

Physics 460 Quantum Mechanics

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Course Information

- Time: T, Th 12:00-1:15
- Location: Phys 110
- TA: Xuefeng Yuan
- Office Hours:
- Homework: 40%
- Midterm: 20%
- Final: 40%
- Textbook:
 1. Introduction of Quantum Mechanics, David J. Griffiths,
 2. Principles of Quantum Mechanics, R. Shankar



Heisenberg's Humor

- Werner Heisenberg was driving along the highway one day, when a highway patrol car pulled up behind him with lights flashing. Heisenberg pulled over and stopped. The patrolman approached the car, and said, "Sir, do you know how fast you were going?"

Heisenberg replied, "No, but I know exactly where I am."



Syllabus (Phys 460)

- Introduction to quantum mechanics
- History overview of quantum theory
- Atom and Quanta: Bohr's Theory
- Wave function and Schrodinger Equation
- Time independent Schrodinger Equation
- Application of quantum theory in transport
- Mathematical formalism
- Heisenberg quantum mechanics and uncertainty principle
- Hydrogen atom
- Identical particles and quantum statistics



Syllabus (Phys 461)

- Time-independent perturbation theory
- Time-dependent perturbation theory
- Fundamentals of the quantum theory: Chemical bonding
- Other approximation methods
- Scattering
- Adiabatic Approximation and Berry phase
- A deeper understanding and new progress in quantum mechanics
- Final remarks



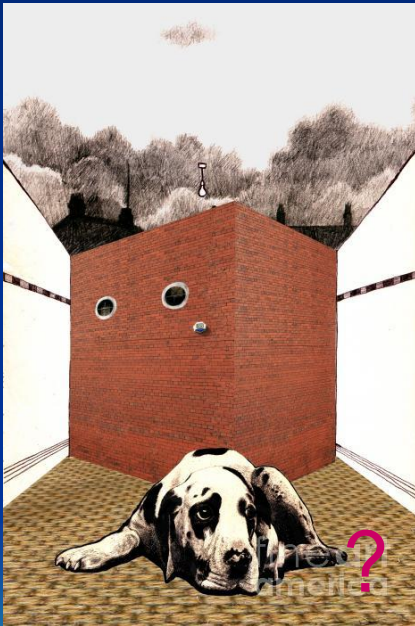
Mathematical Requirements

- Linear Algebra:
 1. complex number
 2. vector, vector space
 3. matrix, basic matrix operations
 4. linear operators
- Calculus: derivative, integral
- Differential equations:
 - Linear differential equations



Introduction to Quantum Mechanics

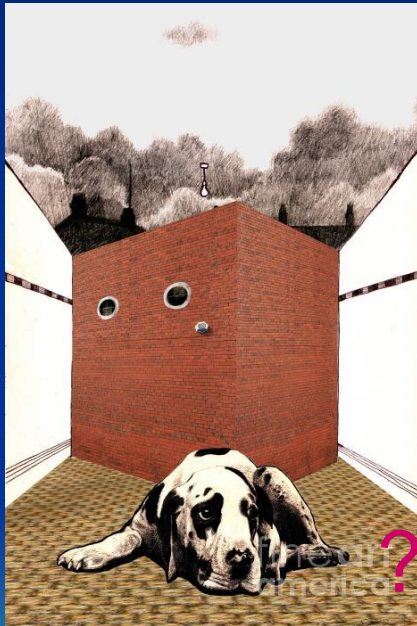
- A law governing microscopic world



- All of objects are built of small common bricks
- The behavior of large objects can be different from their elements
- Classical physics describes the macroscopic world.
- Quantum physics describes the microscopic world.
- Classical physics can be considered as a natural limit of quantum mechanics by taking the Planck constant to be zero

Introduction to Quantum Mechanics

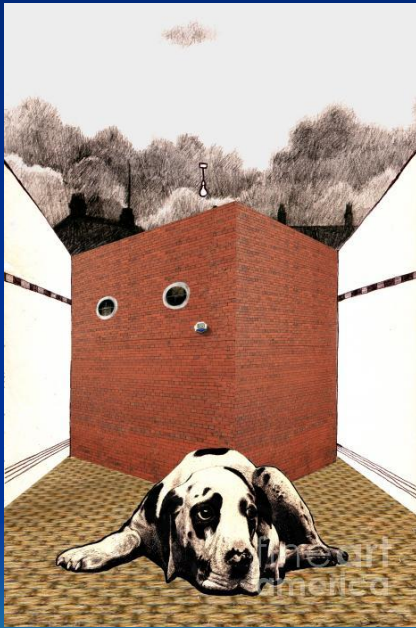
- New principles in quantum mechanics



- A complete different philosophy
Complementary principle: particle and wave are unified
- System is described by its state and is interpreted probabilistically (Things can not be certain fundamentally: Heisenberg Uncertainty principle !!)
- There is new degree of freedom in microscopic world (spin)
- Different statistical property (Identical particle principles)
- The world is intrinsically “complex”.

Introduction to Quantum Mechanics

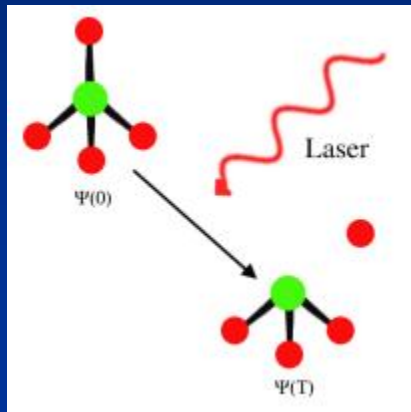
- Is quantum mechanics a ghost?



- successfully explains and predicts atomic physics
- successfully explains and predicts properties of matter (for example, metal vs insulator, magnetism)
- successfully explains and predicts the physics of light (quantum optics)
- understanding macroscopic quantum phenomena at low temperature (For example, superconductors)
- In summary, so far so good.

Introduction to Quantum Mechanics

- Future of quantum mechanics: **quantum control**



- New technology allows us to access nano or sub-nano length scale
- New technology can access extremely low temperature
- New technology can create man-made matter
- Control quantum effects in short length: new quantum device!
- Design new quantum matter
- Control and use quantum information processing (quantum information and quantum computers)
- In summary, future is bright.

Einstein

- Quantum mechanics is very impressive. But an inner voice tells me that it is not yet the real thing. The theory yields a lot, but it hardly brings us any closer to the secret of the Old One. In any case I am convinced that He doesn't play dice”



Niels Bohr

- If quantum mechanics hasn't profoundly shocked you, you haven't understood it yet.”



Richard Feynmann

- I think I can safely say that nobody understands Quantum Mechanics”

