Quantum Mechanics, with Applications	**Spring 2019**
Syllabus	
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The Universe at its Extremes: **Quantum Mechanics, with Applications in Astrophysics and Computation**

S.1 Welcome!

This course is about quantum mechanics, astrophysics and computation. We will use quantum mechanics as the basis for most of our discussions as it is important in numerous other subfields of physics, including the ones we will talk about.

Quantum mechanics is a completely different paradigm of thought from the deterministic physics of classical mechanics. You may have seen things like the *wavefunction* Ψ, the *Heisenberg uncertainy relation*, and the *Schrödinger equation*:

$$-\frac{\hbar^2}{2m}\nabla^2\Psi + V(\boldsymbol{r})\Psi = i\hbar\frac{\partial\Psi}{\partial t},$$

which in this form looks complicated and difficult to solve.

However, it turns out that we don't need the full machinery of calculus to understand quantum mechanics at a meaningful level. Even though quantum mechanics was first conceived in a calculus-based formalism, modern quantum mechanics can also be interpreted in terms of linear algebra. We will mainly adopt the linear algebraic approach to quantum mechanics in this class, so don't worry if you have not learned calculus yet. We will cover all the tools you need to understand the formalism of quantum mechanics.

S.2 Aims of the course

This course aims to introduce you to quantum mechanics and situate it in the context of physics research. Some of the most interesting topics in modern physics arise from the physics you will be learning in this course. We hope that you will not only learn more about the quantum world, but also appreciate the role of quantum mechanics in other fields.

This course does not purport to be a replacement for other quantum mechanics courses. The standard quantum mechanics sequence (which usually comes after a calculus-based course in waves and vibrations) remains essential in interpreting the various results of quantum mechanics. However, we hope that this course will help you understand phenomena you may see in popular science or other fields of physics at a more fundamental level. In the event you do take more courses in quantum mechanics, we expect this course to also help you develop a deeper intuition for the material.

S.3 Prerequisites

There are few prerequisites for this course. We only expect you to have a basic understanding of classical mechanics, as we will introduce the machinery of quantum mechanics from scratch. Nevertheless, some familiarity with complex numbers will be helpful.

S.4 Course outline

Week	**Date**	**Topic**	
1	Feb 23	Introduction to Quantum Mechanics	
2	Mar 2	Two-State Systems, Part I	Quantum key distribution
3	Mar 9	Two-State Systems, Part II	Quantum circuits
-	Mar 16	*Spark*: no class this week	
4	Mar 23	Quantum Physics of Matter	Observational astrophysics
5	Mar 30	Quantum Information	Quantum computing
6	Apr 6	Stars and Black Holes	Theoretical astrophysics

More information can be found in the course schedule (to be released on the first day of the course).

VERSION DATE: February 1, 2019