Quantum Optics

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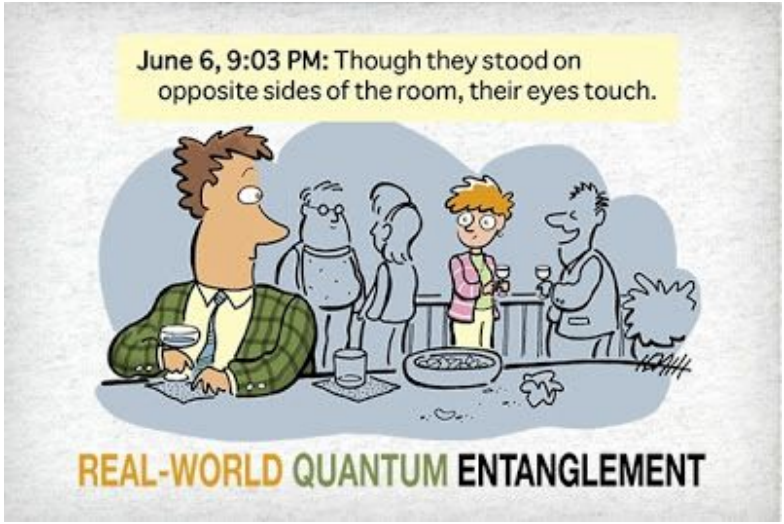
Why It Matters



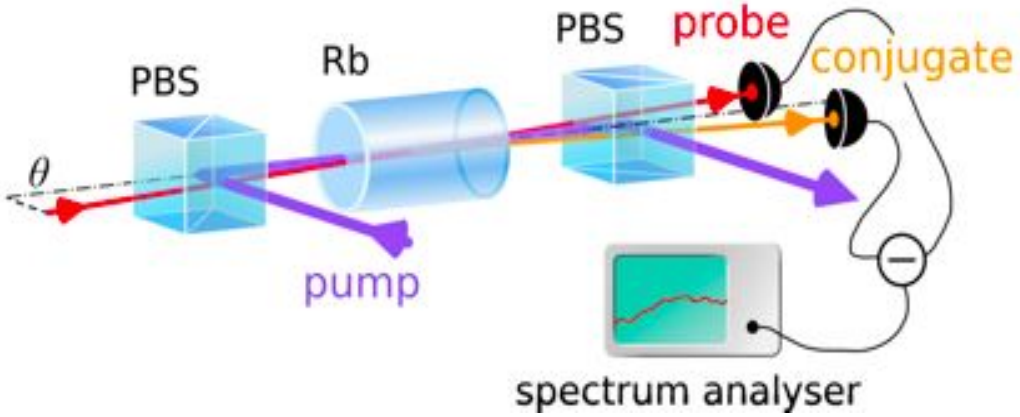
- Explore entanglement, develop more applications beyond the lab

- Quantum communications
  - Can encode and transmit information, hard to control
  - Seeking more control using four-wave mixing (4WM)

- Greater control of quantum systems

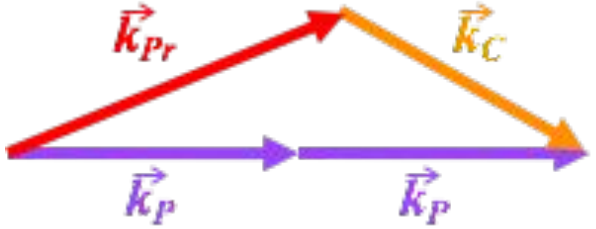
Four-wave mixing (FWM)

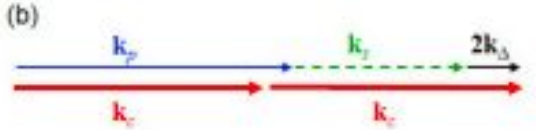
- Generates two entangled beams
  - Strong pump beam, weaker probe beam -> amplified probe, conjugate beam

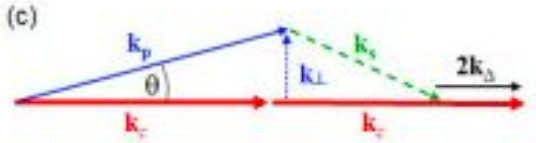


k-vectors

- Photon momentum & k-vectors

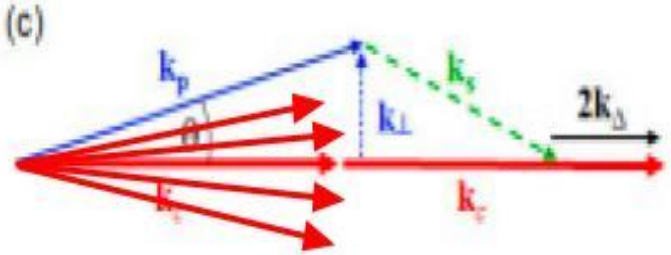






- Phase matching
  - K-vectors line up
  - Δk b/w conjugate/probe and pump reduces efficiency

Ideal process vs reality



- Pump beam should have single k-vector
  - Probe angle corresponds to one conjugate angle
  - Symmetric correlation in far field

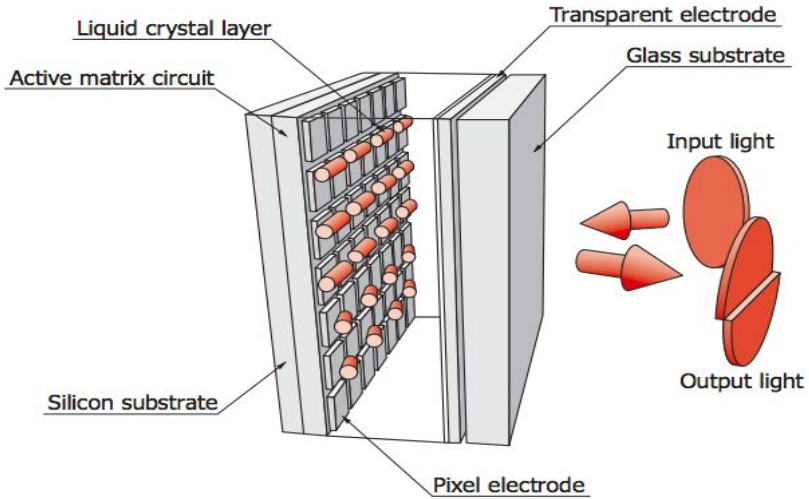
- Finite pump yields range of k-vectors
  - Probe angle has several possible conjugate angles
  - Region of correlation in conjugate beam

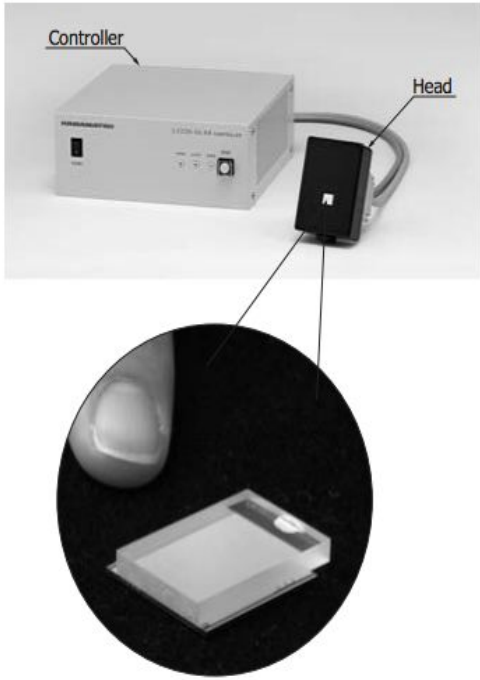
- Beam shape/profile of pump changes this correlation region and that can be done with the Spatial Light Modulator (SLM)

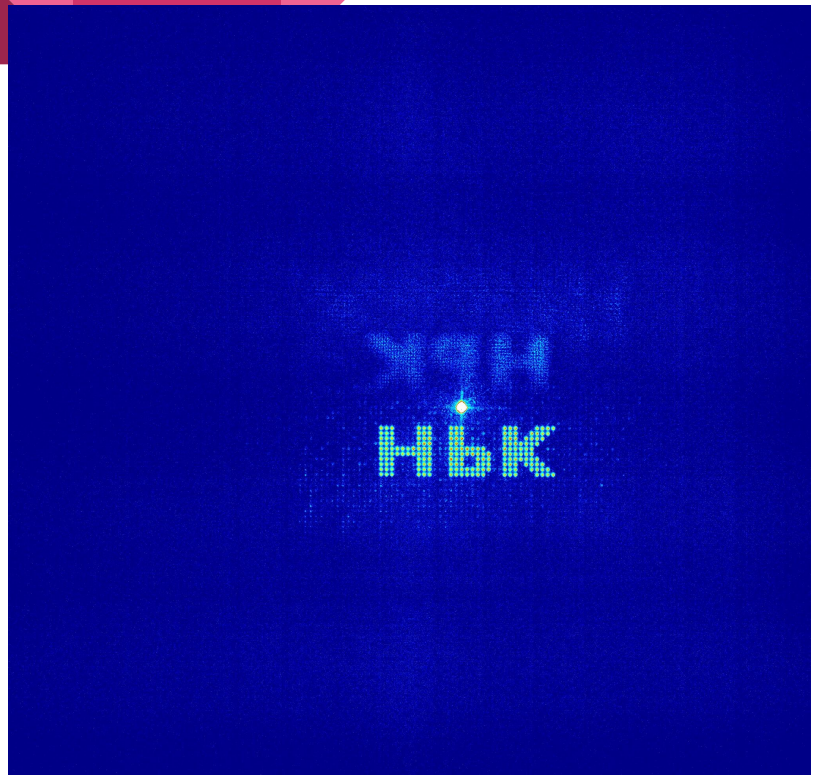
SLM

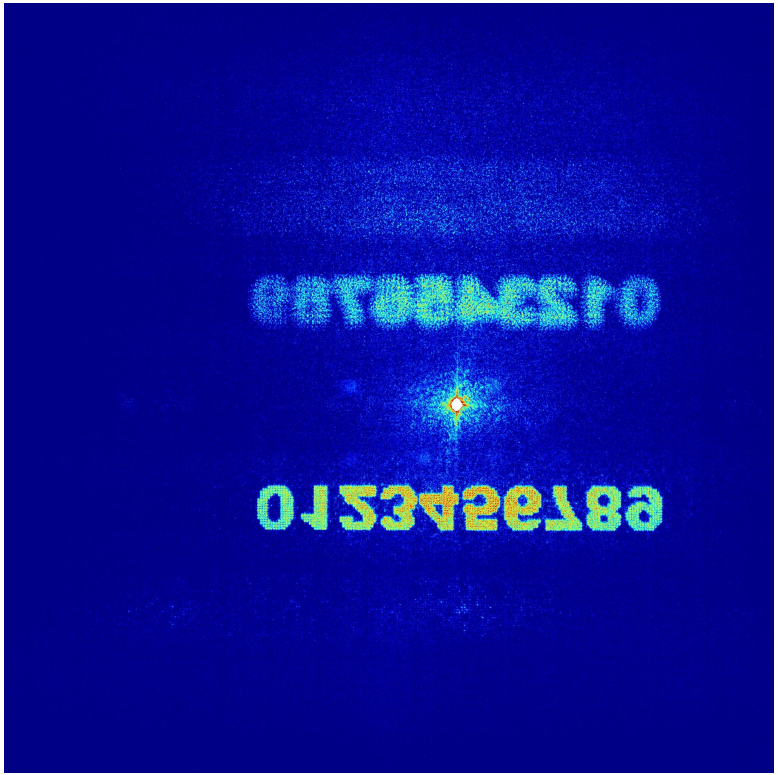
- Acts as a mirror

- Individual pixels correspond to liquid crystals
  - Tilts change path lengths of photons and the beam phase difference



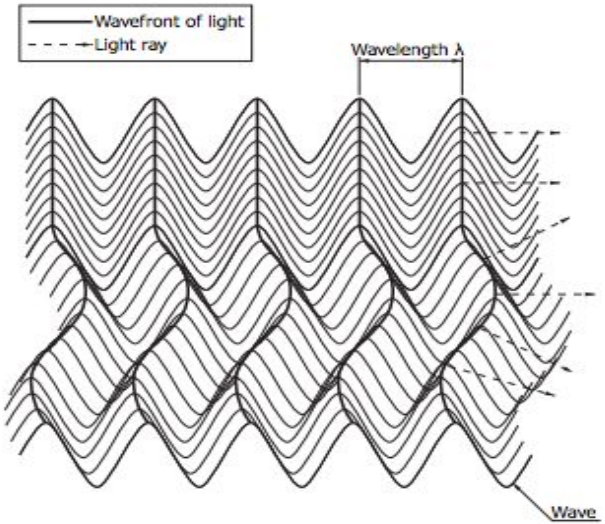






Goals of SLM

- Image/pattern created at a given plane
  - Goal is to figure out how to use the SLM to produce a specific pattern
- Use MATLAB to create an interface
- Optimize control of amplitude and phase



References

“Phase Spatial Light Modulator LCOS-SLM.” Hamamatsu Photonics, Hamamatsu, www.hamamatsu.com/resources/pdf/ssd/e12_handbook_lcos_slm.pdf.

Itay Katzir, Amiram Ron, and Ofer Firstenberg, "Diffraction manipulation by four-wave mixing," Opt. Express 23, 6379-6391 (2015)

“Quantum Entanglement.” *North Texas Drifter*, Blogspot, 11 Apr. 2013, northtexasdrifter.blogspot.com/2013/04/quantum-entanglement.html.