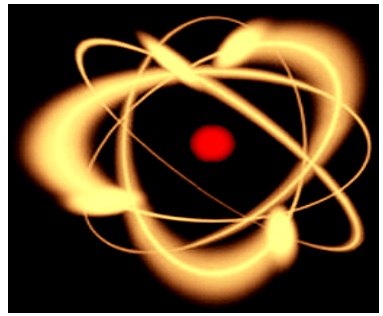
ATOMIC & LASER

Ultrafast Quantum Optics Group



Ian Walmsley

walmsley@physics.ox.ac.uk

Tel: 01865 272 205

2008 FASTQUAST Projects

Control of single photons

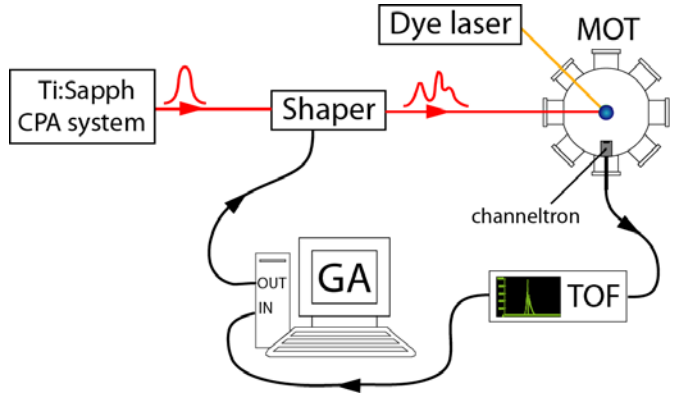
Control of cold molecules

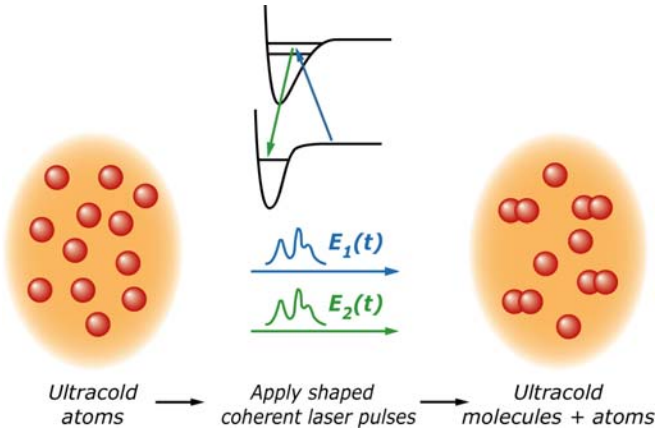
Ultrafast characterization (w. APE GmbH)

Ultrafast Coherent Control in ultracold matter

w/ B. Chatel, E. Dimova, J. Mur-Petit, C. Foot, F. Masnou, C. Koch, and T. Köhler

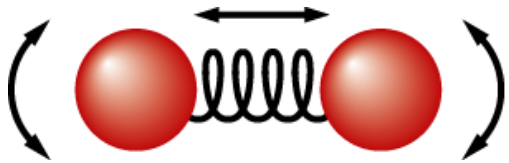
- **Closed loop control using shaped ultrashort pulses**
  - Flexibility of control
  - Optimal pathway to target state given system uncertainty

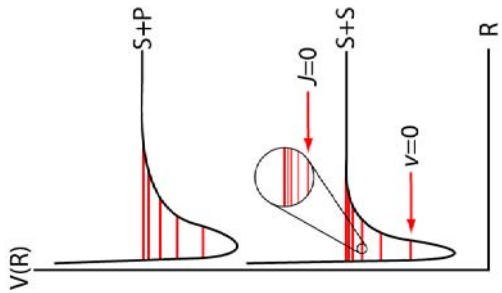




- **Synthesis of cold molecules**
  - Optically controlled collisions of ultracold atoms

- **Molecules in optical lattices**
  - Coherent optical control in BECs





Ultrafast meets ultracold

Ultracold

=

Ultraslow

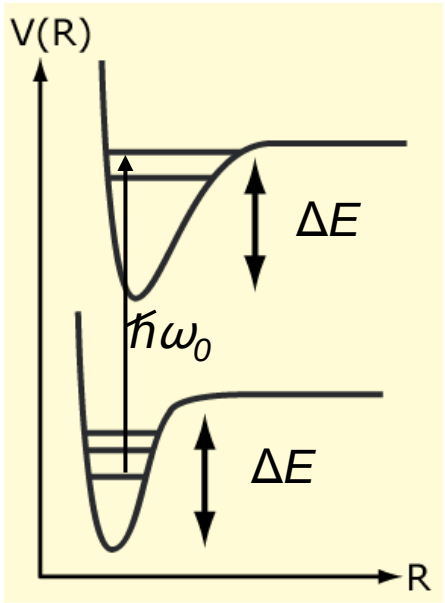
?

Ultrafast

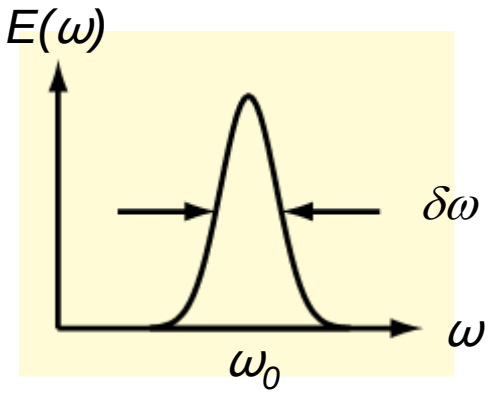
=

Coherent broadband field

Quantum system ⟷ interaction ⟷ Control field

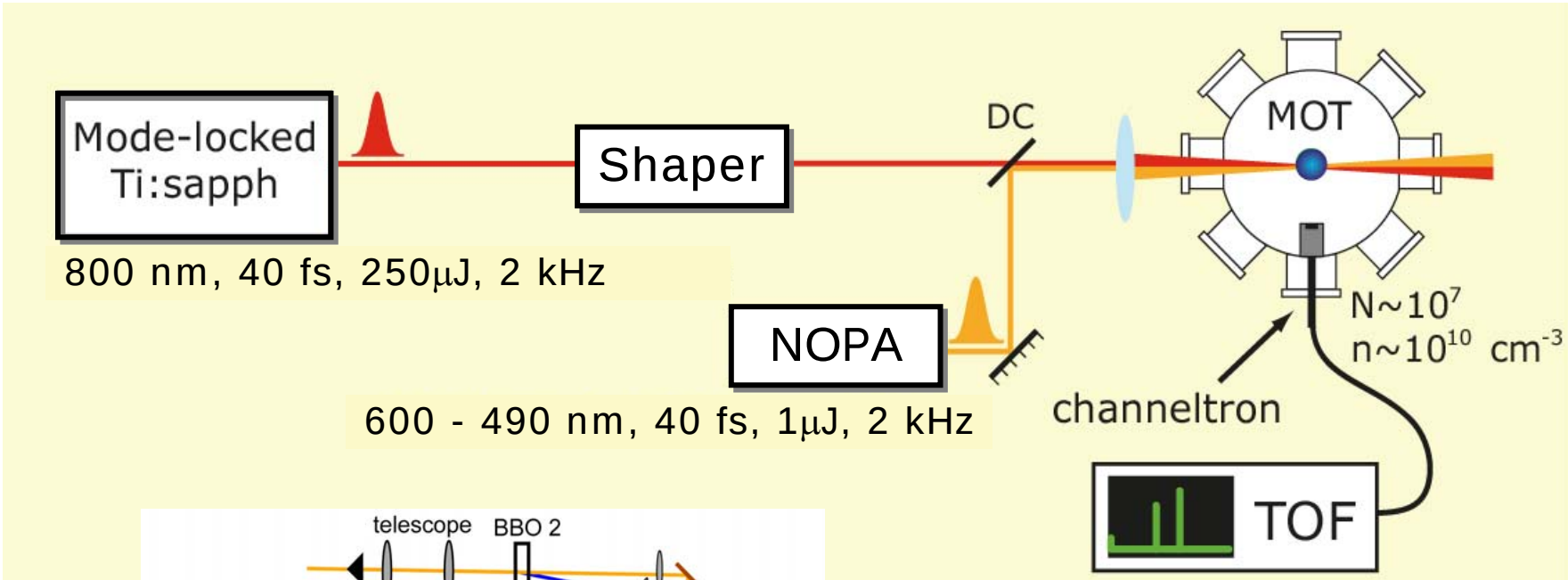


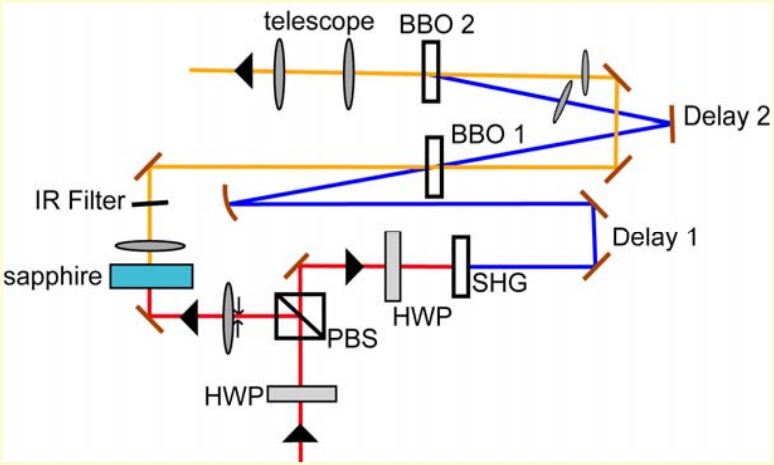
$\Delta E \sim \delta\omega$

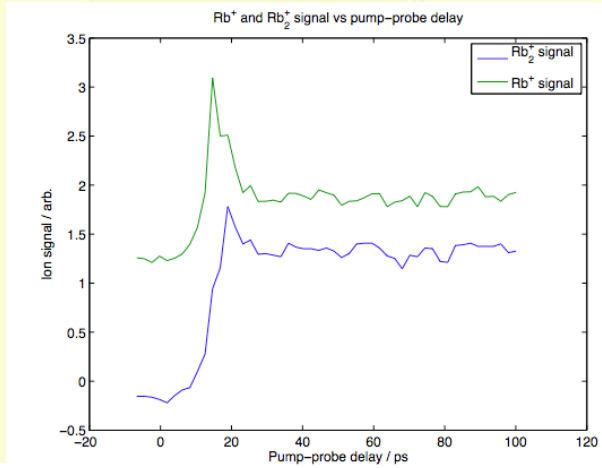


Dynamics of photoassociated wavepacket

Posters: Dave McCabe, Duncan England, Hugo Martay, Melissa Friedman

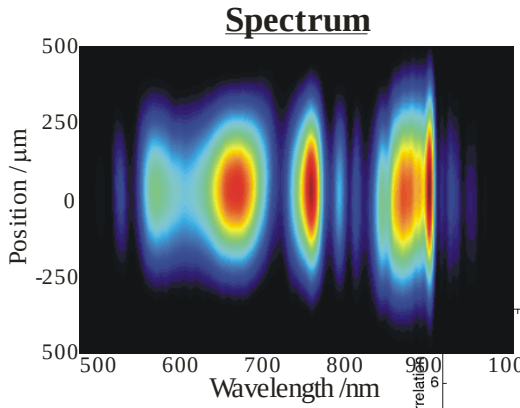






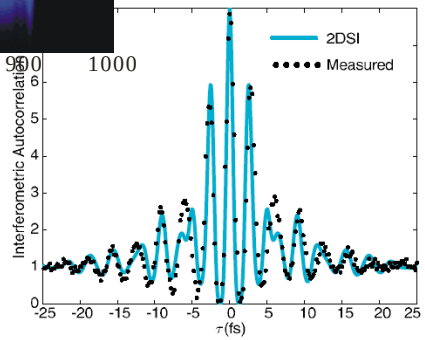
Ultrafast characterization

- **Space-time measurements**
  Shaped ultrabroadband pulses

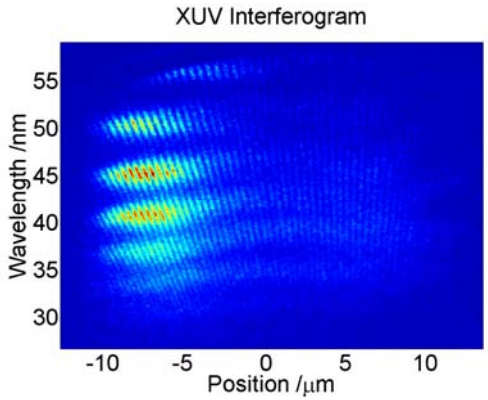


w/ C. Lukas
(APE GmbH)

- **Single-cycle pulsed fields**
  - Control/characterization of shortest possible pulses



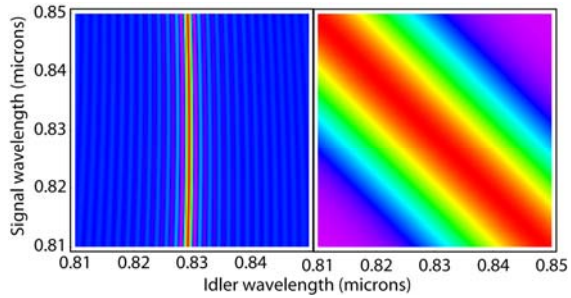
- **Attosecond pulsed fields**
  - XUV interferometry for multielectron dynamics



- **3-D measurement of time-dependent pulsed fields**
  - Full information about space-time response of nonlinear systems

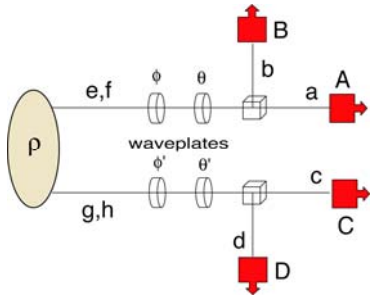
Control of single photons

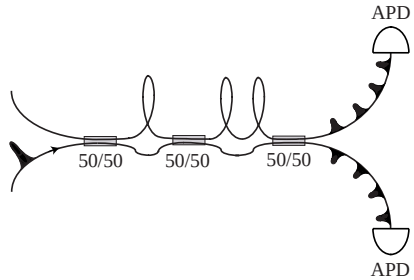
- **Entanglement engineering for quantum-enhanced technologies**
  - Communications
  - Cryptography
  - Computation
  - Precision measurement



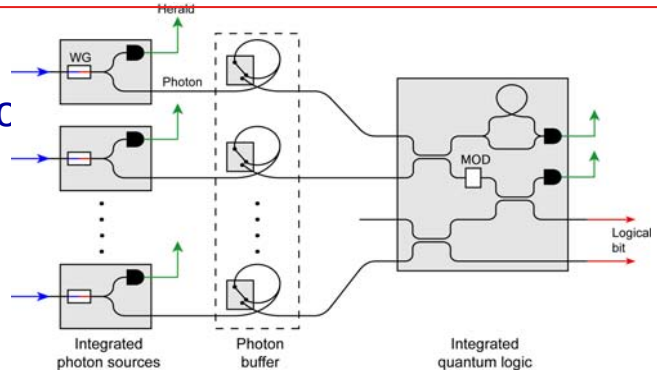
- **Photon sources**
  - Design and engineering of single and entangled photon sources

- **Detectors**
  - Photon-number resolving detectors
  - Optimal state detection and process tomography

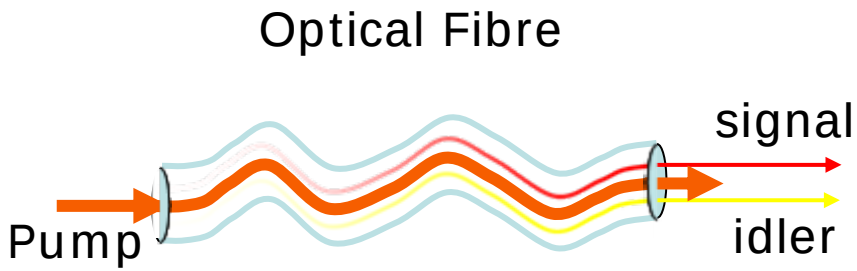




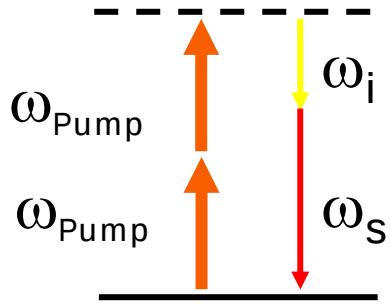
- **Quantum networks**
  - Long-distance quantum communicatic
  - Linear optical quantum computing
  - Precision metrology beyond SQL



Spontaneous four-wave mixing in photonic crystal fibers



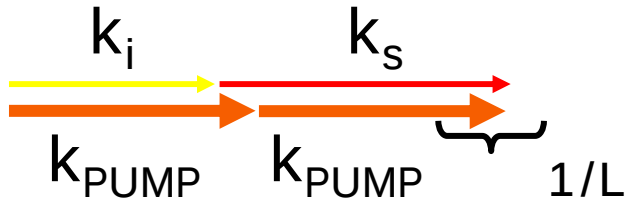
Energy is conserved...



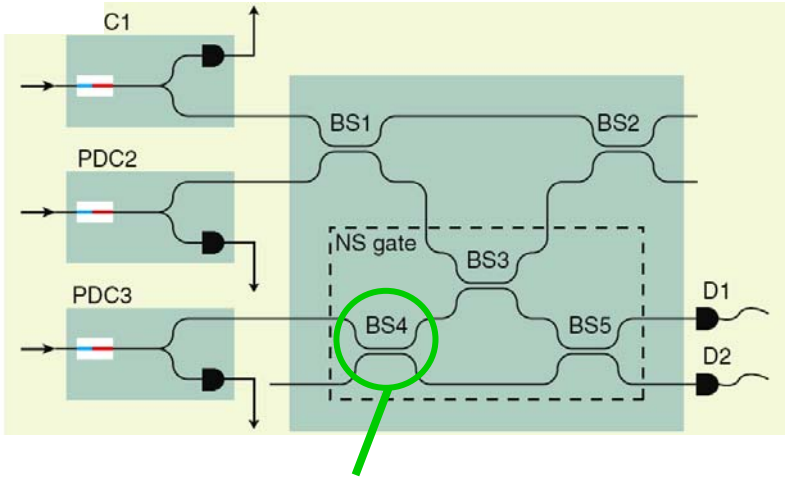
- Two pump photos are spontaneously converted into two sideband photons in a $^{(3)}$ material.

- small core size and long interaction length compensate for small $^{(3)}$ vs. $^{(2)}$ in crystals

... as well as momentum

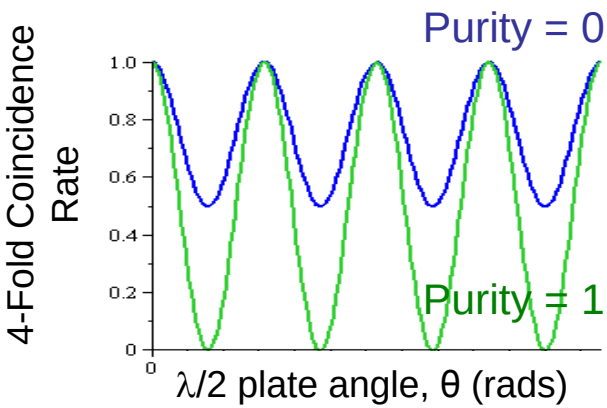


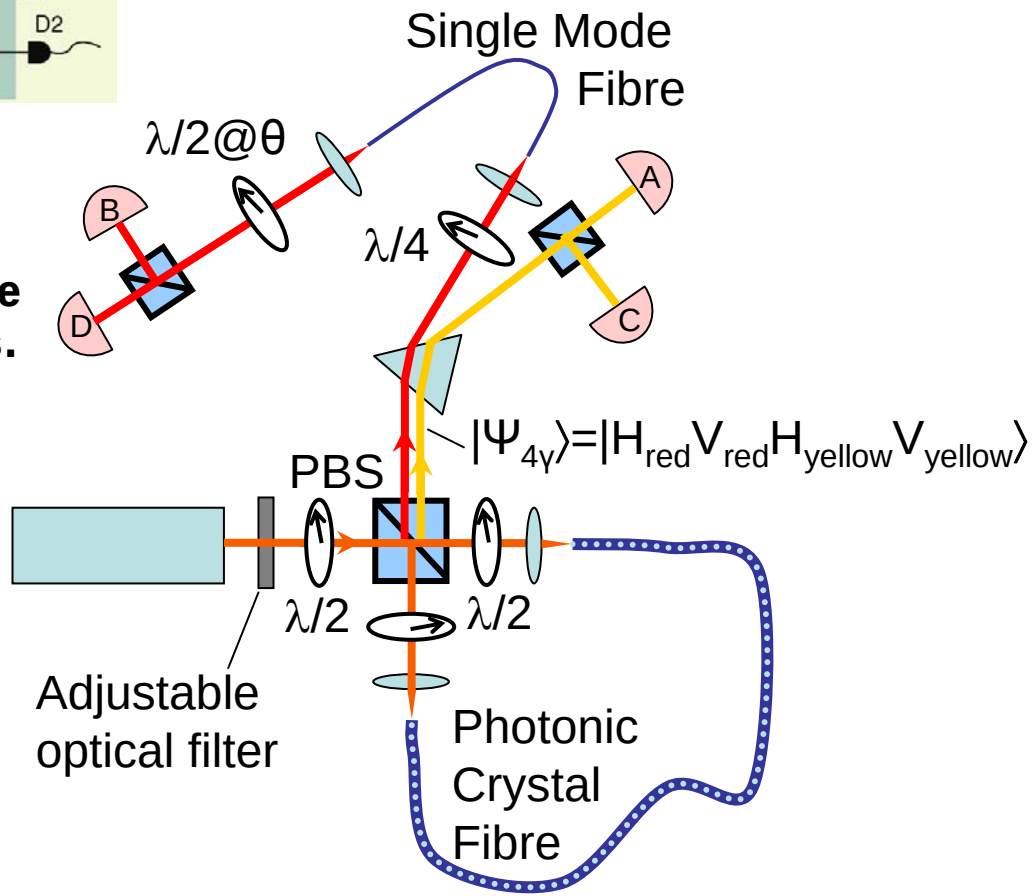
Two-photon interference: testing purity



• Discrete Variable measurement-based quantum-computing requires heralded photons and a quantum memory

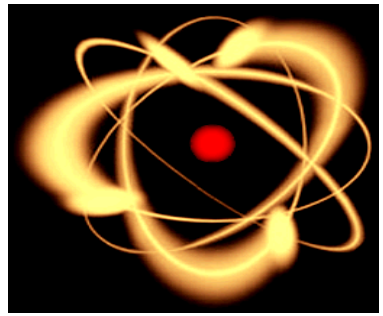
• High visibility Hong-Ou-Mandel interference is critical for optical quantum logic gates. **For this we need photons in a pure states.**





ATOMIC & LASER

Ultrafast Quantum Optics Group



Ian Walmsley

walmsley@physics.ox.ac.uk

Tel: 01865 272 205

2008 FASTQUAST Projects

Control of single photons

Control of cold molecules

Ultrafast characterization (w. APE GmbH)