

Molecules and Photons 2023

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Instytut Fizyki PAN, lecture room D, Fridays: 14:00-16:00

First lecture: 24th February

The interaction of molecules and photons is the key to understanding molecular properties and, at higher photon energies, to molecular reactivity.

The course will proceed in the time-honoured manner of dealing with molecular phenomena as revealed and studied at successively increasing photon energies: starting from microwave, through infrared and onto visible/UV. The physical phenomena are molecular rotation, vibration and electronic states, respectively.

For PhD students at the Institute of Physics, the course is intended to provide the basis for answering the “Molecular Physics” questions at the Physics Doctoral Exam. At the same time these questions provide a more specific guide to the syllabus of this course:

1. Potential energy profiles in molecules: conformers, barriers, tunnelling.
2. Methods for determining the geometry of molecules.
3. Electric dipole moment of molecules in gas and liquid phases.
4. Ab initio and DFT computational methods for determining molecular properties.
5. Identification of molecules under astrophysical conditions: methods and objects.
6. Fundamentals and applications of rotational spectroscopy.
7. Intermolecular interactions.
8. Molecular vibrations: normal mode analysis, symmetry, and measurement methods.
9. Rotational structure in the vibrational spectra of diatomic and triatomic molecules.
10. The Frank-Condon rule: breakdown of the adiabatic approximation: conditions and consequences.
11. Intramolecular transitions: general conditions for their occurrence, and selection rules.
12. Mechanisms of nonradiative electronic energy transfer (Förster and Dexter).
13. Methods of molecular spectroscopy that utilise the Fourier transform.
14. Lasers, including those based on molecular transitions.
15. Electronic states: Jabłoński diagram, fluorescence, and phosphorescence.