PHYS2750 Theoretical methods of laser-matter interactions

[45h] 6 credits

Teacher(s): Philippe Antoine, Didier Fussen, Bernard Piraux
Language: French
Level: Second cycle

Aims

A: Laser-matter interaction (22.5-0)
Introduction of the main concepts and different theoretical approaches necessary to study the interaction of an electromagnetic field with a quantum system (atom, molecule, etc.)
B: Spectroscopy of atoms and molecules (22.5-0)
Introduction to spectroscopy, oriented towards spectra of vibration-rotation of molecules, or towards the electronic spectra of atoms and molecules.
C: Theoretical treatments of atomic collisions (22.5-0)
Study of collision processes, particularly those related to astrophysics and controlled thermonuclear fusion.

Main themes

A : Description of the electromagnetic field and interaction Hamiltonian.
perturtive methods (time -dependent and -independent). Non-perturbative methods (Floquet methods, dressed atom, essential states). Coupling of a bound state to a continuum of states.
B : Two possible orientations, presented in alternance :
Vibration-Rotation spectra:
Rovibrational Hamiltonian of polyatomic molecules, the rotation and vibration to any order, vibrational and rotational resonances, rotational and vibration spectra, Stark molecular effect.
Electronic spectra:
Introduction to rovibronic spectroscopy of simple molecules. Quantum defect theory. Feshbach resonances and perturbations in spectra. Predissociation of molecules.
C : Quantum theory of electron-atom scattering (elastic and inelastic collision).
General theory of collisions and theoretical approaches (perturbative methods, "Close-coupling" method, R-matrix)
Heavy particle collisions: semi-classical treatment of excitation, electron transfert, concept of diabatic state, Landau-Zener model, resonances.
Laser assisted collisions.

Programmes in which this activity is taught

SC3DA Diplôme d'études approfondies en sciences