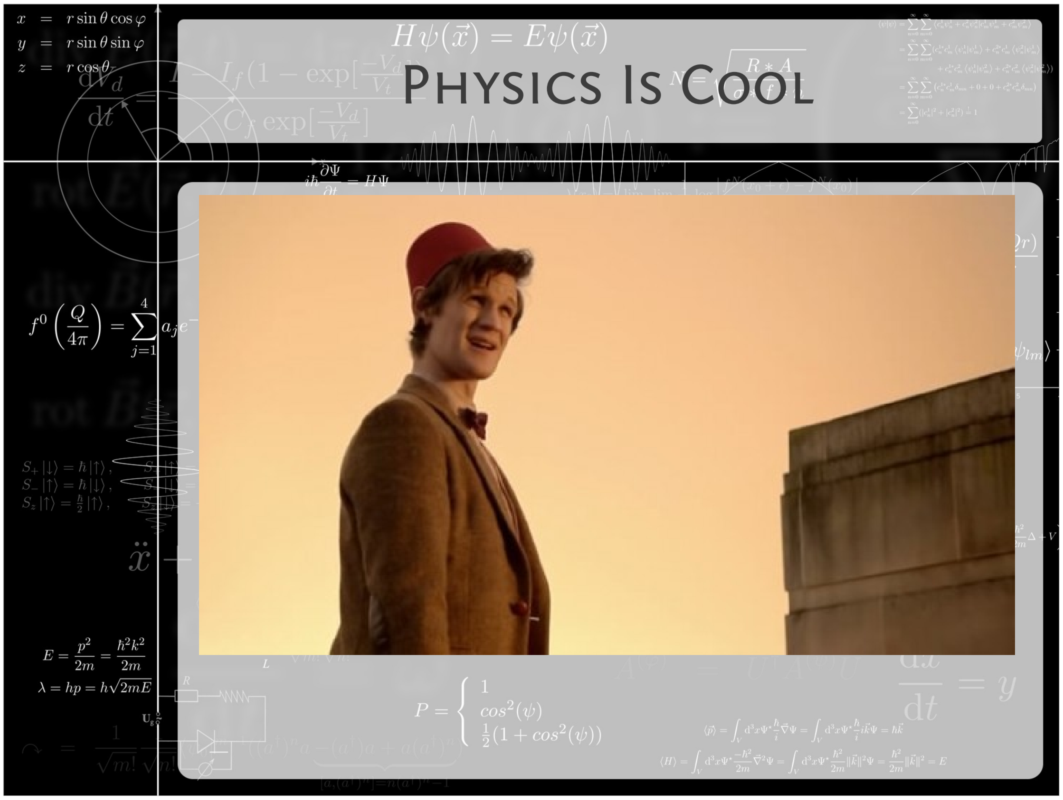


On to my favorite topic: ME!

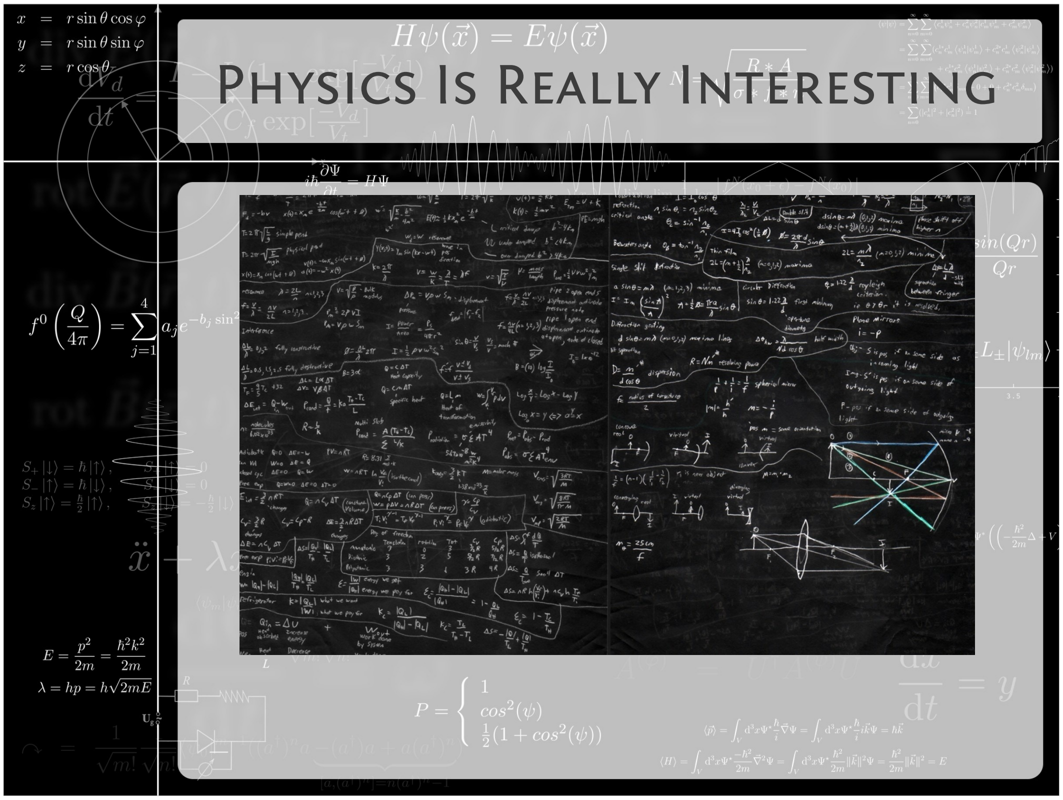
I've been a computer dork since I was a kid. I always figured I'd end up doing something with computers as a profession.

I entered UIUC as a computer science major, but after taking introductory mechanics and E&M, I decided to get a physics degree as well.

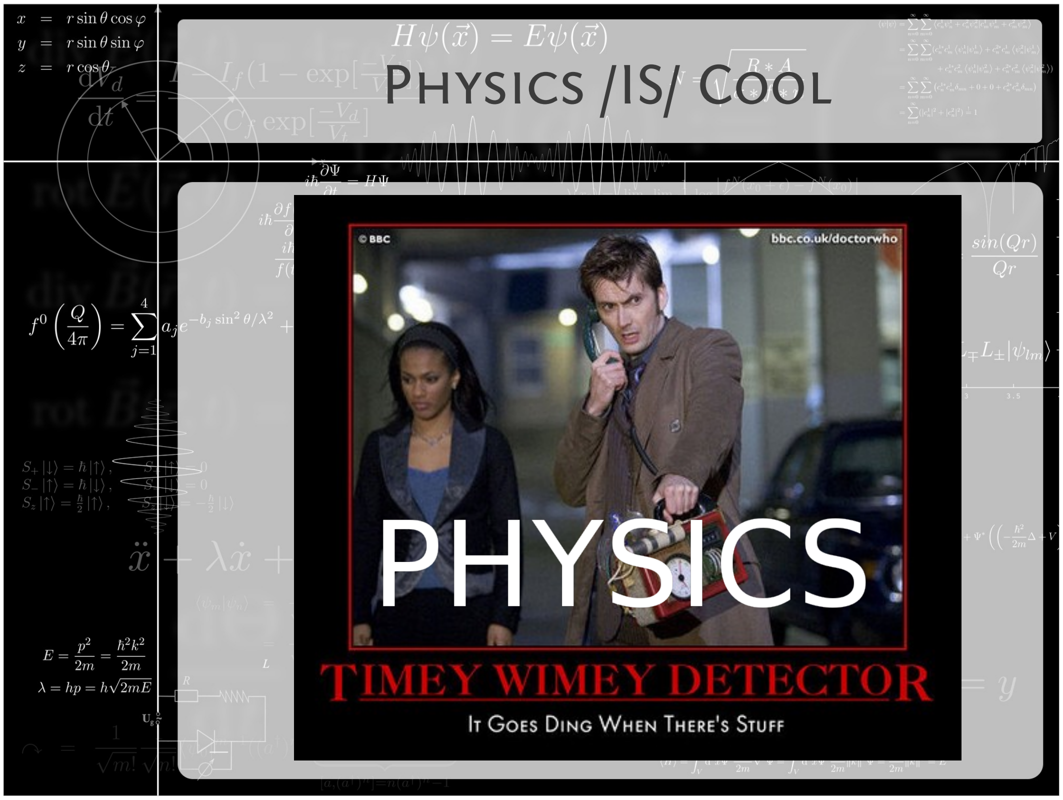
Why did I study physics?



I did physics because I thought it was cool.

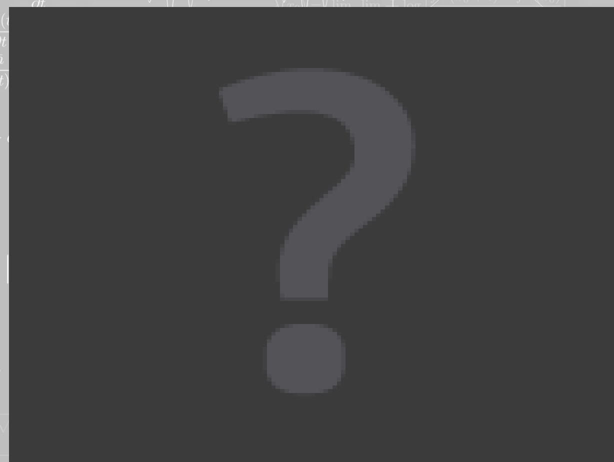


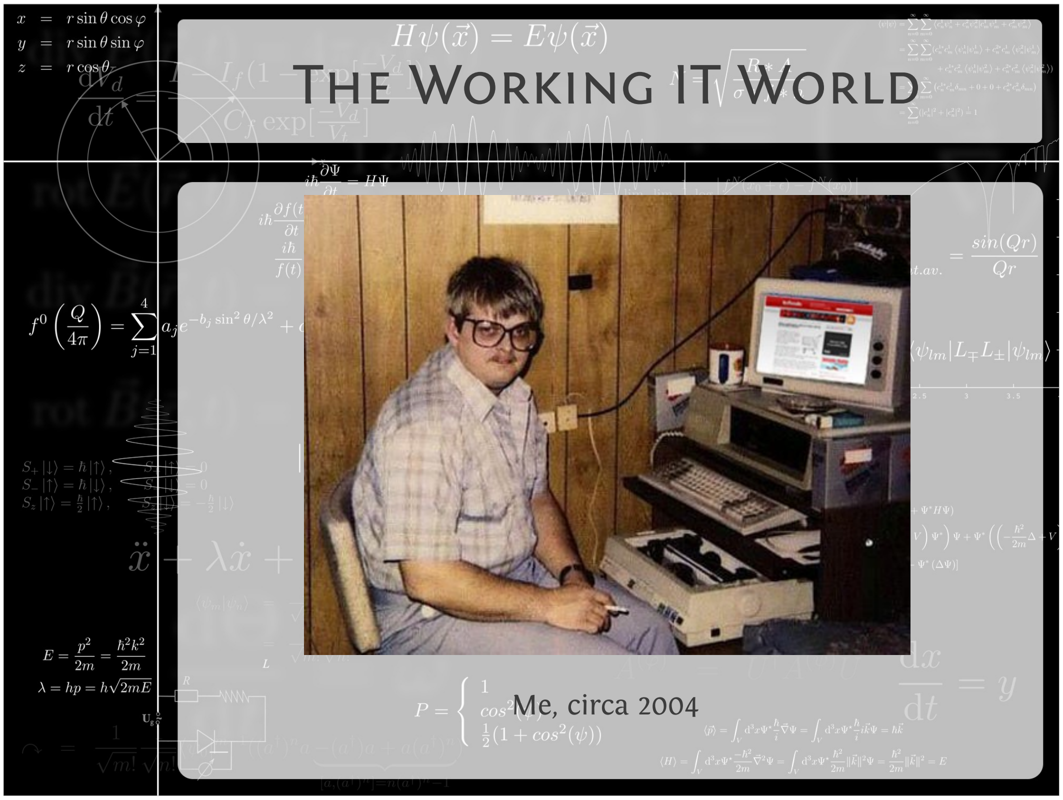
Not cool, but because I thought it was really interesting. Complex systems, neat math, being able to build neat gadgets, understanding how the universe works...



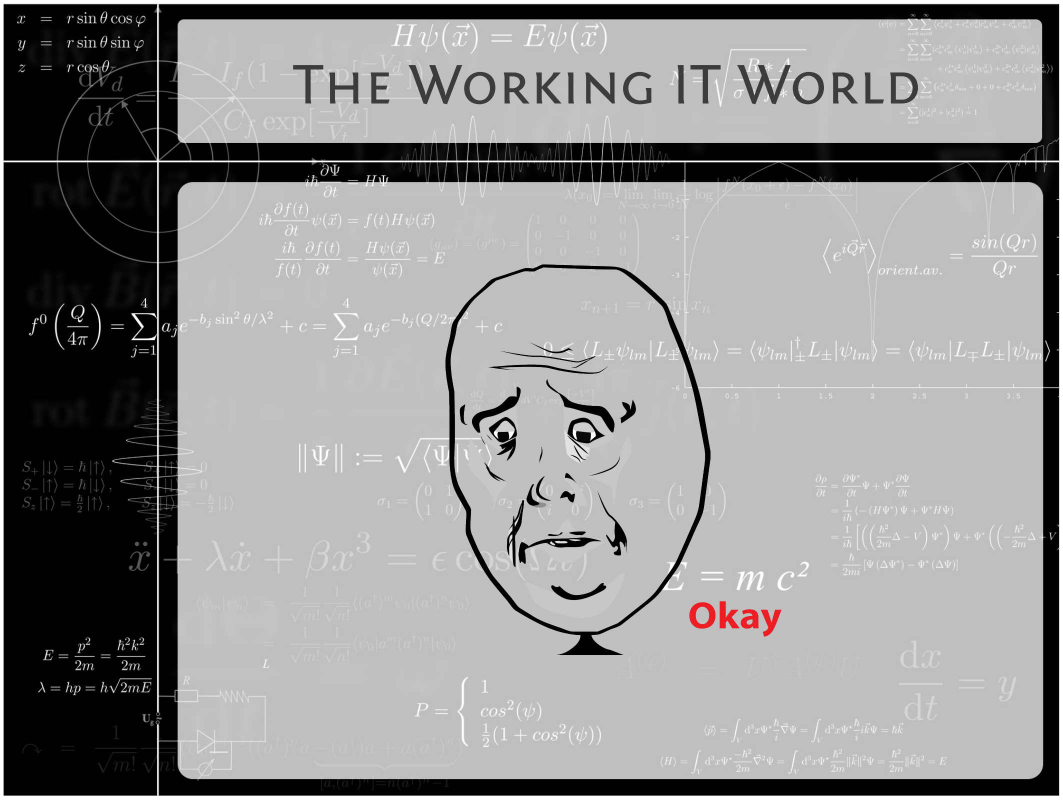
Okay, maybe I thought it was a little bit cool. Maybe I still do.

Practical Applications

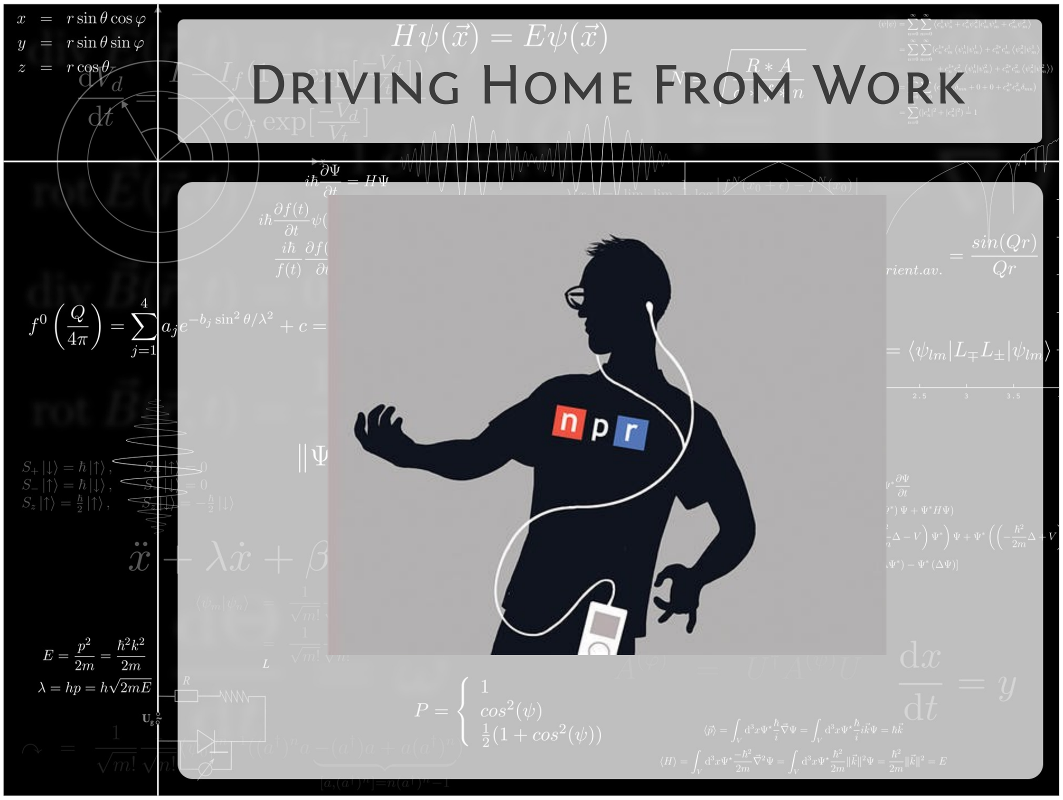




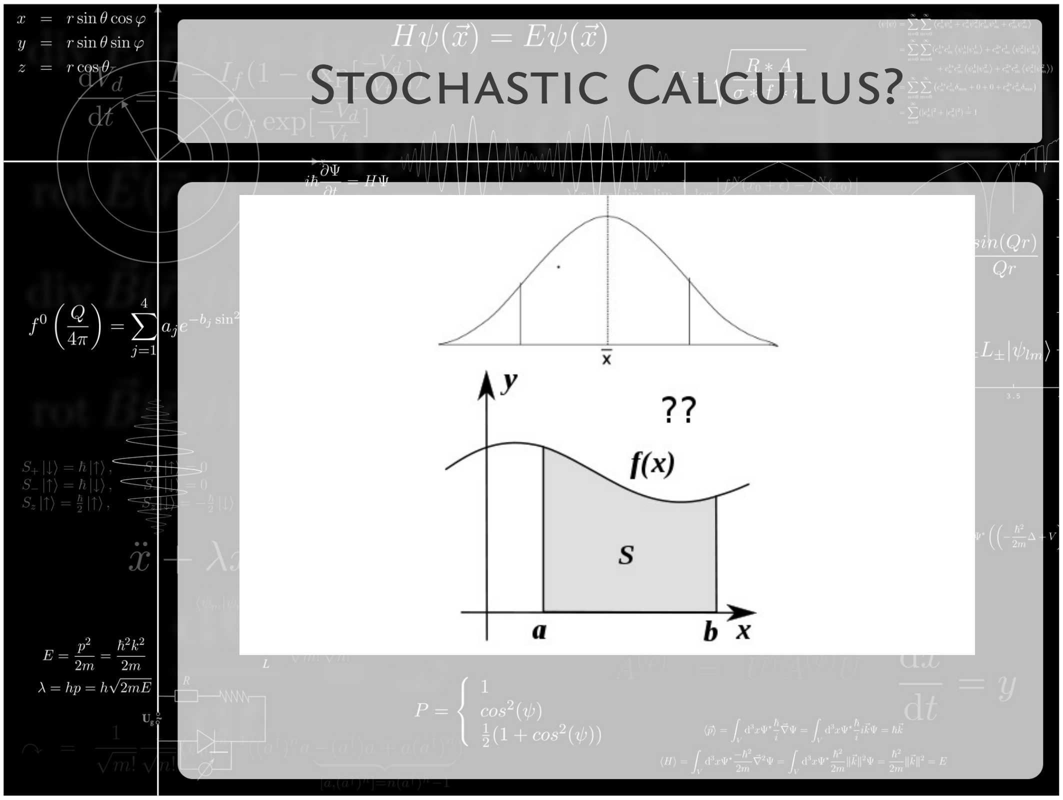
After I graduated in 2002, I started off my career in the world of computers. I did some software development, some networking, some systems administration. It was...



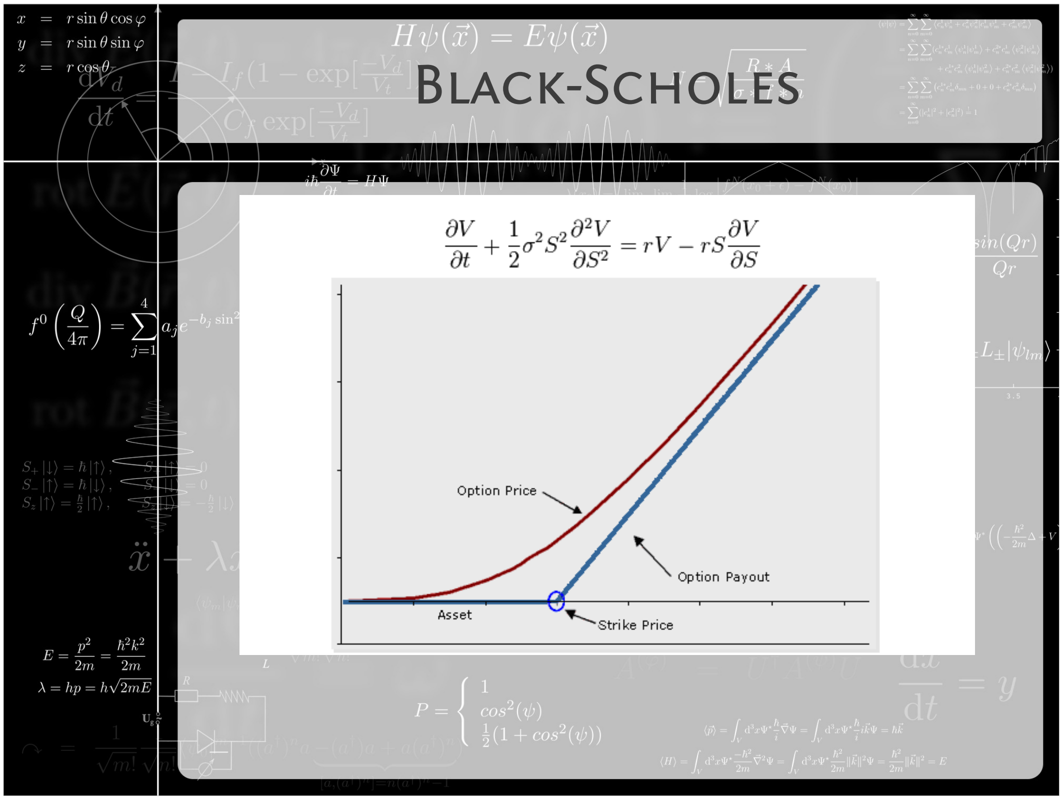
OKAY. It was really frustrating not getting to use much of the stuff that I'd learned here, either on the computer science or physics side, though.



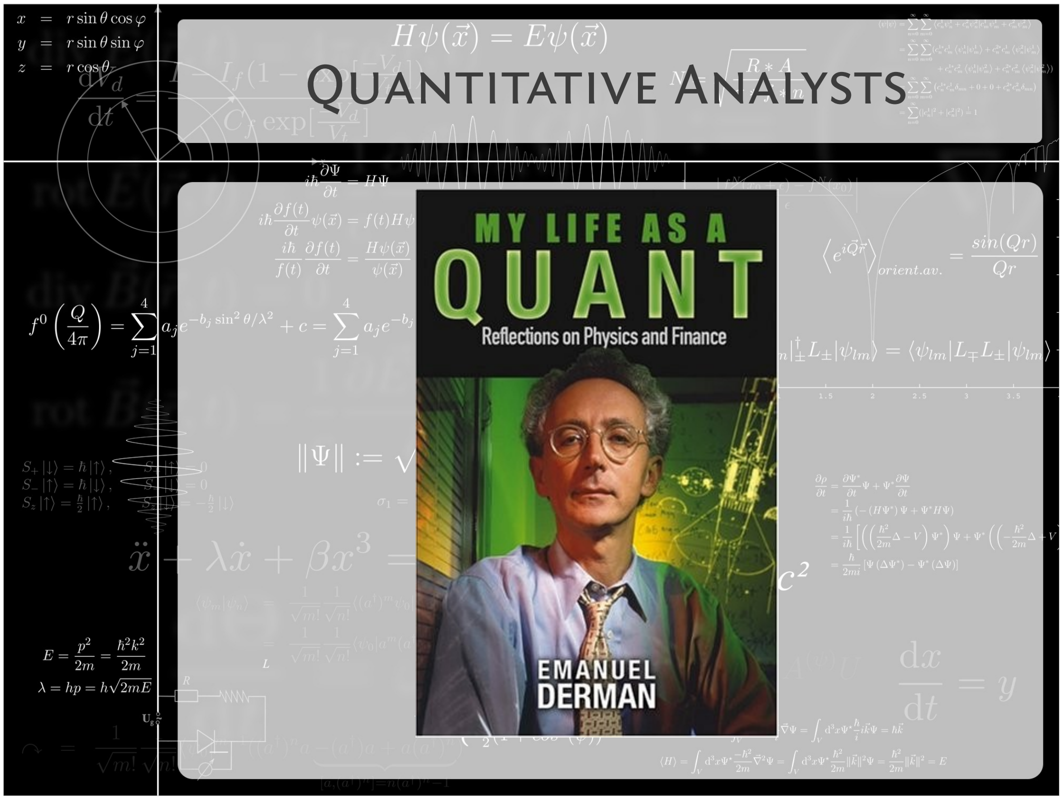
One fateful day in 2006, I was slogging back home on I-88 from a job as a systems administrator at a high school in the western suburbs of Chicago, when there was a NPR article that came up on the radio talking about something that some professor at some university in France was doing with stochastic calculus. The name intrigued me, because I had no idea how you could fit those terms together in any meaningful way.



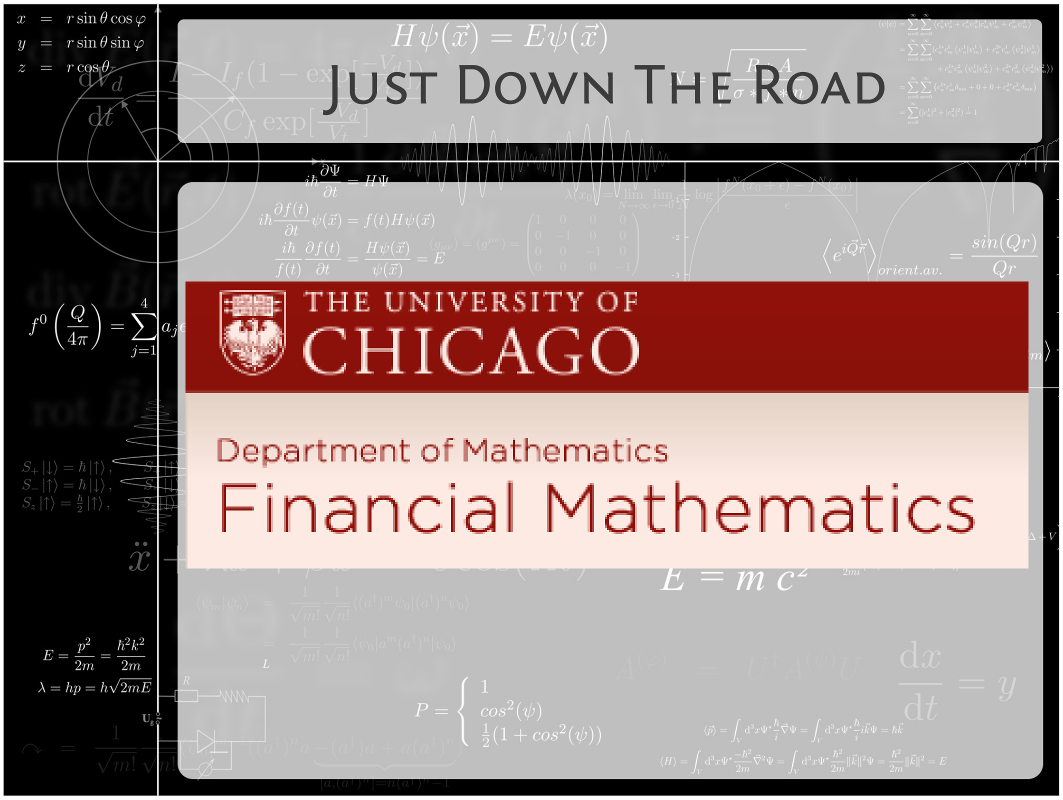
When I got home, I settled down with a nice unhealthy dinner and my laptop, and decided to see what Wikipedia had to say about "stochastic calculus".



As the name implied, it was, in fact, a marriage of calculus and probability theory, and it was used in "financial mathematics". I followed the link to that article, which lead me to reading about quantitative analysts ("quants"), Black-Scholes pricing, and computational finance.



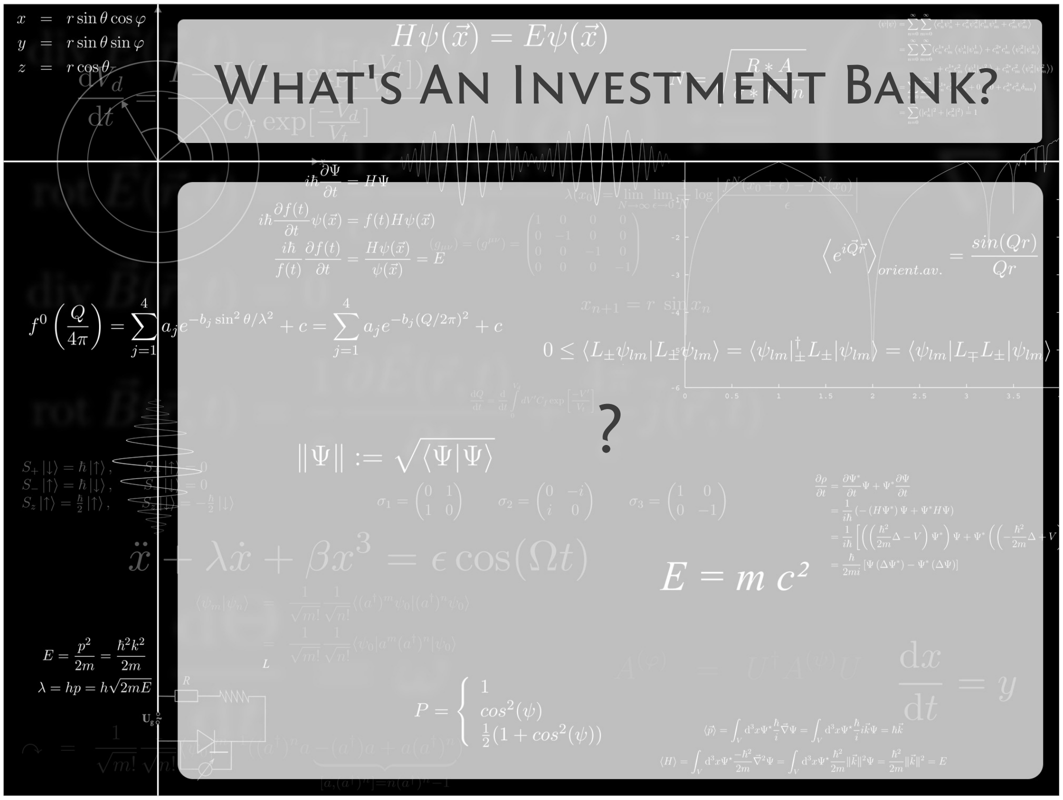
Turns out, there was this whole field of financial mathematics/computational finance was in large part the product of people with physics and applied math backgrounds who also by necessity learned a fair amount of computer science. And I was like, "hey, maybe I could do that."



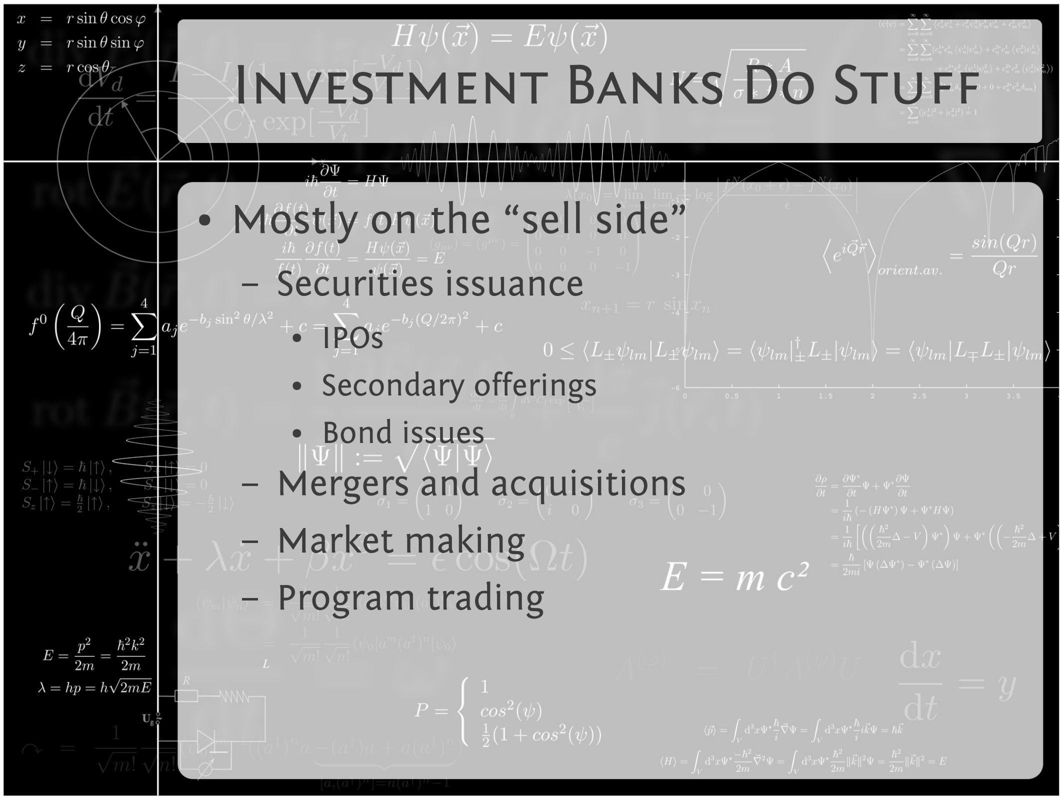
Conveniently enough, there was also an at-the-time well-regarded financial mathematics program at the University of Chicago. I applied, got in, and by summer 2008, had a masters degree in financial mathematics.

On the whiteboard: basics of Black-Scholes.

I also had a job offer as a software developer in NYC through the "IT Quant" program at Credit Suisse, a large investment bank.



What is an investment bank? I didn't really know when I started.

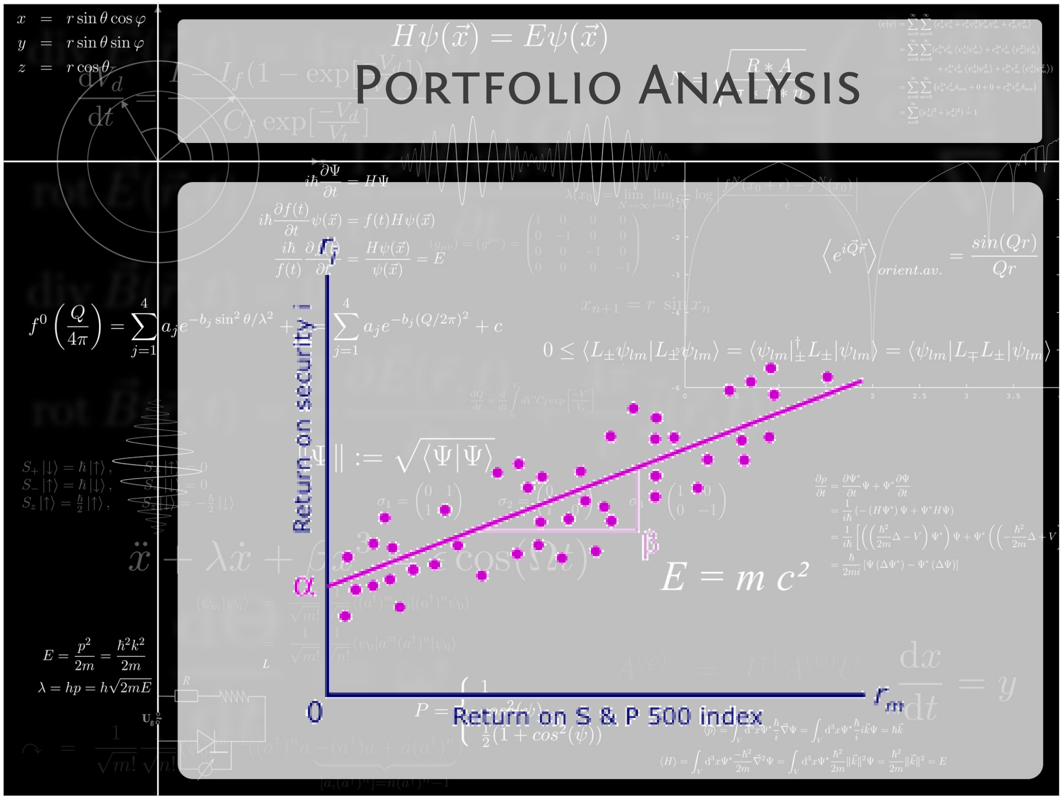


I still don't know. Or at least, I don't have a concise answer.

Investment Banks Do Stuff

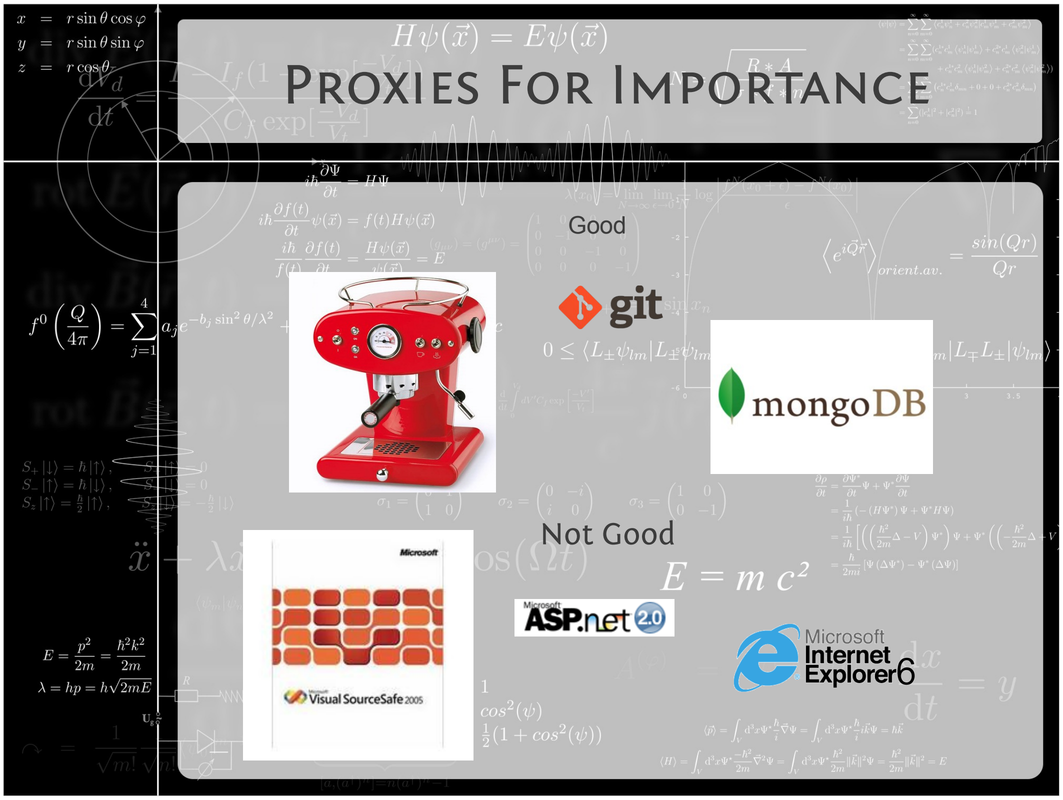
- Dark pools
- Derivative creation
- Proprietary trading (not anymore…by that name)
- Provide villains for the popular media

They also have securities analysts, who provide recommendations for folks on the "buy side."



While I was at Credit Suisse, I was responsible for maintaining and extending the functionality of a program that allowed our customers to do a variety of things, including monitoring execution of trades that they had placed through our program trading desk as well as basic option pricing and portfolio analytics.

While the job didn't involve "doing math" per se (i.e., I was not a quant), what the product did was fundamentally mathematical and required understanding of options pricing and portfolio theory to identify errors and make improvements. It wasn't anything terribly wild, just tree-based pricing and linear regression, but it was a start. Moreover, what we were doing was taking imperfect sets of data (securities prices provided by third parties), finding ways to handle the imperfections, and creating tools to do analyses of them, which is a lot like what you'll



After about two years there, I decided to start looking for other opportunities. The project didn't really seem to have a future, and from a technology standpoint was fairly archaic, which both impeded progress and made bringing on qualified new developers difficult.

One important thing that I took away from my experience there is that updated technology is a decent proxy for whether or not you want to be working on a project. Much like you can tell if a research lab is important by whether it has its own espresso machine, if the software that you're considering taking over is written on .NET 2.0 and does not have an immediate plan for an upgrade...perhaps it's not the job you want. Lesson learned.

After a few months of interviewing, I found a job with a small hedge fund that seemed to fit my background well.

One nice thing I discovered in my search: everyone in finance needs people who are willing and able to program. The hard part was less finding a job and more finding a job that didn't want to have you working 16 hours a day maintaining a spreadsheet that has become a critical institutional application.

What's A Hedge Fund?

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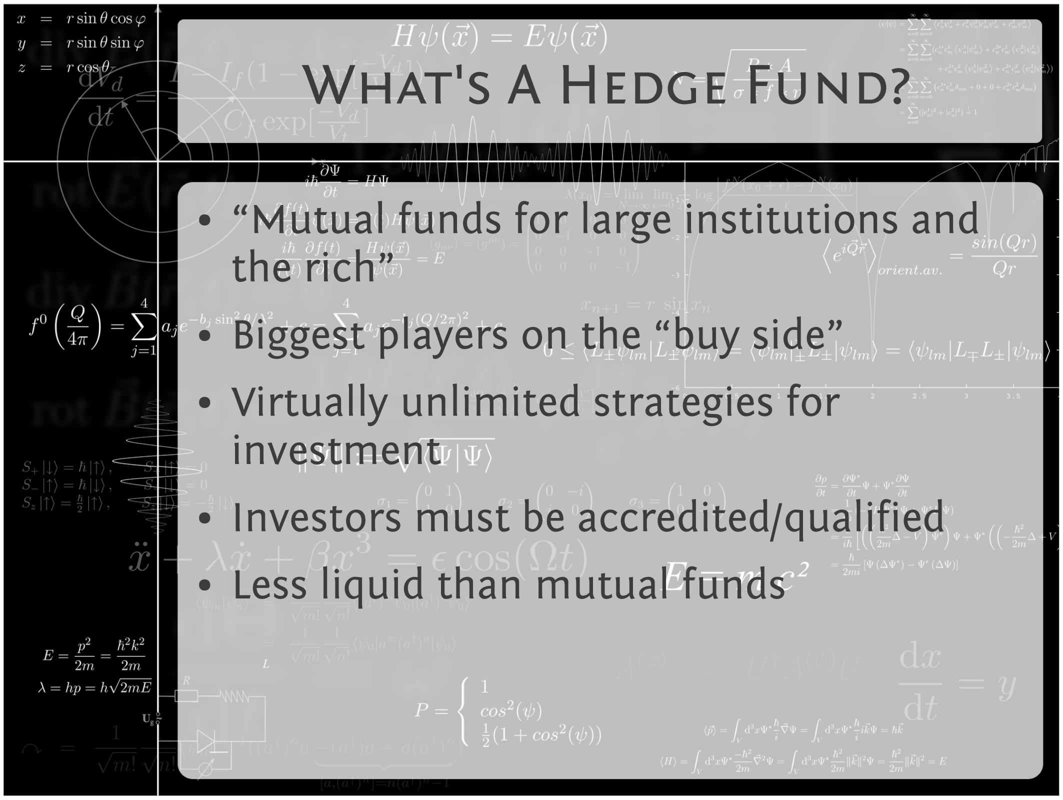


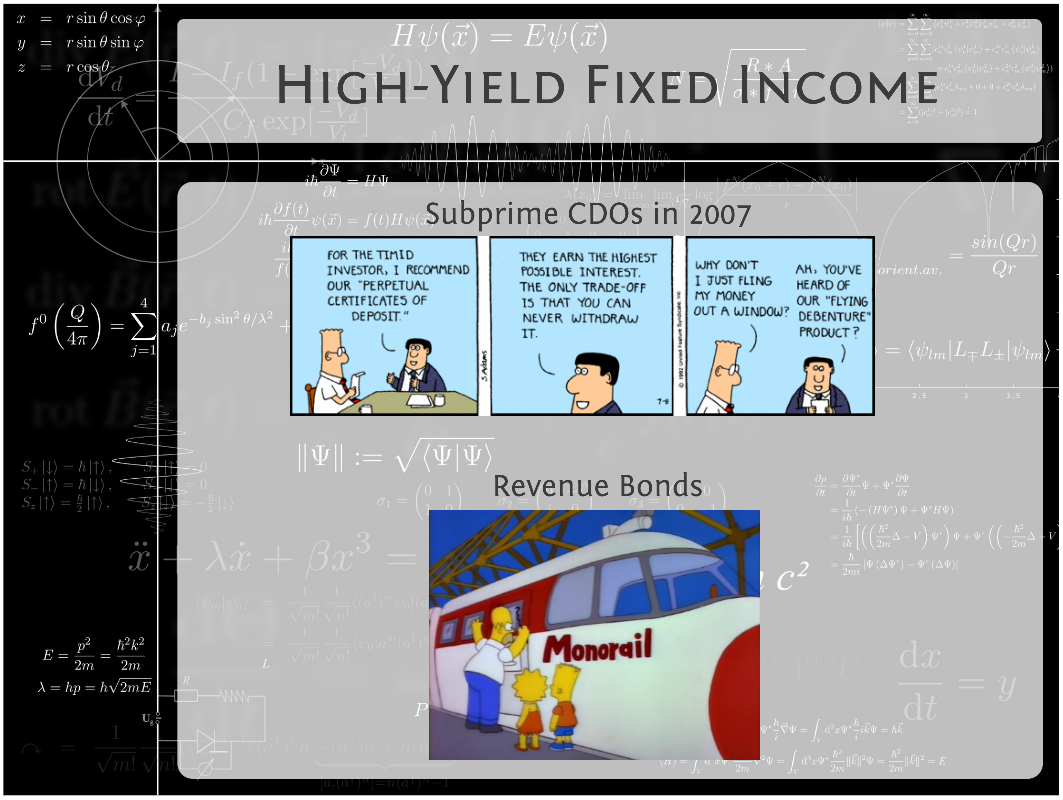
It's an organization that manages a big fund of money and can engage in pretty much any kind of (legal) strategy to try to make more money with it. Because they're not limited to conservative methods of investing, you have to have a high net worth and claimed investment knowledge to be able to participate in a hedge fund.

What does it mean to short a stock?

First hedge fund strategy, hence the name. Arose in the late 40s.

A.k.a. “vulture funds”.

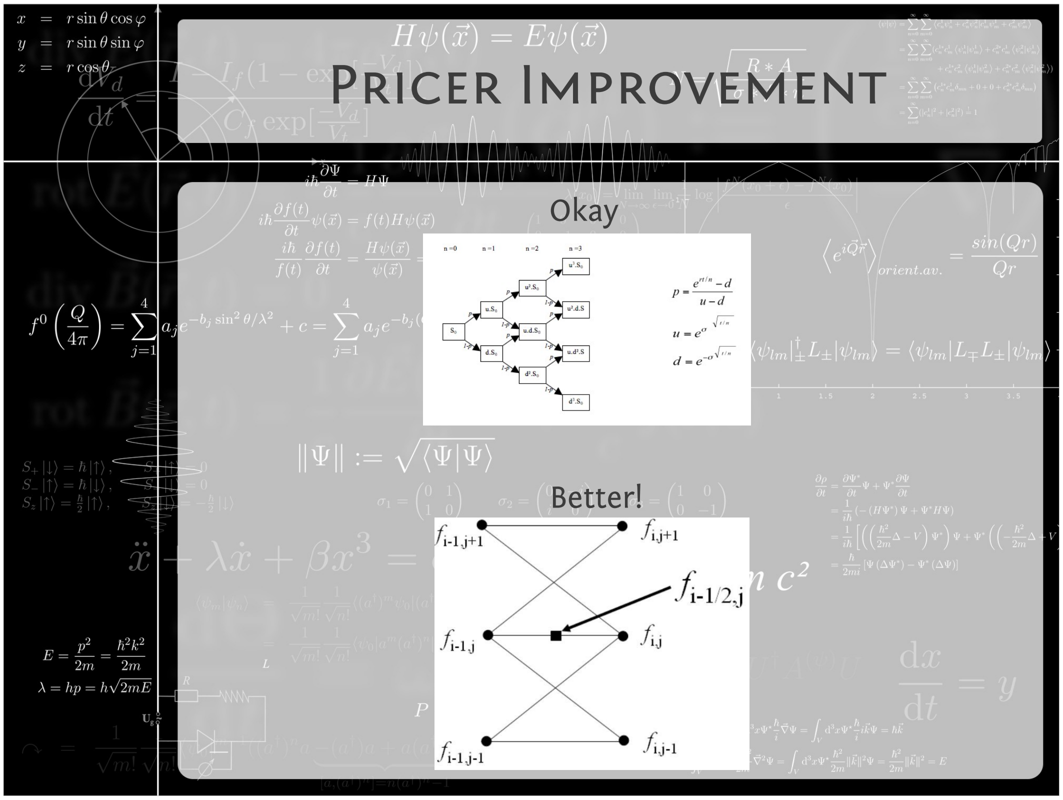
Seized in Ghana by NML Capital, a subsidiary of Elliott Management Corporation.



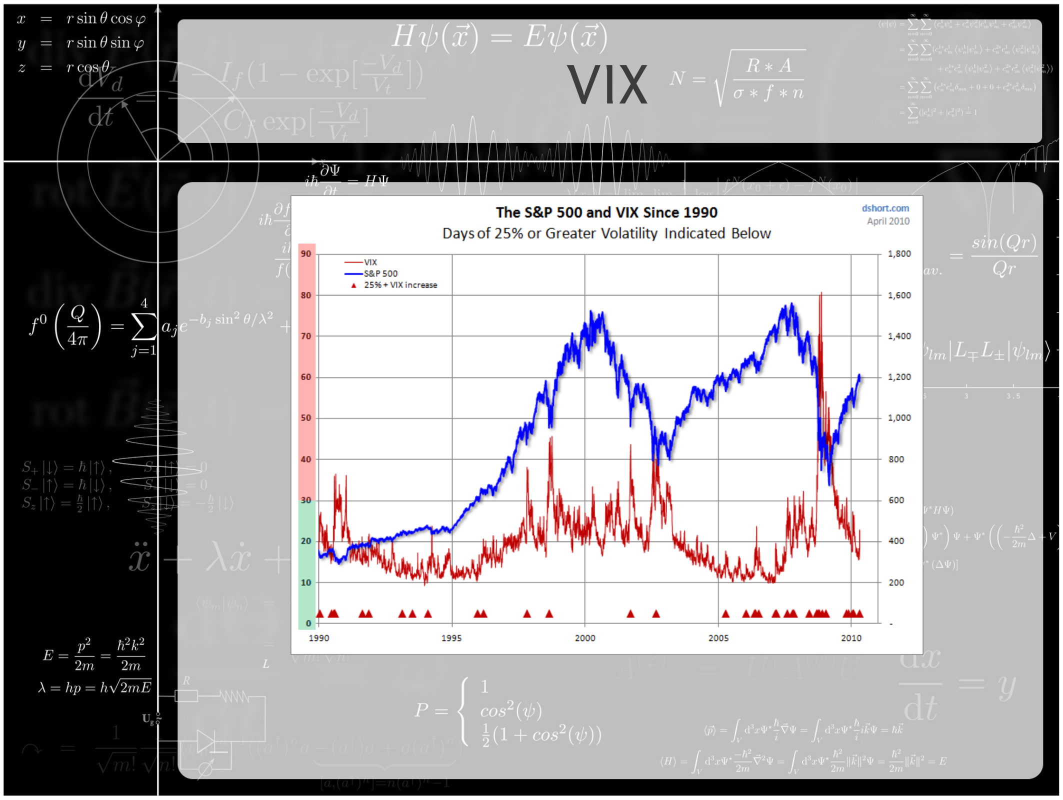
Explain CDO and revenue bonds.

Pause to allow people to read cartoon.

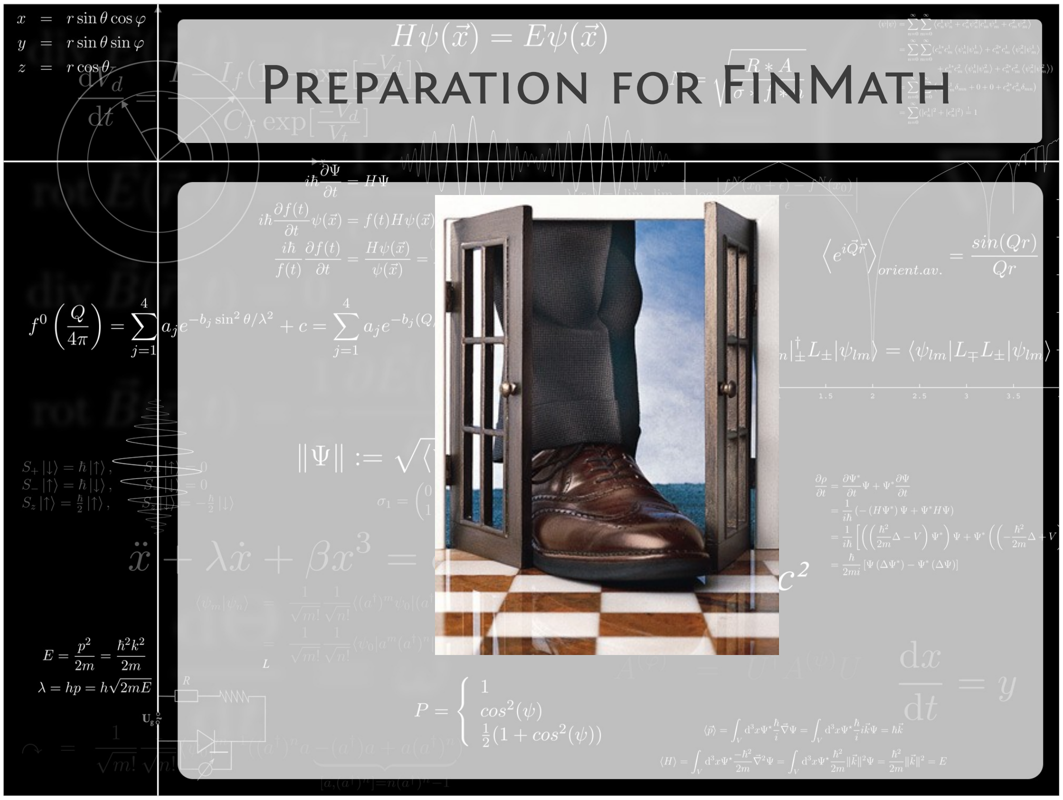
Alphabet wanted someone to be part of a small team of developers who would create tools for their traders. Technologically, we were allowed pretty much free reign, and what they were doing was mathematical enough in nature that my physics and financial math background was appealing. This sounded pretty darn good.



...and it was! One of the first contributions I was able to make out of the gate was seeing an option-pricing program they'd written that was giving them problems because it was very slow. It turned out they were using a tree-based pricer, and I realized that if I replaced it with a partial differential-equation-based one, it'd be faster and more stable.



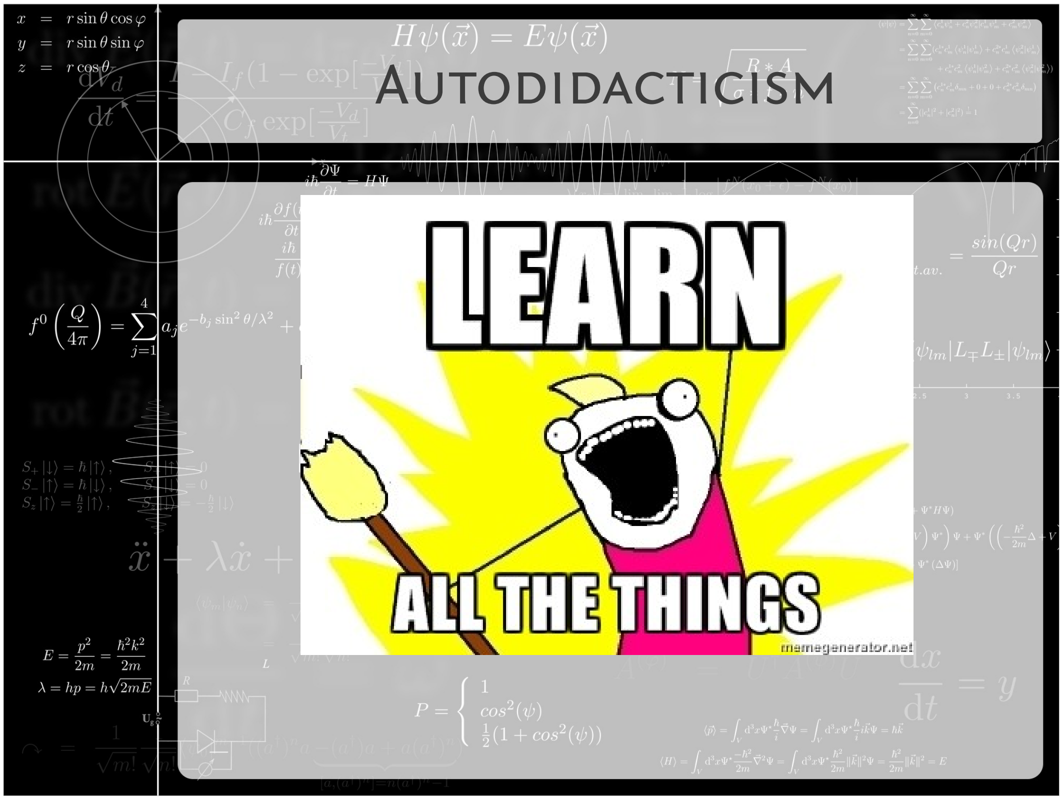
I had to learn how swaptions were modeled and understand why the VIX is defined the way that it is. Again, I wasn't making models---we had a trader with a math Ph.D. and a full-time quant with a Ph.D. who did that---but we had to understand them to implement and troubleshoot them. Throughout my tenure there, I was involved with a number of projects that involved creating tools that required understanding and implementation of financial models (some complex, some not), and communication of how to use them to the end consumers--- the traders and risk managers.



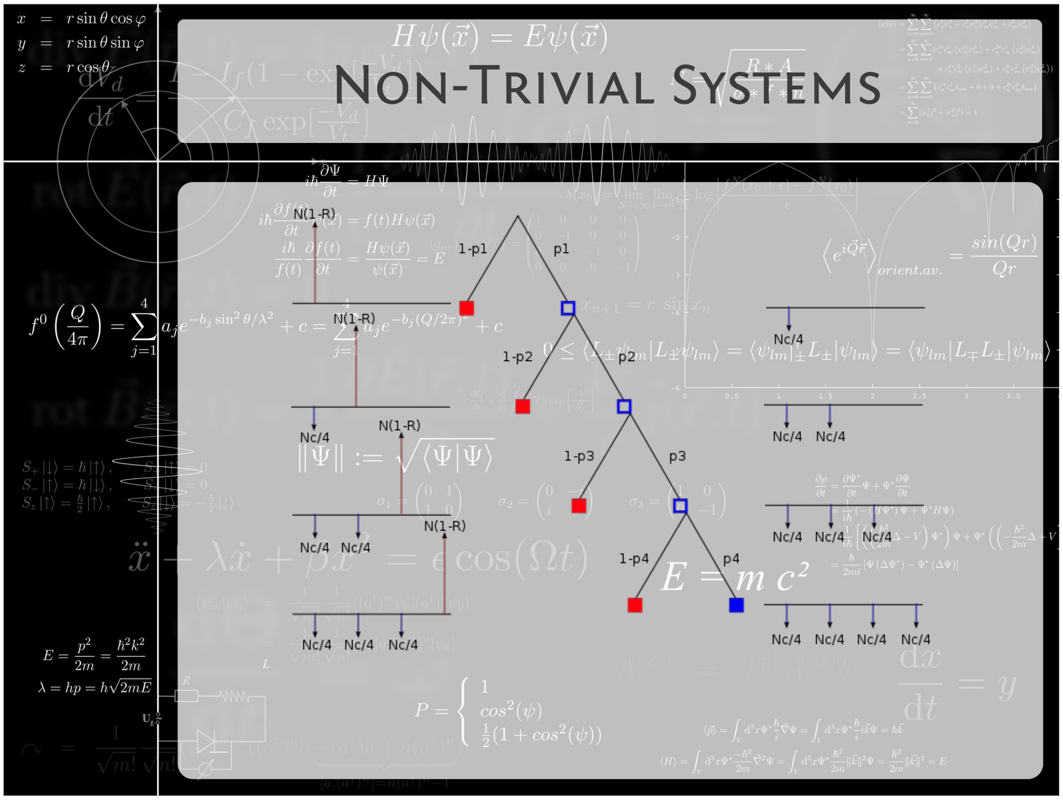
The mathematical background is ideal for a candidate for a financial mathematics program.

You can teach a mathematician finance easily. You can't teach a financier math the same way.

To this end: I don't specifically recommend taking finance classes (though I wouldn't suggest it's a bad thing).



Doing physics requires a willingness to sit down with books and papers and learn a lot on your own. So does modern finance.

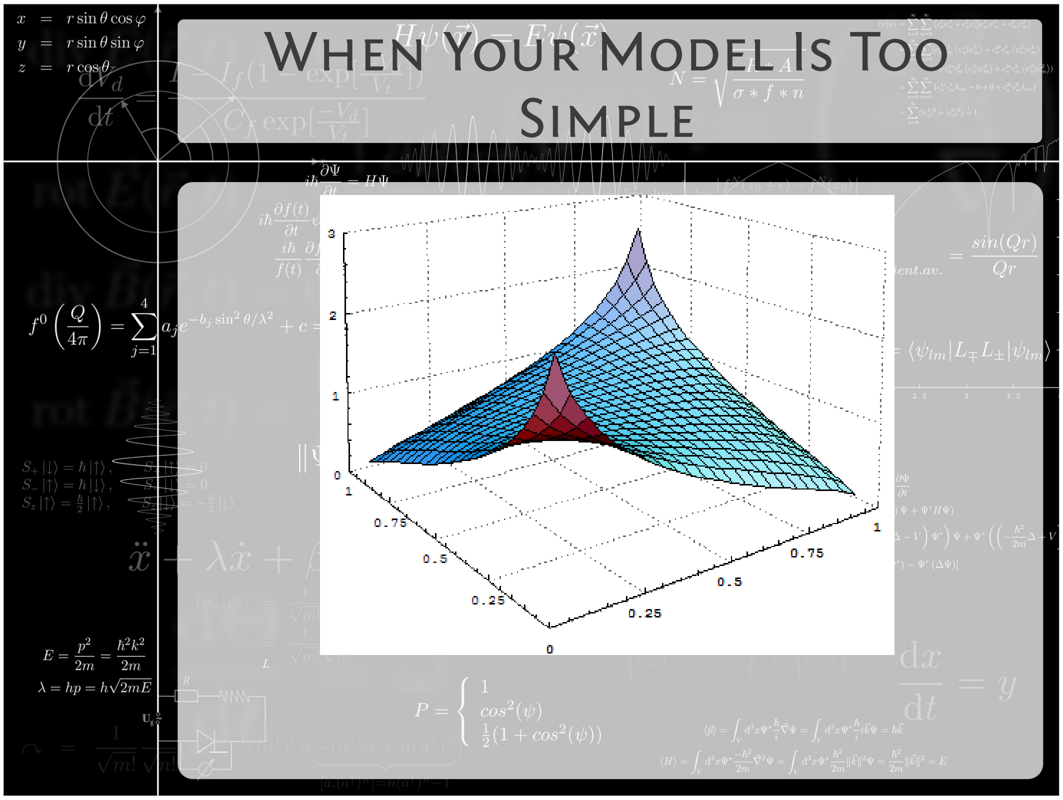


How does physics prepare you for modern finance? The theoretical side of physics deals with systems of objects whose behavior is governed by non-trivial mathematical models. Modern financial derivatives are objects whose behavior is modeled by non-trivial mathematical models.

CDS pricing.

What's a CDS?

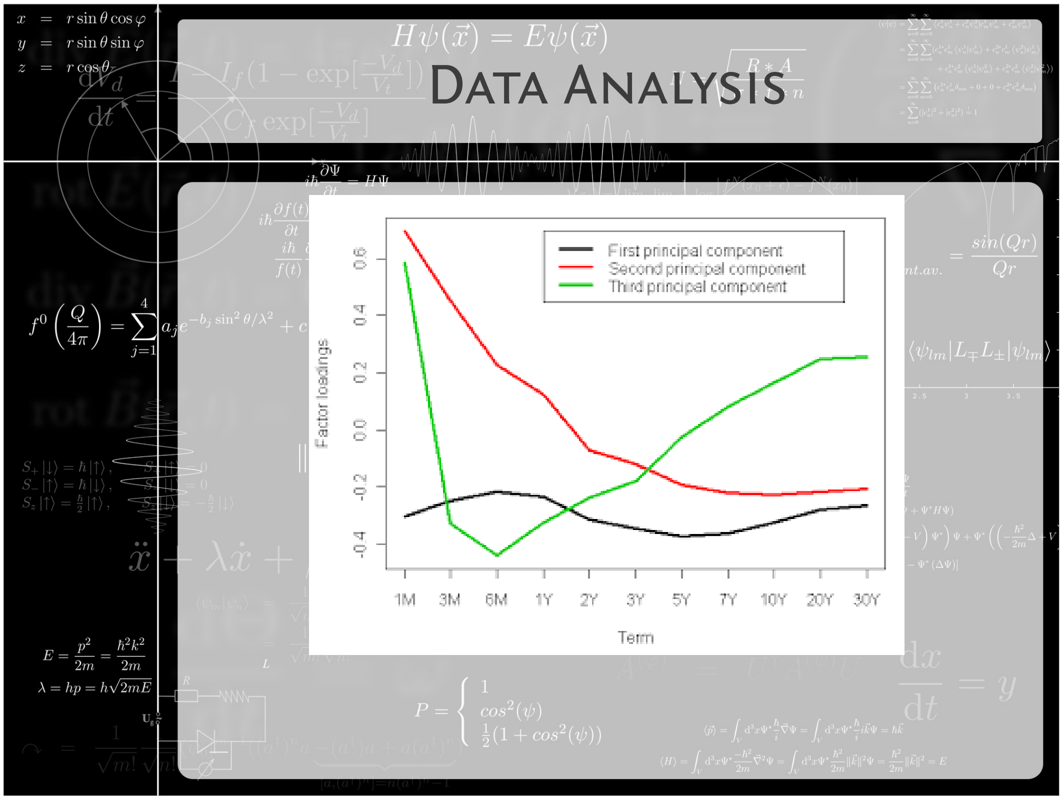
Spiel on pricing.



Gaussian copula, the “formula that killed Wall Street”. Pioneered for use in describing correlation between defaults of debt securities by David X. Li.

What's a CDO?

A good reminder that you should test well the validity of your theories and ensure that you're using them in the correct domains, something you would hopefully also pick up in your physics education.



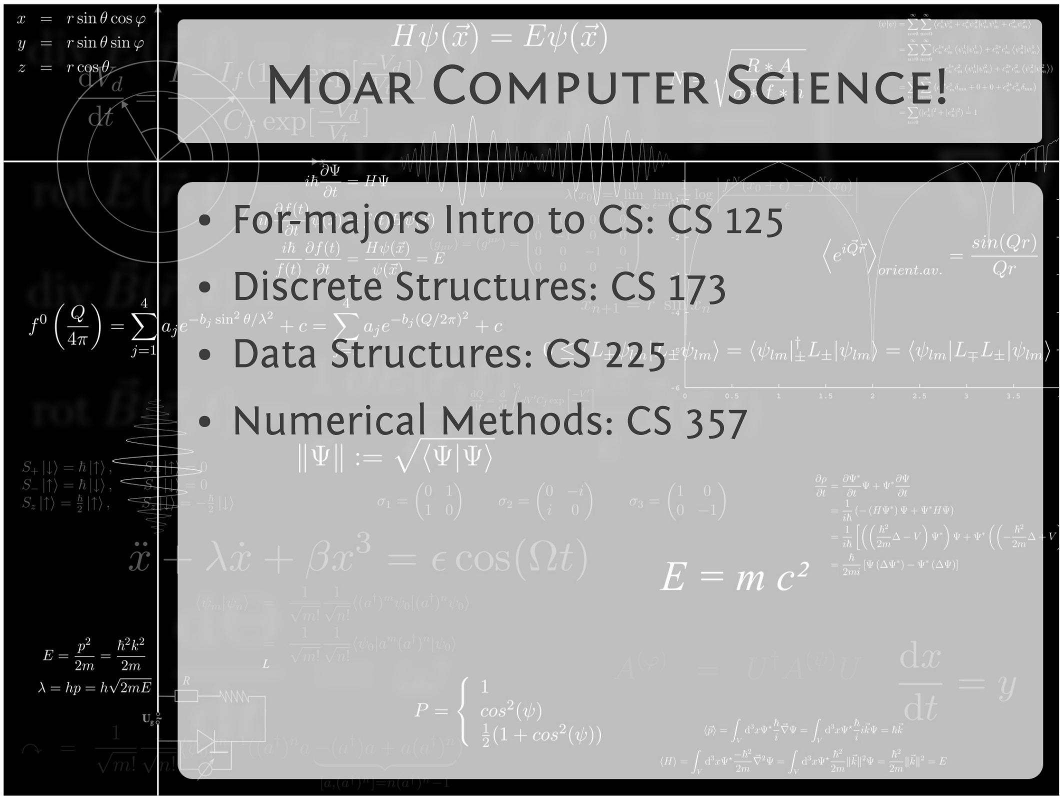
Doing physics requires you to be able to sift through potentially noisy data to test hypotheses, calibrate models, and simplify data so that they can be understood. So does modern finance.

What's a bond?

Yield curve. Principal components pictured above.

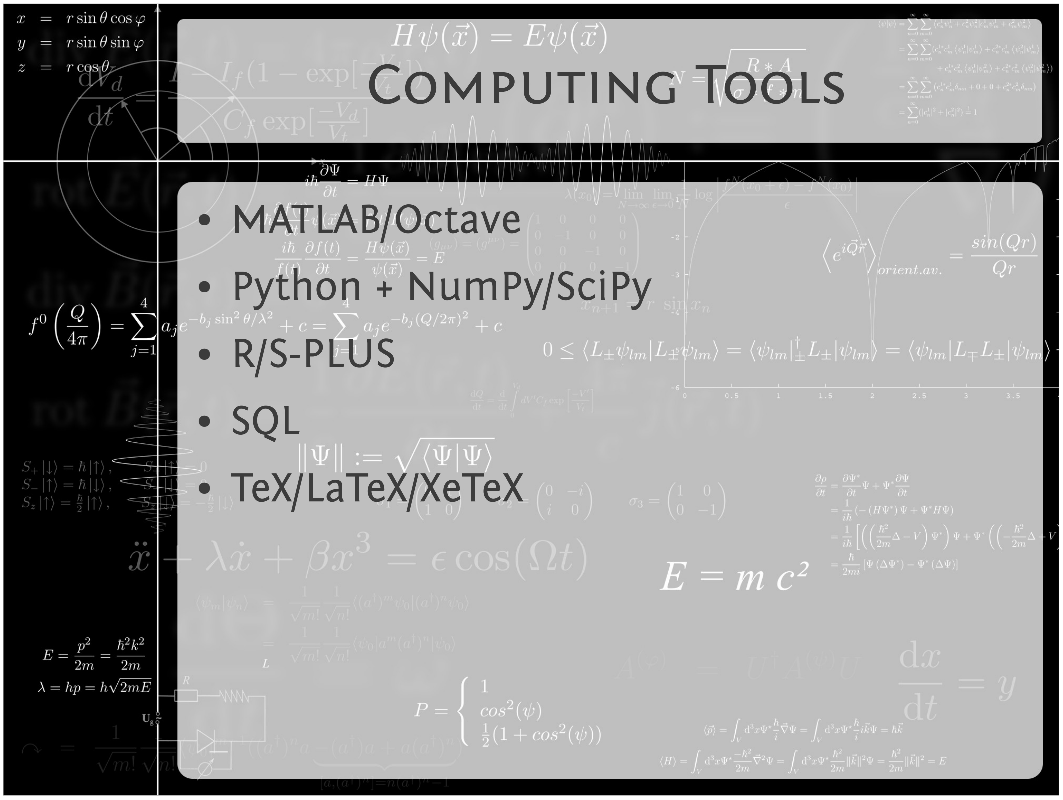
Up-And-Down-Sides

- Good compensation, but not trader- or banker-level
- High employability
- Get to use technical knowledge…sometimes
- “Now” is better than “right” or “good”
- Always learning
- Lots of intelligent, motivated people
- The bottom line is the bottom line



This is the “specific recommendations” section. No need to take notes; presentation will be available online. I also have cards so you can email/FB/G+/LinkedIn me.

Everything that involves data analysis involves programming to some degree. CS101 is a cursory introduction to programming, but to gain facility with it, I'd strongly recommend taking several CS-major courses: the for-majors intro course (CS 125), Discrete Structures, Data Structures, and Numerical Methods.



Python is a language which is free, runs everywhere, and has a ton of libraries for doing data analysis (NumPy and SciPy being outstanding examples).

R is also free and outstanding for doing statistical analyses.

SQL is the language that is used for querying and updating all modern relational databases, which as the name implies, are where you might find data stored or need to store data. You only need to know the basics, but you should know the basics.

Reading

- *Financial Calculus*, Baxter and Rennie
- *Concepts and Practice of Mathematical Finance*, Joshi
- *Options, Futures, and Other Derivatives*, Hull
- *Investments*, Bodie, Kane, and Marcus

IAmA Quant Dev