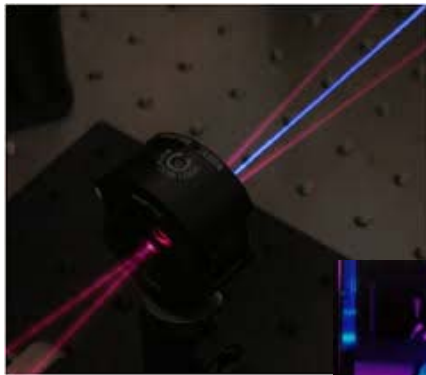


Nonlinear Optics

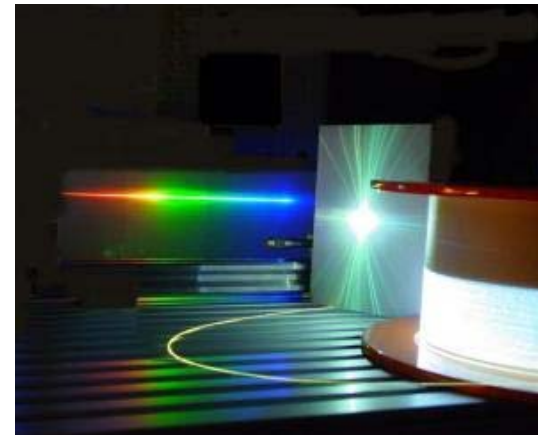
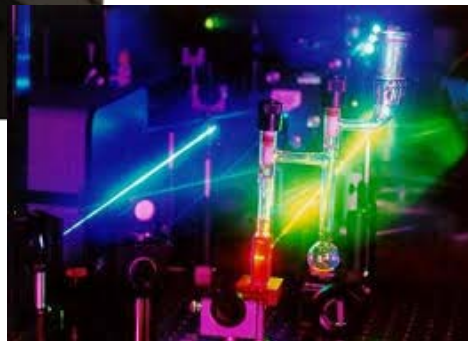
François Hache

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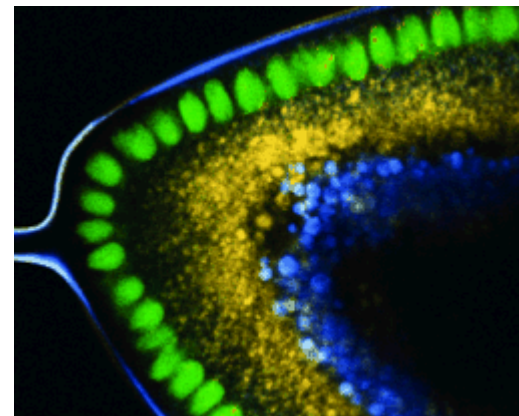
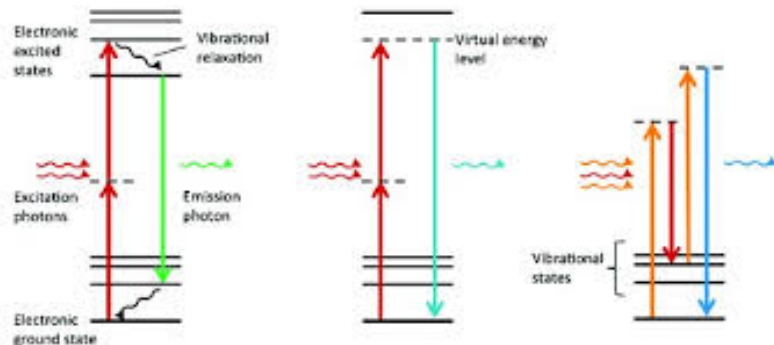
Nonlinear optics : what for ?



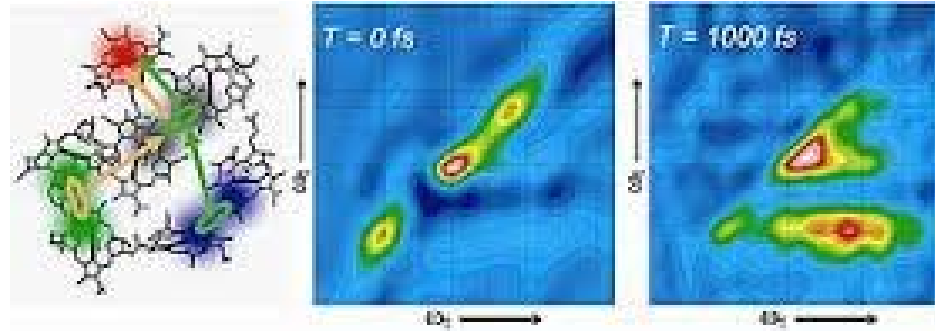
... generate new optical frequencies



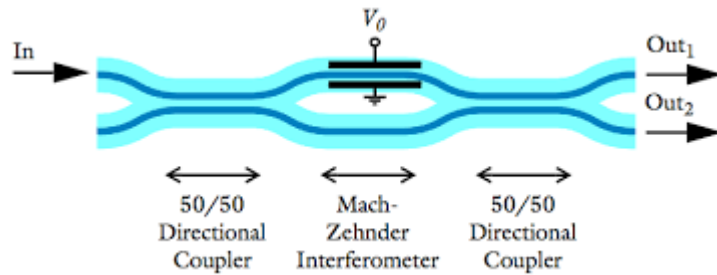
... have new contrasts in microscopy



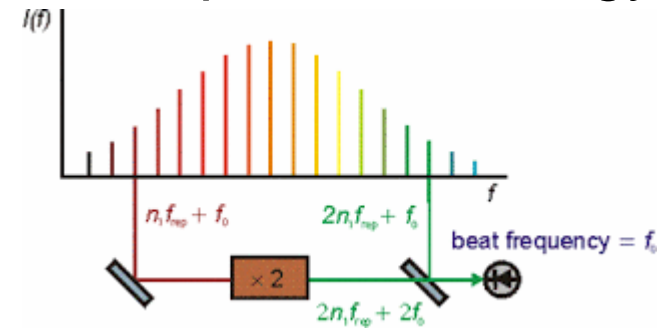
... devise new spectroscopic tools



... control ultrashort pulses and their propagation



... improve metrology



Nonlinear optics

1) Nonlinear susceptibilities

Course Introduction to nonlinear optics
Nonlinear susceptibilities
Propagation equation

Training Anharmonic oscillator

2) Second order effects

Course Two-wave mixing, Manley-Rowe relation
Second harmonic generation (SHG)
Phase-matching, quasi-phase matching

Training Parametric gain, OPO's,
thresholds of SROPO and DROPO

3) Ultrashort pulses

Course Group-velocity dispersion
Kerr effect
Self focussing and applications

Training Self-phase modulation, solitons

4) Quantum calculation of nonlinear susceptibilities

Course Liouville equation, perturbative response
Calculation of $\chi^{(2)}$

Training Non resonant $\chi^{(2)}$

5) Response-functions – Two-dimensional spectroscopy

Course Rotating-wave approximation
Pump-probe experiments
2D-spectroscopy

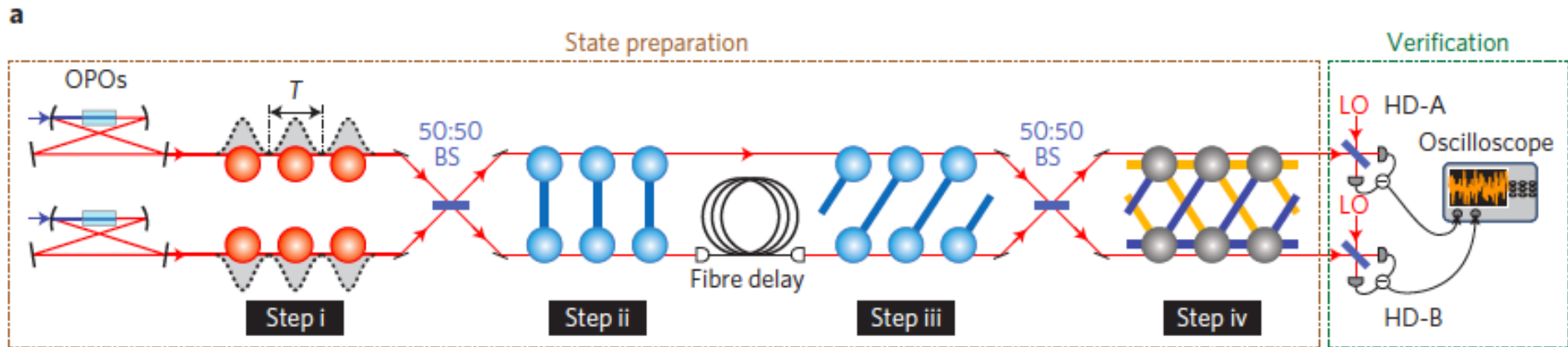
Training Fluorescence / resonant Raman

Quantum Optics

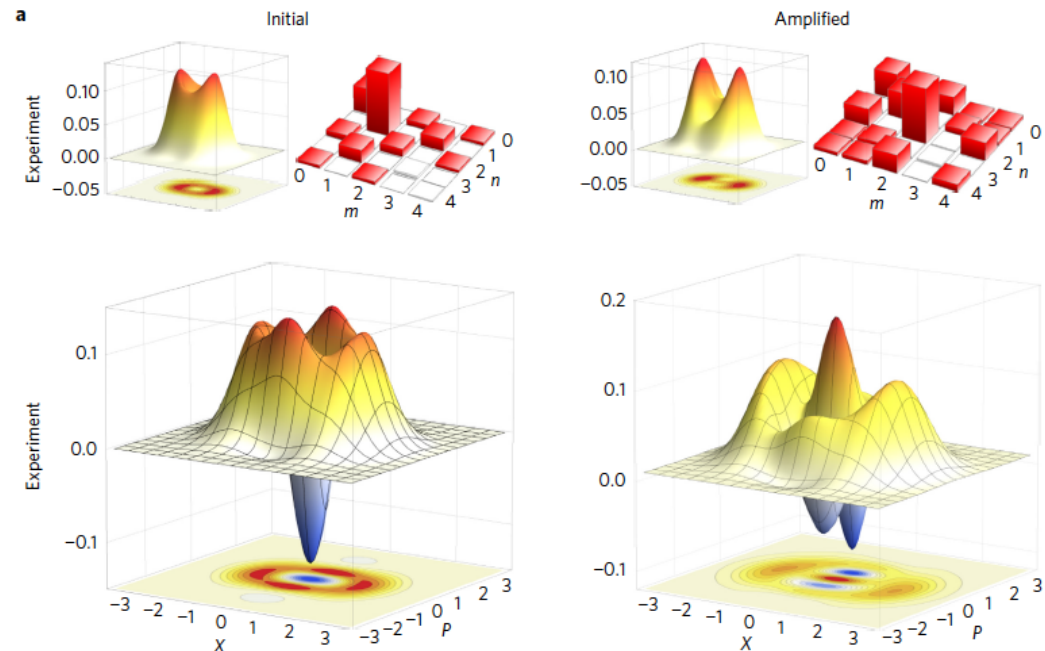
Nicolas Treps

Nicolas.treps@sorbonne-universite.fr

Multimode Quantum optics

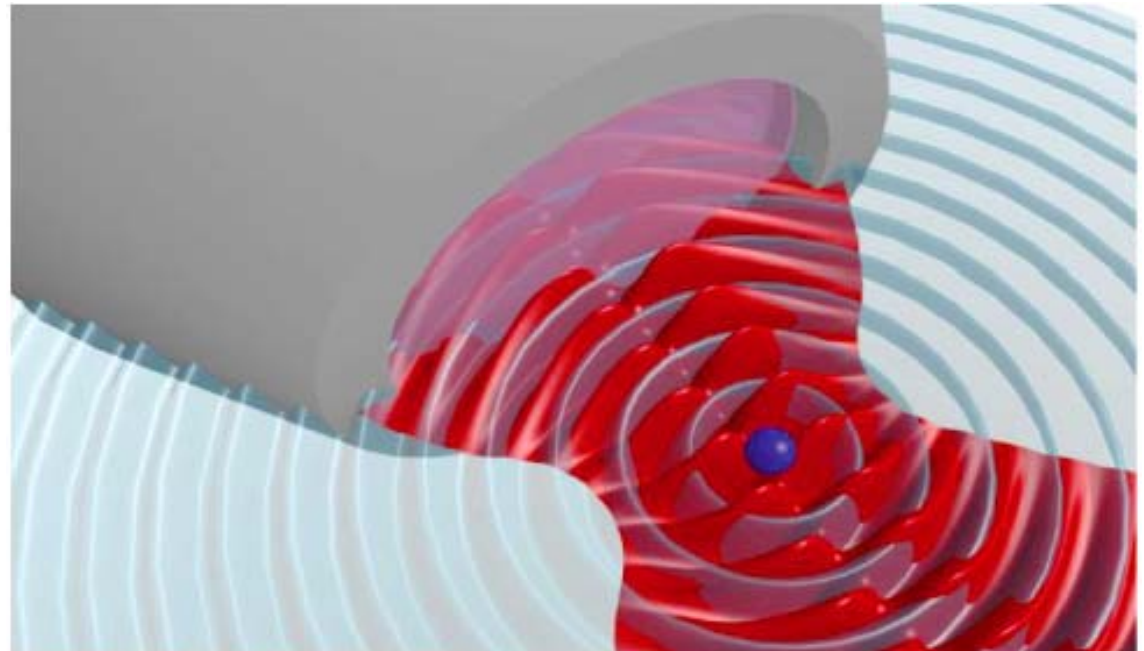
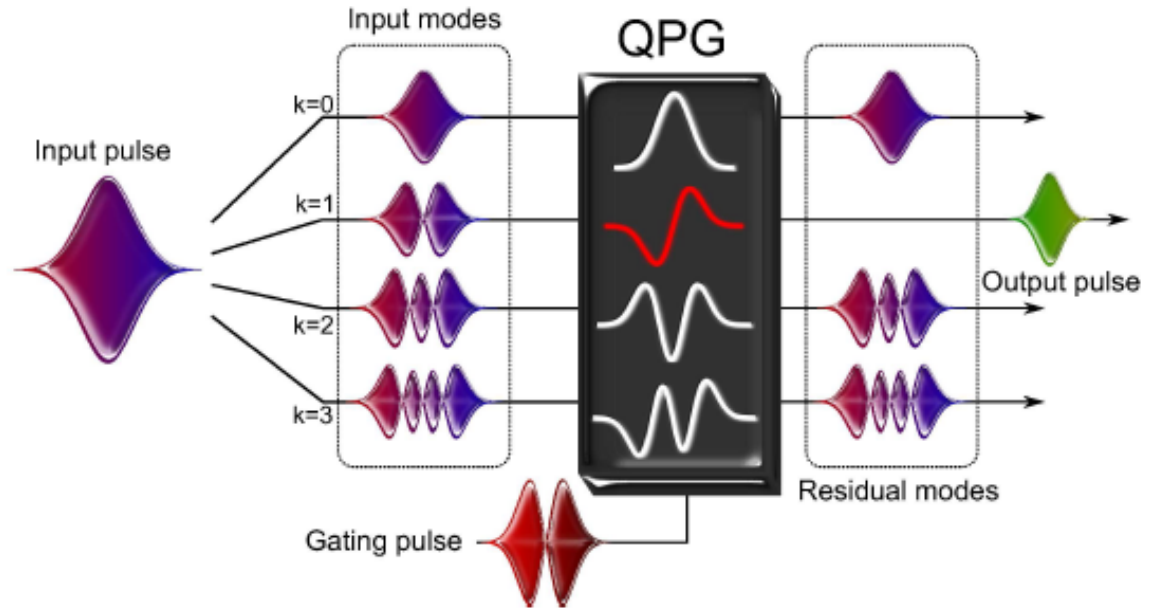


Generate large entangled and exotic states



manipulate quantum modes with nonlinear optics

Use them for quantum metrology



Quantum optics

1) Multimode quantum optics

Course Derivation of the multimode quantum field

Training Multimode Hong-Ou Mandel

2) Quantum states of the multimode field

Course Hybrid approach to quantum optics

Training Entanglement and non-separability

3) Gaussians states decomposition

Course Bloch Messiah and Williamson decomposition

Training Multimode squeezing

4) Non-Gaussian operation

Course Mode dependant photon subtraction

Training Non-Gaussian states generation

5) Quantum metrology

Course Cramér Rao bound

Training Quantum interferometry