What do we mean when we talk about *Modern Physics*?

Introduction to special relativity and Quantum Physics
100 Years of the Quantum
M. Tegmark and J.A. Wheeler
Scientific American, Feb., 68 (2001)

- Einstein explained the photoelectric effect.
- Planck explained blackbody radiation.
- Bohr developed the hydrogen atom model.
- de Broglie's wave hypothesis.
- Onnes discovered superconductivity.
- Schrödinger's wave equation.
- Heisenberg's uncertainty principle.
- Pauli's exclusion principle.
- Shockley's P, N type Silicon.
- Bardeen's first world electric crystal.
It was a marvelous time to be alive. by Einstein

We regard quantum mechanics as a complete theory for which the fundamental physical and mathematical hypotheses are no longer susceptible of modification.

by Heisenberg and Born, 1927
The 5th international congress of physics, Brussels, 1927
Quiz: True or False

Relativity and quantum mechanics are esoteric concepts which have no application in everyday life.
Nuclear Power

\[ E = mc^2 \]

\[ Mc^2 + [BE] = \sum_{i=1}^{N} m_i c^2 \]

GPS

relativity correction : 38 \( \mu \)s/day

\[ \rightarrow 0.8 \text{ cm} \]
1950s 1960s 1970s 1980s 1990s 2000s

- INTEL 4004: 1st microprocessor
- 1900s: Vacuum tube
- 1950s: 1st transistor
- Ge
- 1970s: 1st IC
- 256bit RAM
- INTEL 4004: 1st microprocessor
- 1965: Double every 18 months (Moore's Law)
- 1970s: 1st IC
- Bottom-up technique
- Top-down technique
- 2000s: Future
- 1900s: Vacuum tube
- Ge
- Atom

Future
1. To enliven and humanize the text with brief sketches of the historical development of 20th century physics.

2. To provide simple, clear, and mathematically uncomplicated explanations of physical concepts and theories of modern physics.

3. To clarify and show support for these theories through a broad range of current applications and examples.

Introduction to special relativity and Quantum Physics

**Relativity**
Starting from the hypothesis of constancy of the speed of light, Einstein showed the far-reaching consequences for simultaneity, measures of time and distance, and conservation of energy and momentum that run counter the intuition of classical mechanics and Galilean transformations.

**Quantum Physics**
The microscopic world of atoms and subatomic particles revealed the wavelike nature of matter and a probabilistic description of mechanics. We will examine the basic experimental evidence and theoretical underpinnings for these ideas, with the aim of understanding the basis for all modern physics.
Schedule

<table>
<thead>
<tr>
<th>Chapter One</th>
<th>Relativity I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter Two</td>
<td>Relativity II</td>
</tr>
<tr>
<td>Chapter Three</td>
<td>The Quantum Theory of Light</td>
</tr>
<tr>
<td>Chapter Four</td>
<td>The Particle Nature of Matter</td>
</tr>
<tr>
<td>Chapter Five</td>
<td>Matter Waves</td>
</tr>
<tr>
<td>Chapter Six</td>
<td>Quantum mechanics in One dimension</td>
</tr>
<tr>
<td>Chapter Seven</td>
<td>Tunneling Phenomena</td>
</tr>
</tbody>
</table>

Midterm Exam. I

Midterm Exam. II

Final Exam.
The Cast of Characters

- **Lectures/Discussion:** 許世英
  - 工六館472室
  - x56164
  - syhsu@cc.nctu.edu.tw

- **HW/Discussion:** 鍾廷翊，王聿宸
  - 工六館657室
  - x56166
  - Office hour: TBA
Grades

1. Midterm exam.I 30%
2. Midterm exam.II 30%
3. Final exam. 40%

Homework : extra credits 10%

Basic Course Philosophy

- read about it (text)
- untangle it (lectures)
- challenge yourself (homework)
- close the loop (discussion)
References

Comparable level


“… In a few years, all great physical constants will have been approximately estimated, and [...] the only occupation which will then be left to men of science will be to carry these measurement to another place of decimals.”

James Clerk Maxwell in 1871

1900 Max Planck announced his famous formula on the blackbody spectrum.

-------- The first shot of the quantum revolution

“There is plenty room at the bottom.” Richard P. Feynman
Quiz: True or False

Physics is fun and I am excited about the class of modern physics.

Answer: True, of course