Spatial Light Modulators

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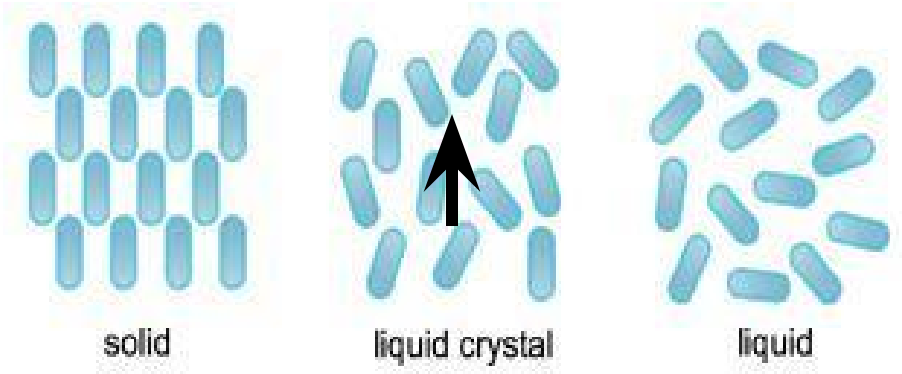
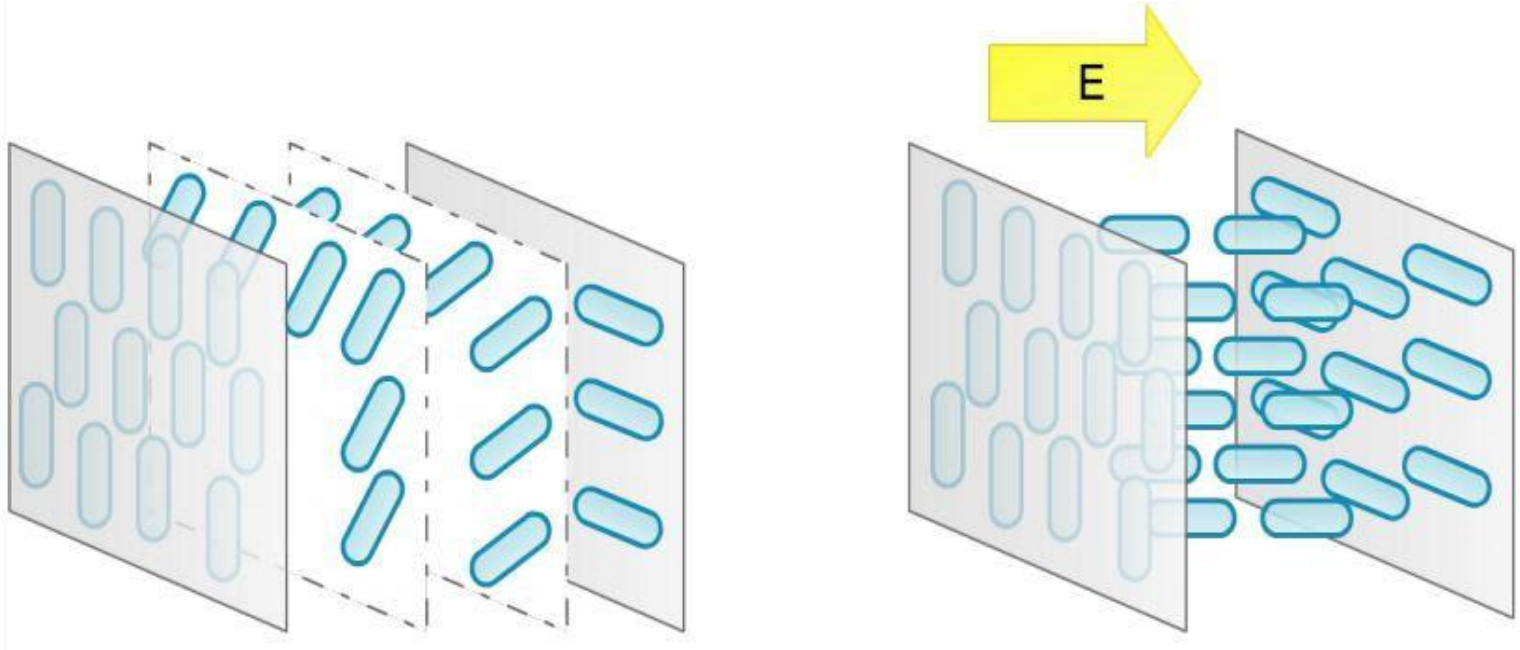
Basics

- Change amplitude and phase of light beam in space and time
- Liquid crystal
  - rod-like molecules that inhabit a state between a liquid and a solid
  - birefringent
  - electrically anisotropic
- Usually computer controlled



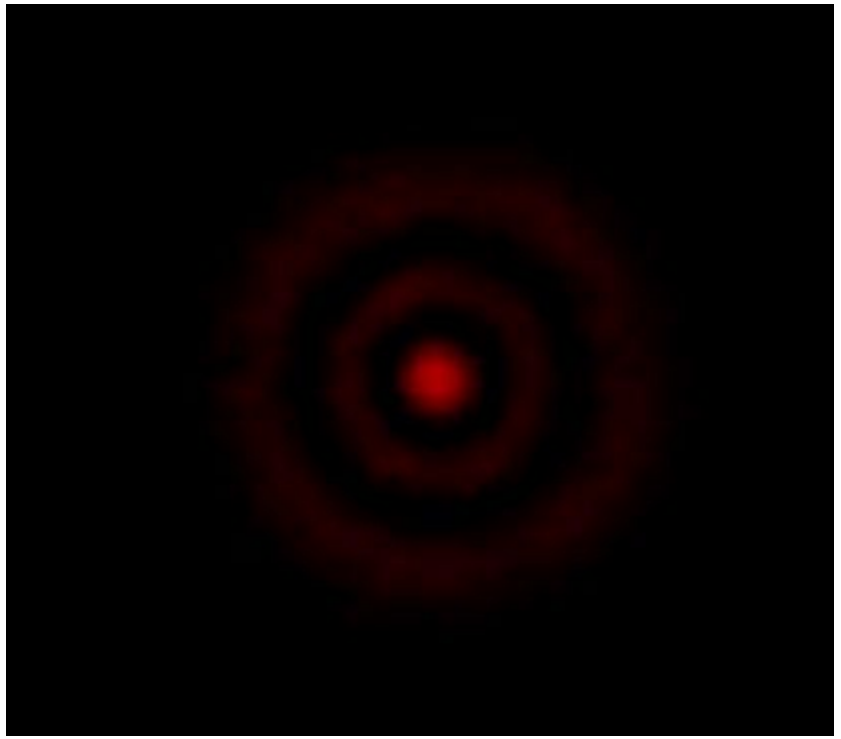
Types of SLMs

- Transmissive (LCD) or reflective (LCoS)
- Vertically aligned nematic (VAN), parallel aligned nematic (PAN), twisted nematic (TN)



Applications

- Realizes phase holograms
- Creates “designer” beams
  - Holography
  - Optical Correlation
  - Micro-particle manipulation
  - Variable optical elements



Advantages

- Easily and quickly varied
- Controlled by computer
- High resolution

Limitations

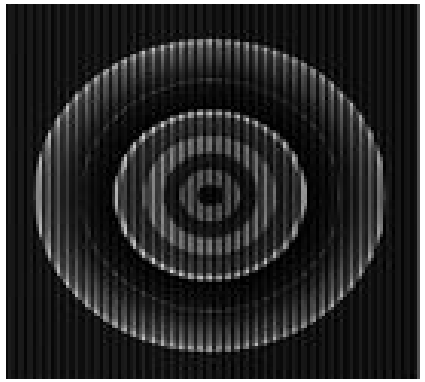
- Phase ripple
- Cost
- Potentially, limited phase range

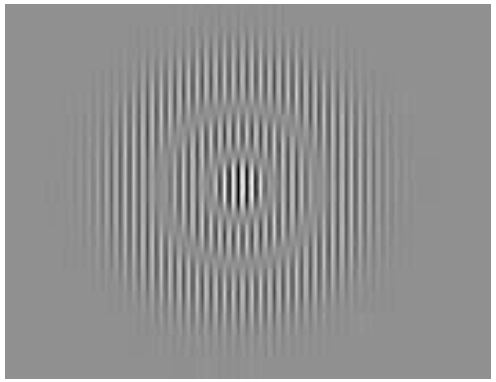
Controlling Your SLM

- Control as external monitor
  - Extend monitor
    - Paint, Photoshop, Powerpoint
  - Use as separate monitor
    - MATLAB, LabView, Mathematica

Encoding Phase Masks

- Davis *et al.* demonstrated technique for encoding amplitude information with phase only SLM
  - Binary diffraction grating
- Arrizón *et al.* demonstrate encoding that optimizes diffraction efficiency and can be implemented using SLM with less than 2π phase modulation
  - Blazed diffraction grating
  - Requires device calibration



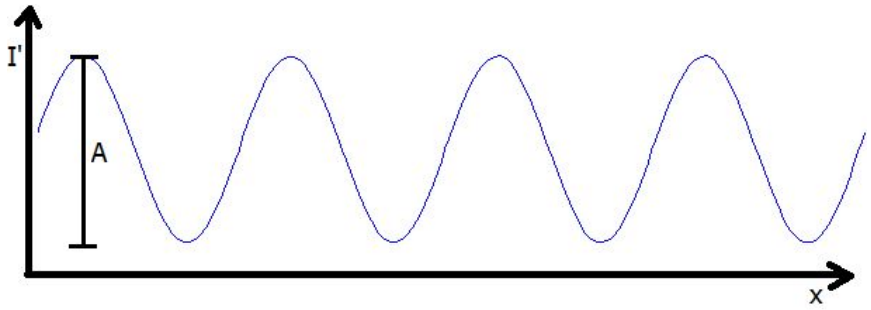


J. A. Davis, D. M. Cottrell, J. Campos, M. J. Yzuel, and I. Moreno, “Encoding amplitude information onto phase-only filters,” Appl. Opt. 38, 5004–5013 (1999).

Arrizón, Victor, Ulises Ruiz, Rosibel Carrada, and Luis A. González. "Pixelated Phase Computer Holograms for the Accurate Encoding of Scalar Complex Fields." *Journal of the Optical Society of America A* 24.11 (2007): 3500. Web.

Device Calibration

- Create a lookup table between grayscale value and induced phase delay
- Vary amplitude on of grating on the SLM and measured the corresponding relative 1st diffraction order intensities



$$\Psi = J^{-1}[Aa]sin(\phi)$$

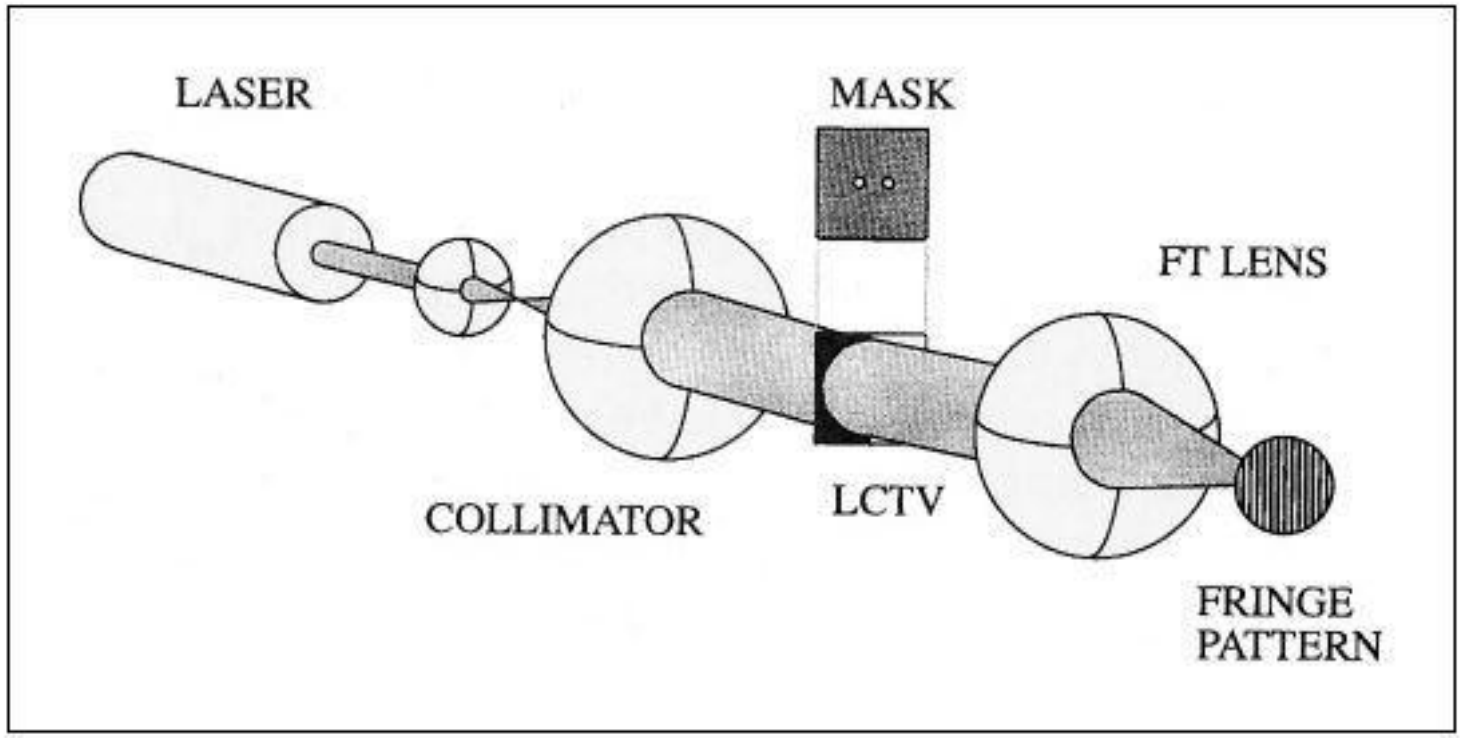
$$\phi' = gsvalue = [\phi * \frac{255}{2\pi}]$$

$$\phi' = \gamma^{-1}[\phi * \frac{255}{2\pi}]$$

$$\Psi = J^{-1}[Aa]sin(\gamma^{-1}[\phi * \frac{255}{2\pi}])$$

- Replace mirror in interferometer with SLM
  - Twymann-Green, Mach-Zehnder, etc.

Device Calibration Ctnd



A. Bergeron, J. Gauvin, F. Gagnon, D. Gingras, H. H. Arsenault, and M. Doucet, "Phase calibration and applications of a liquid-crystal spatial light modulator," Appl. Opt. **34**, 5133-5139 (1995)

Cambridge Correlators SDE1024

- Low-cost
- Widely used

Resolution	1024 x 768
Pixel Pitch	9 microns
Active Area	9.3 x 7 mm
Phase Range	~1.6 π @ 633 nm

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References

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