	Cold Matter	Semestre 2
	M2 OMP modules optionnels	

Professor(s) :	Hélène Perrin (CNRS, Université Paris 13), Jérôme Lodewyck (CNRS, Université Paris 6, Observatoire de Paris) + encadrants de TP en labo	
Type enseignement	Course 10,5 h TD 10,5 h TP 4 h	**3 ECTS**
Language:	English or French	

Objective
Given the basics of the laser manipulation of the external and internal degrees of freedom of atoms. Initiate the students to precision measurements with cold atoms (clocks, gyrometers, and gravimeters).

Required knowledge
Basic quantum mechanics (first quantization, spin and angular momentum, Rabi oscillation).

Content
First part:
Course 1: light forces
- TD dipole force : optical lattice
Course 2: laser cooling (Doppler/Sisyphus)
- TD radiation pressure : Zeeman slower OR magneto-optical trap
Course 3: Atom interferometry I
- TD diffraction by a standing wave
Course 4: Atom interferometry II
- TD Calculation of the phase of an interferometer

Second part:
Course 5: basics of atomic clocks
- TD effect of atomic collisions in micro-wave clocks OR Ramsey fringes
Course 6: sources of noise and systematic effects
- TD quantum projection noise
Course 7: atomic clocks, atom interferometers and applications
- TD cold atom gravimeter

+ a 4h lab class in a real situation, within one of the laboratories of IFRAF, to be in contact with the more recent developments in the field.

Expected skills at the end:
Be able to compute the light forces acting on an atom, and the phase of a matter wave interferometer. Know the Ramsey fringe method. Be able to define and characterize a clock (Allan variance).

Bibliography
M2 lecture notes of Jean Dalibard ; Advances in Atomic physics (Cohen / Guéry-Odelin) ; Laser cooling and trapping (Metcalf / van der Straten)

Evaluation
Final written exam (80%) and written notes on the lab class (20%).