106 學年度第二學期(2018)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 (9:10-12:10) at Room 311 of IAMS

Kaito Takahashi

Week 1 (2/27)

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 CD_3H+F

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

Week 2 (3/06)

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 (3/13)

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 (3/20)

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 (3/27)

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 (4/10)

Wave-particle duality of large molecules

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

Week 2 (4/17)

Van der Waals force and weak interactions

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

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Jim Jr-Min Lin

Week 1 (4/24)

Estimate the global production rate of methane (in Tg/year)

-- Although this may seem non-trivial at first look, it is quite doable after knowing basic knowledge of chemical reaction kinetics. The involved tools including rate equation, steady-state approximation, Arrhenius temperature dependence, and the measured number density of OH radicals, etc.

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Ming-Shine Chang

3 weeks (5/01, 5/08, 5/15)

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 (5/22, 5/29, 6/05)

1. Atom-photon interaction in a three-level system (5hrs)
    - Electromagnetically induced transparency (EIT)
    - Slow light, Storage of light and optical quantum memory
    - Nonlinear optics based on the EIT
    - Single photon and bi-photon generation based on EIT

2. Cooperative radiation phenomena (4 hrs)
    - Resonant dipole-dipole interactions
    - Superradiance and subradiance
    - Future prospects

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Yu-Ju Lin

2 weeks (6/12, 6/19)

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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2017.12.11