#### 104 學年度第二學期(2016)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
2/23Tuesday 9:10~12:00	Prof. Kaito Takahashi	4/26Tuesday 9:10~12:00	Prof. Ming-Shien Chang
3/1Tuesday 9:10~12:00	Prof. Kaito Takahashi	5/3Tuesday 9:10~12:00	Prof. Ming-Shien Chang
3/8Tuesday 9:10~12:00	Prof. Kaito Takahashi	5/10Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/15Tuesday 9:10~12:00	Prof. Michitoshi Hayashi	5/17Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/22Tuesday 9:10~12:00	Prof. Michitoshi Hayashi	5/24 Tuesday 9:10~12:00	Prof. Ying-Cheng Chen
3/29Tuesday 9:10~12:00	Prof. Jer-Lai Kuo	5/31Tuesday 9:10~12:00	Prof. Yu-Ju Lin
4/12Tuesday 9:10~12:00	Prof. Jer-Lai Kuo	6/7Tuesday 9:10~12:00	Prof. Yu-Ju Lin
4/19Tuesday 9:10~12:00	Prof. Ming-Shien Chang	6/14Tuesday 9:10~12:00	Prof. Yu-Ju Lin

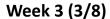
## Kaito Takahashi

#### Week 1 (2/23)

- 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 CD₃H+F
- 1.5 hour on "Born-Oppenheimer approximation and its failures (using equations)"

#### Week 2 (3/1)

- 2 hours of "Linear Combination of Atomic Orbitals (using equations and figures)"
  - Diatomic molecules (H<sub>2</sub><sup>+</sup>, H<sub>2</sub>)
  - Polyatomic molecules using LCAO
- 1 hours of "Vibration of diatomic molecules"
  - Harmonic oscillator, morse oscillator



- 1.5 hours on "Vibration in polyatomic molecules, normal modes"
- 1.5 hours on "Potential Energy Surface and reaction"

# Michitoshi Hayashi

## Week 1 (3/15)

Wave-particle duality of large molecules

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

#### Week 2 (3/22)

Van der Waals force and weak interactions

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

## Jer-Lai Kuo

#### Week 1 (3/29)

Understanding structure of water via molecular spectroscopies (I)

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

## Week 2 (4/12)

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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# **Ming-Shine Chang**

#### 3 weeks (4/19, 4/26, 5/3)

- 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 (5/10, 5/17, 5/24)

- 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

# Yu-Ju Lin

#### 3 weeks (5/31, 6/7, 6/14)

- atoms dressed by photons
- Bose-Einstein condensates
- selected topics of cold atoms in optical lattices

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