

“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 at Room 209 of IAMS

**Ying-Cheng Chen**

3 weeks (2/18, 2/25, 3/4)

1. Introduction to atom-photon interaction (4 hrs)
  - Two-level atom without spontaneous decay
  - Rabi oscillation and Ramsey fringe
  - Spontaneous emission
  - Two-level atom with spontaneous decay
  - Optical Bloch equation
  - Optical force on atoms
2. 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

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**Ming-Shine Chang**

3 weeks (3/11,3/18 3/25)

- Atom trapping and cooling
  - Magnetic trap
  - Optical dipole trap
  - Ion trap
  - Laser cooling
  - Magneto-optical trap
  - Evaporative cooling
- Bose-Einstein Condensation
  - Cold collisions
  - Spinor condensates
- 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**

3 weeks (4/1, 4/8, 4/15)

- trapping of cold atoms
  - atoms dressed by photons
  - Bose-Einstein condensates
  - selected topics of cold atoms in optical lattices
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### **Kaito Takahashi**

Week 1 (4/22):

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 (4/29):

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

- Diatomic molecules ( $\text{H}_2^+$ ,  $\text{H}_2$ )
- Polyatomic molecules using LCAO

1 hours of “Vibration of diatomic molecules”

- Harmonic oscillator, morse oscillator

Week 3 (5/6):

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

1.5 hours on “Potential Energy Surface and reaction”

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### **Jer-Lai Kuo**

Week 1 (5/13):

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 (5/20):

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.

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**Michitoshi Hayashi**

Week 1 (5/27):

Wave-particle duality of large molecules

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

Week 3 (6/3):

A wonder of double-well potentials

--Tunneling, localization, Delocalization, and more.

Week 3 (6/10):

Chiral response of molecules

--Interaction between molecules and the radiation fields.

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