

105 學年度第二學期(2017)台大物理系/TIGP 開課課程大綱

“當代原子與分子物理導論”

(Introduction to recent trends in atomic and molecular physics)

Lectures in English on every Tuesday (9:10-12:00) at Room 311 of IAMS

Date	lecturer	Date	lecturer
2/21 Tuesday 9:10~12:00	Prof. Kaito Takahashi	5/2 Tuesday 9:10~12:00	Prof. Ming-Shien Chang
3/7 Tuesday 9:10~12:00	Prof. Kaito Takahashi	5/9 Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/14 Tuesday 9:10~12:00	Prof. Kaito Takahashi	5/16 Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/21 Tuesday 9:10~12:00	Prof. Michitoshi Hayashi	5/23 Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/28 Tuesday 9:10~12:00	Prof. Michitoshi Hayashi	6/6 Tuesday 9:10~12:00	Prof. Yu-Ju Lin
4/11 Tuesday 9:10~12:00	Prof. Jer-Lai Kuo	6/13 Tuesday 9:10~12:00	Prof. Yu-Ju Lin
4/18 Tuesday 9:10~12:00	Prof. Jer-Lai Kuo		
4/25 Tuesday 9:10~12:00	Prof. Ming-Shien Chang		

Kaito Takahashi

Week 1 (2/21)

1.5 hours on “Recent success in using quantum simulations to understand interesting physics and chemistry”

- Using quantum chemistry methods to predict metal surface reactions
- Ab initio molecular dynamics simulation on liquid/solid phase of water
- Quantum chemistry calculation of proteins
- Reaction dynamics using quantum chemistry based trajectories to understand curious reaction features for $\text{CD}_3\text{H}+\text{F}$

1.5 hour on “Born-Oppenheimer approximation and its failures (using equations)”

Week 2 (3/7)

2 hours of “Linear Combination of Atomic Orbitals (using equations and figures)”

- Diatomic molecules (H_2^+ , H_2)
- Polyatomic molecules using LCAO

1 hours of “Vibration of diatomic molecules”

- Harmonic oscillator, morse oscillator

Week 3 (3/14)

1.5 hours on “Vibration in polyatomic molecules, normal modes”

1.5 hours on “Potential Energy Surface and reaction”

Michitoshi Hayashi

Week 1 (3/21)

Wave-particle duality of large molecules

-- Review on the foundation and concept of quantum theory and its application to molecules

Week 2 (3/28)

Van der Waals force and weak interactions

-- Quantum fluctuation, Coulomb interaction, Exchange energy, etc.

Jer-Lai Kuo

Week 1 (4/11)

Understanding structure of water via molecular spectroscopies (I)

-- This lecture will introduce different spectroscopic methods to probe different structures of water in gas, liquid to crystalline phases.

Week 2 (4/18)

Understanding structure of water via molecular spectroscopies (II)

-- We will introduce a few simple examples on how computational methods can be useful to understand experimental data to extract structural information.

Ming-Shine Chang

2 weeks (4/25, 5/2)

1. Introduction to atom-photon interaction

- Two-level atom without spontaneous decay
- Coherent control on a two-level atom: Rabi's and Ramsey's methods
- Two-level atom with spontaneous decay
- Optical Bloch equation

2. Atom trapping and cooling

- Optical force on atoms
 - Laser cooling
 - Magneto-optical trap
 - Magnetic trap
 - Optical dipole trap
 - Evaporative cooling
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Ying-Cheng Chen

3 weeks (5/9, 5/16, 5/23)

1. Atom-photon interaction in a three-level system (4hrs)
 - Electromagnetically induced transparency (EIT)
 - Slow light, Storage of light and stationary light
 - Nonlinear optics based on the EIT
 - Single photon and bi-photon generation based on EIT
 2. Coherent manipulation of atoms with lasers
 - Raman transition
 - Controlling the internal and external states
 - Application to quantum information sciences
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Yu-Ju Lin

2 weeks (6/6, 6/13)

1. Bose-Einstein condensates
 - stationary state and dynamics
 - experimental probe
 - research highlights
 2. atoms dressed by photons
 - dressed states
 - artificial gauge potential associated with the dressed state
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