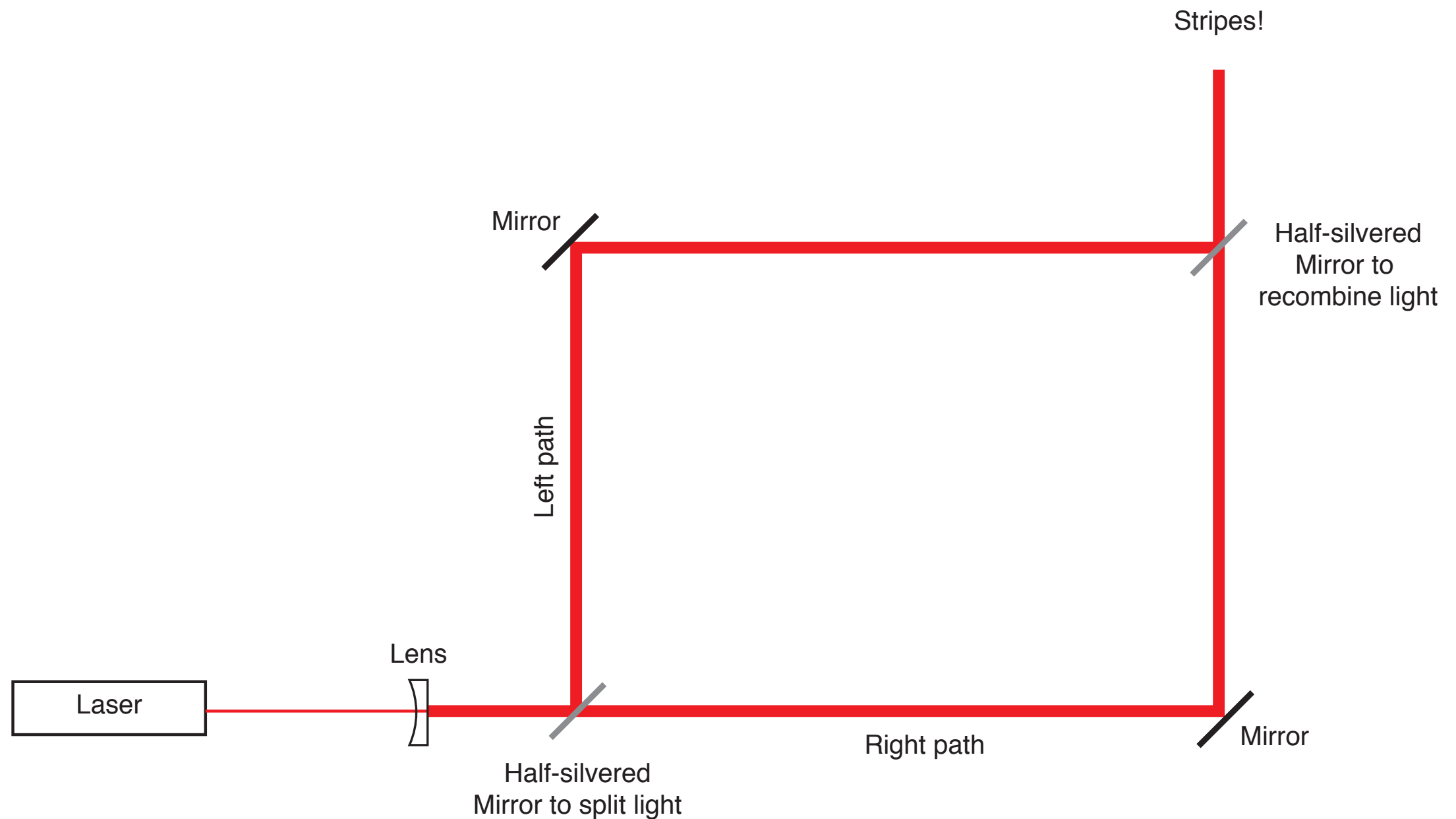
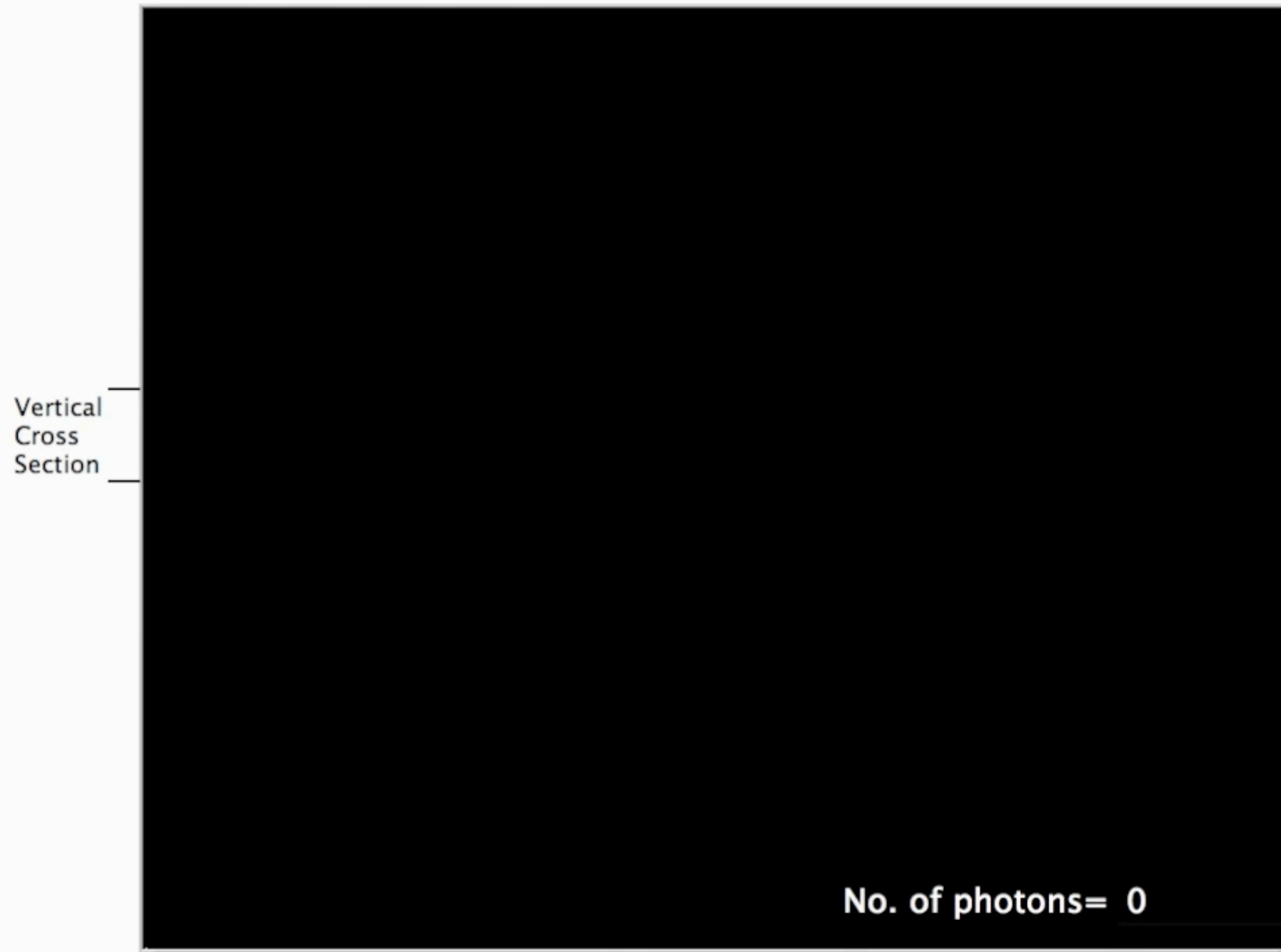


The world is made of notes

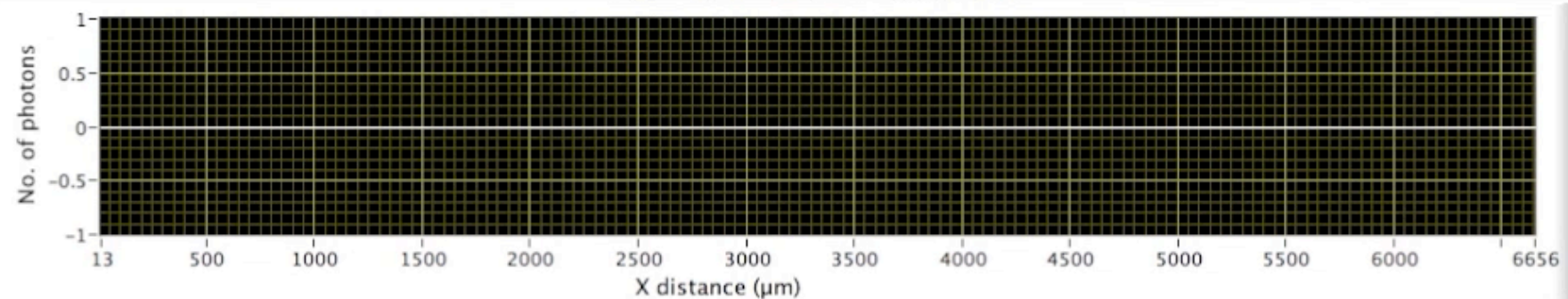
Which path did the photon take?



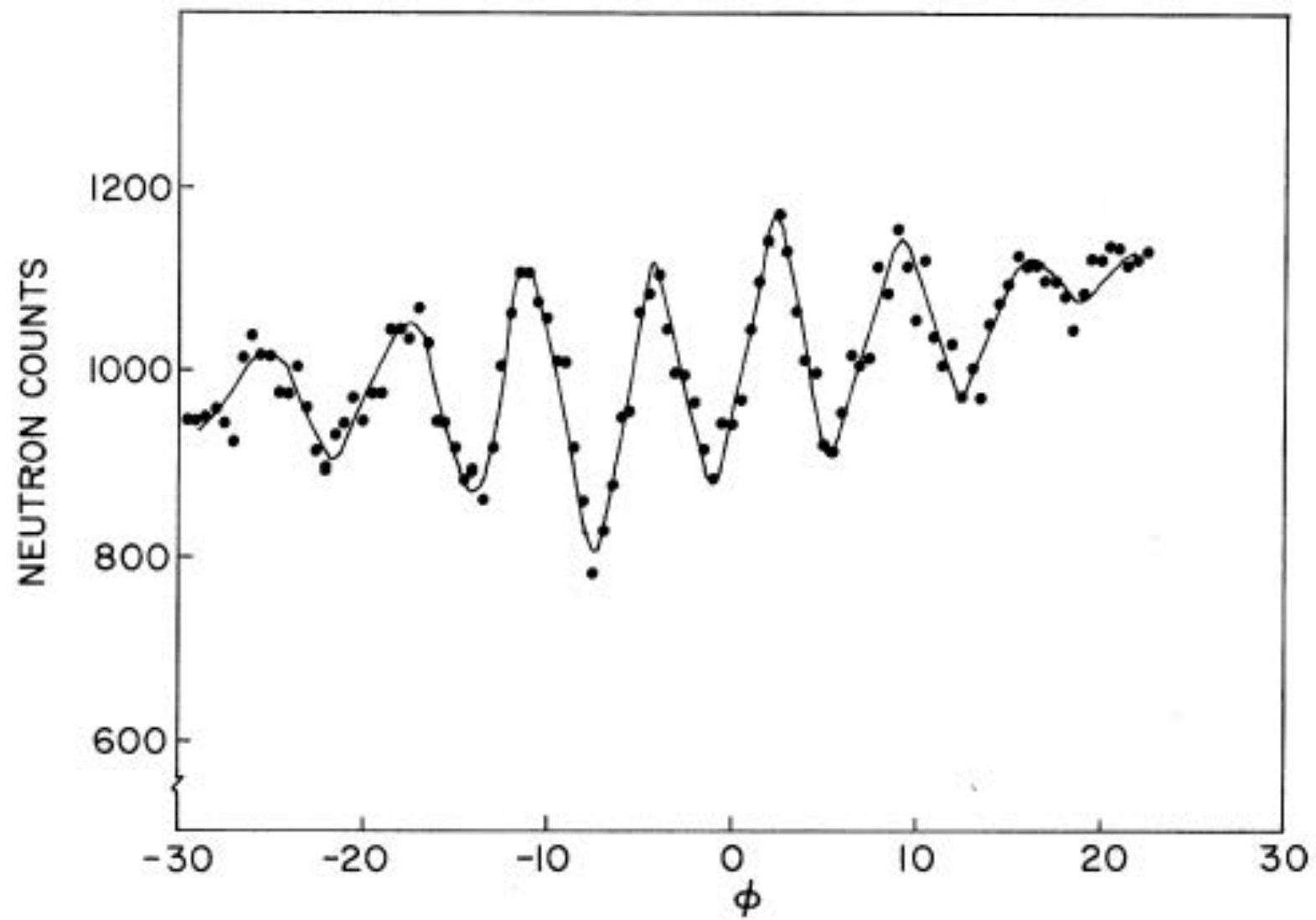
Young's double slit with a coherent source photon by photon



Vertical cross section



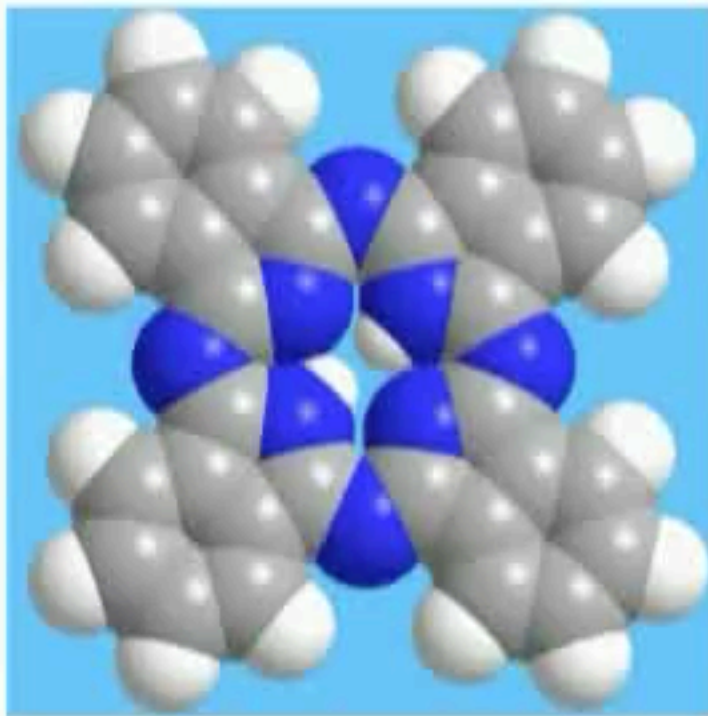
Neutrons



$C_{32}H_{18}N_8$ (~3000 particles)

The quantum molecular movie

The wave-particle duality of phthalocyanine



Thomas Juffmann
Adriana Milic
Michael Müllneritsch
Peter Asenbaum
Alexander Tsukernik
Jens Tüxen
Marcel Mayor
Ori Cheshnovsky and
Markus Arndt



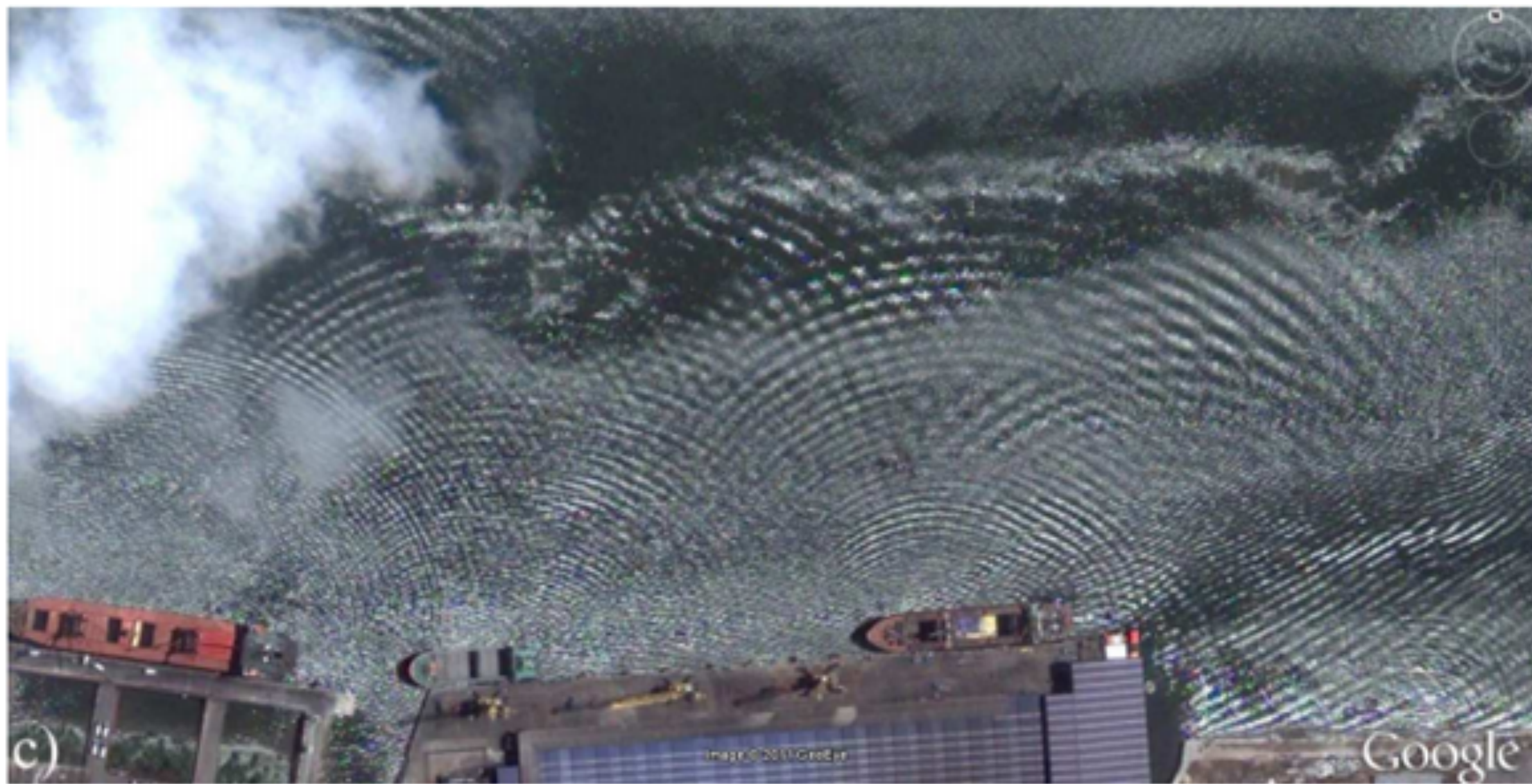
All particles **move** like waves and **hit** like particles

- From photons, to electrons, to neutrons, to molecules, they **all** move like waves and hit like particles
- Color is related to both wavelength and energy

Fundamental feature of how our universe works

Ripples

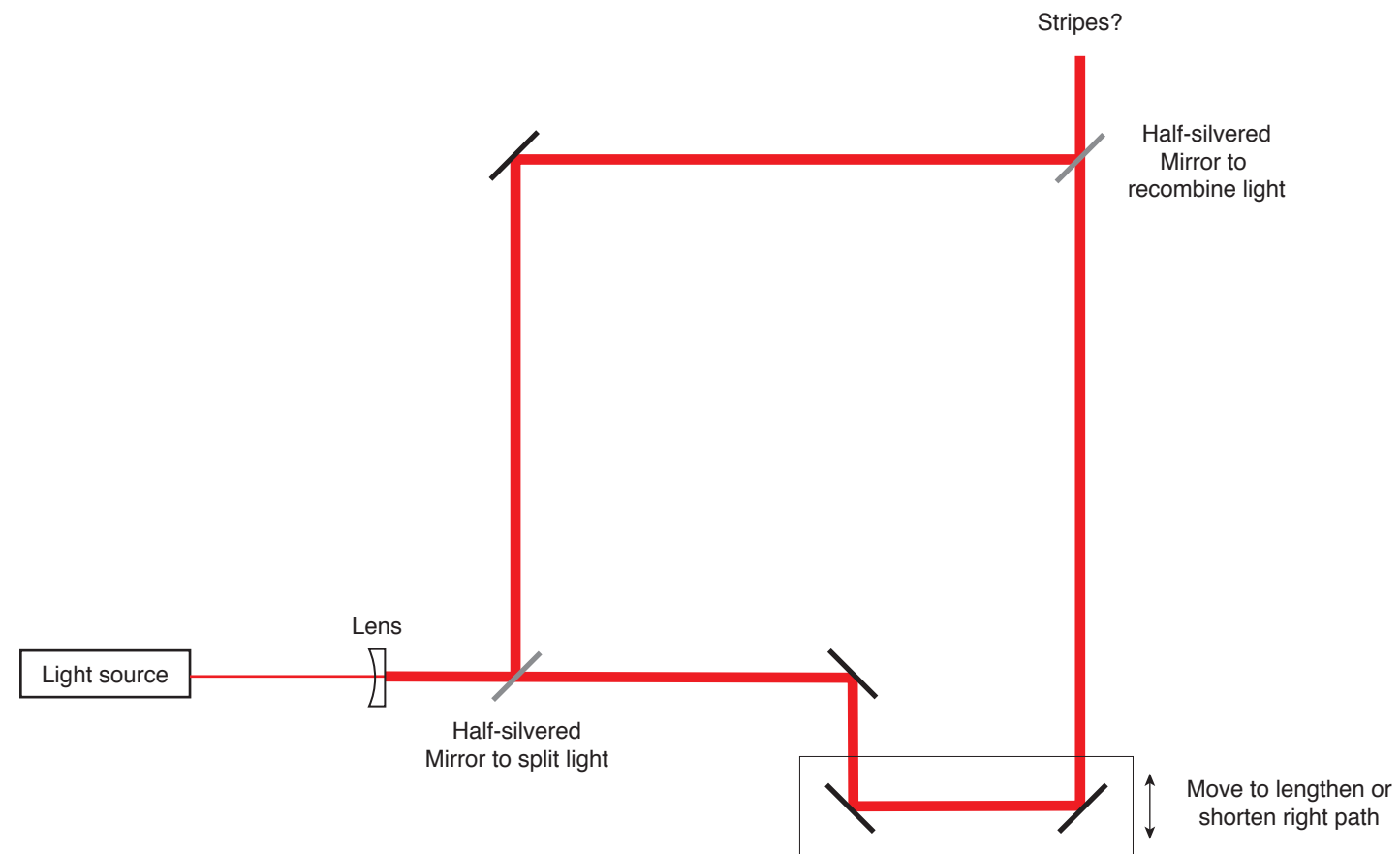




If all particles move like waves: two key questions

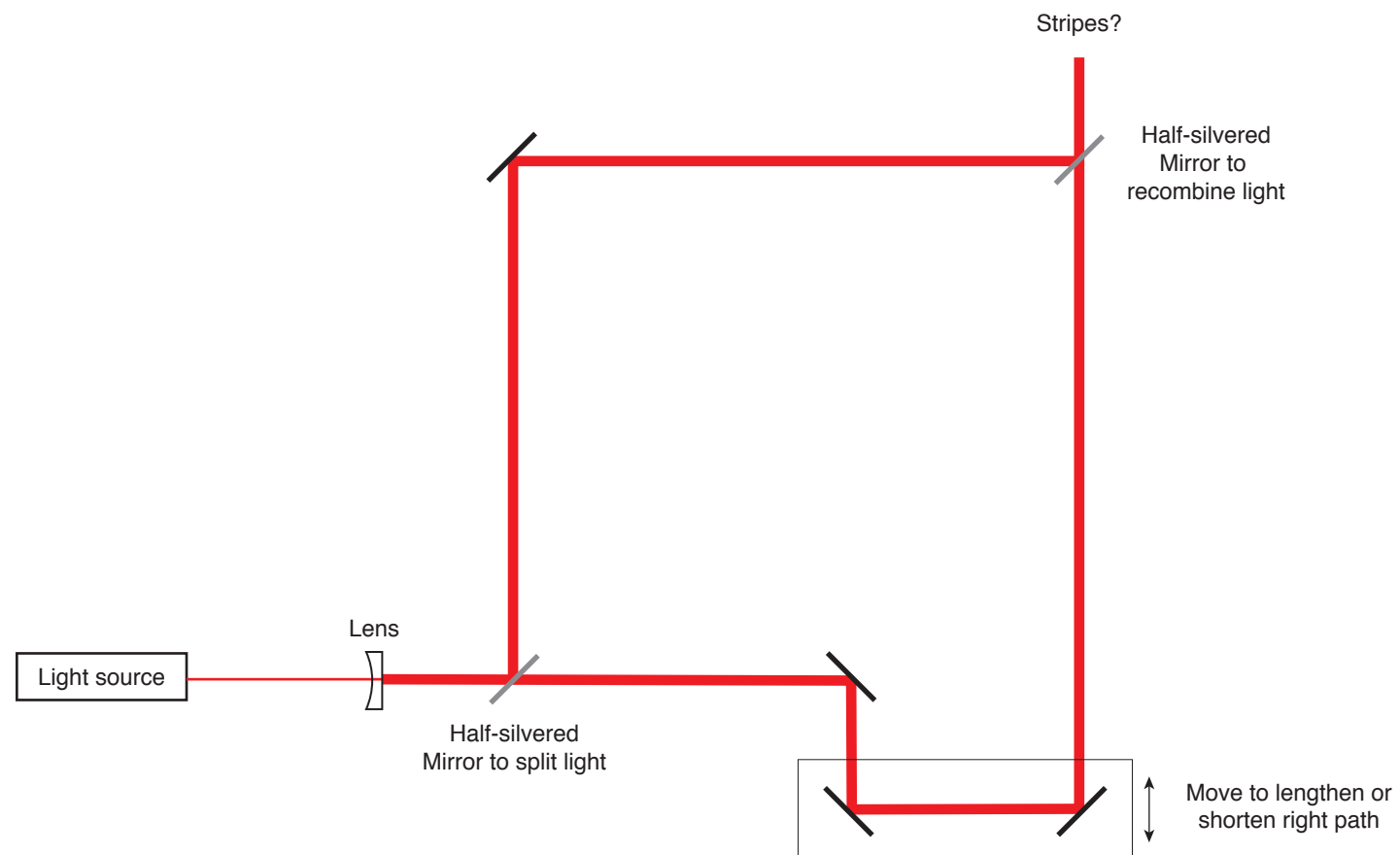
- How long is a particle ripple?
- How wide is a particle ripple?

Fancier interferometer



Stripes fade

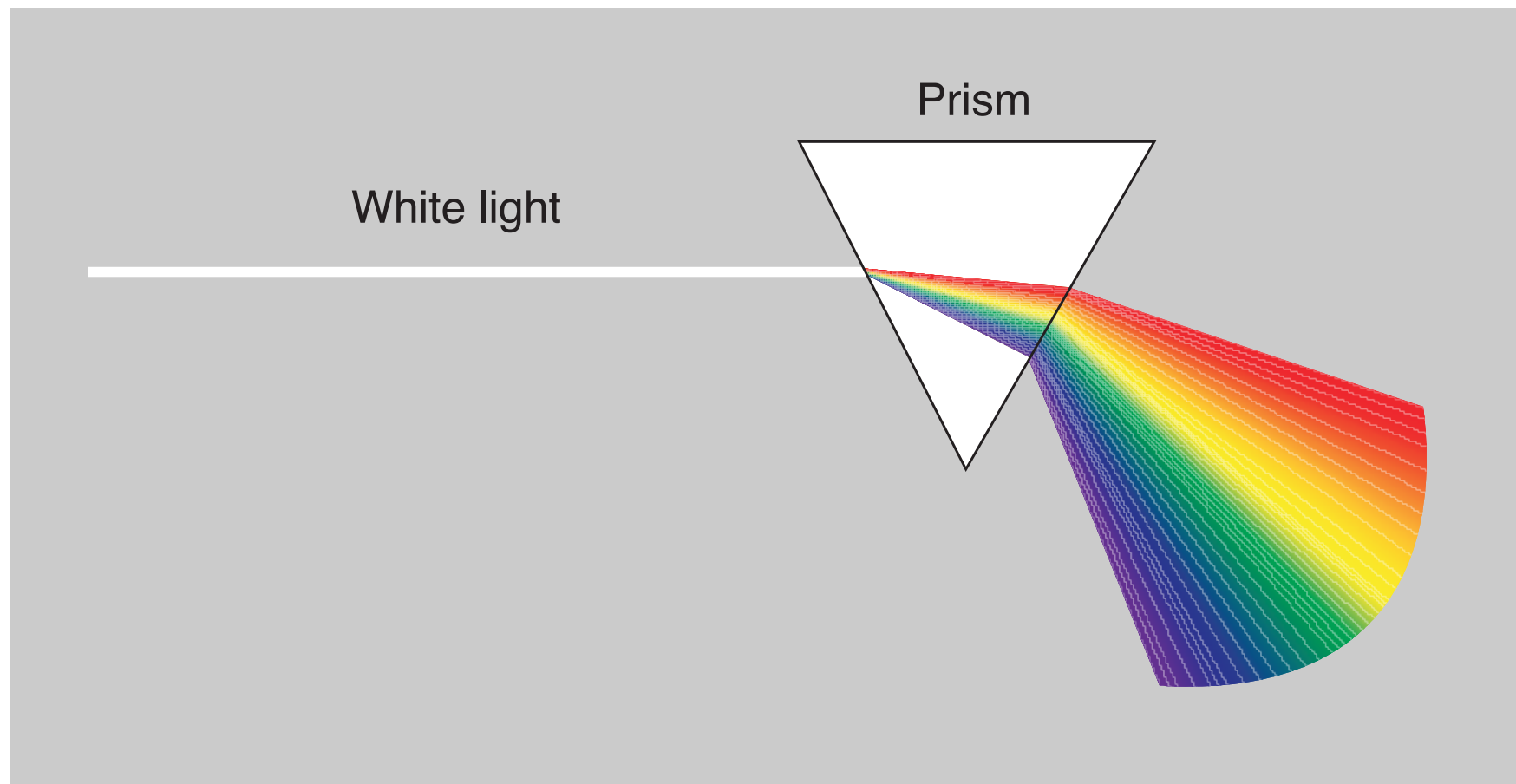
- Sometimes very quickly (white light; microns)
- Sometimes very slowly (fancy lasers; km)



Going through the bulb drawer

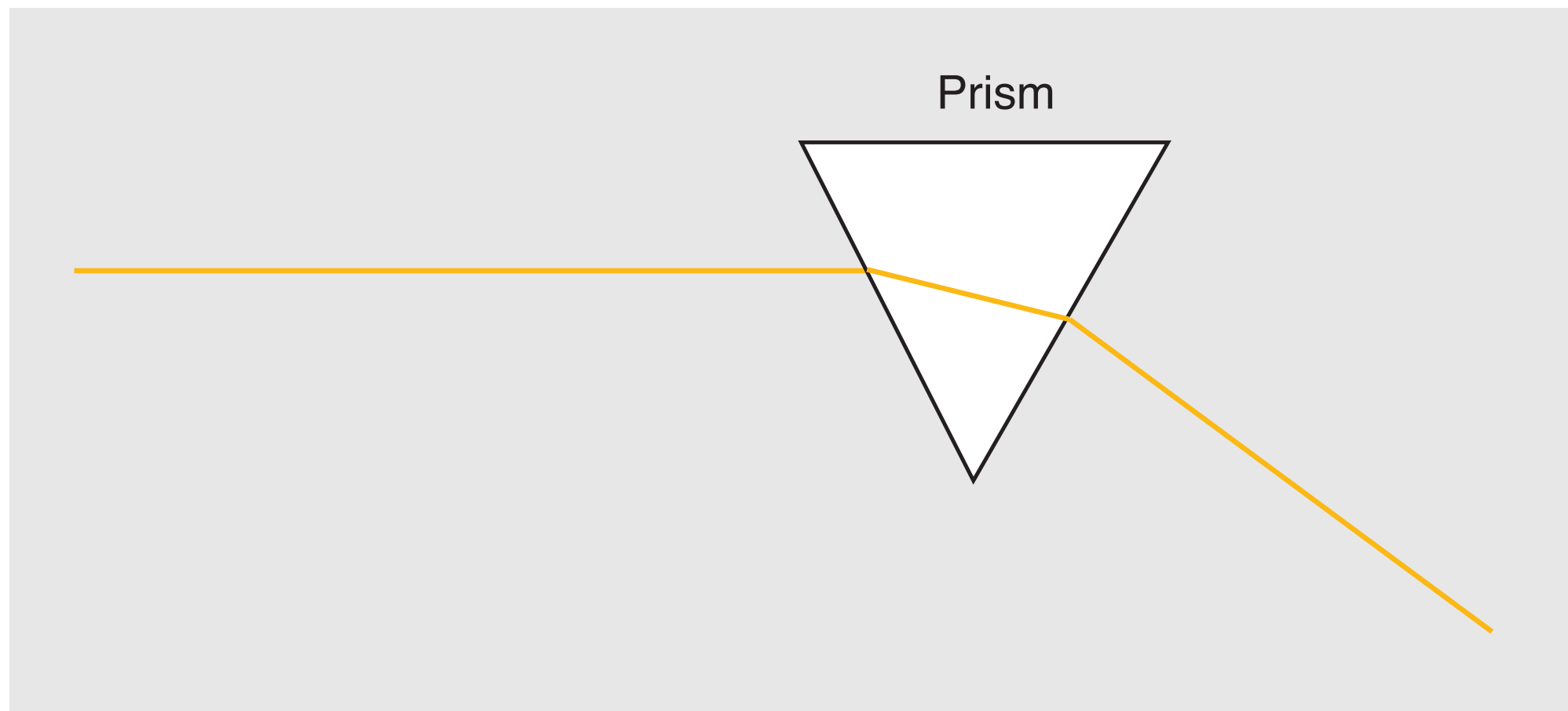
Sunlight, starlight, incandescent light bulb

- Wide range of color
- Very short ripple



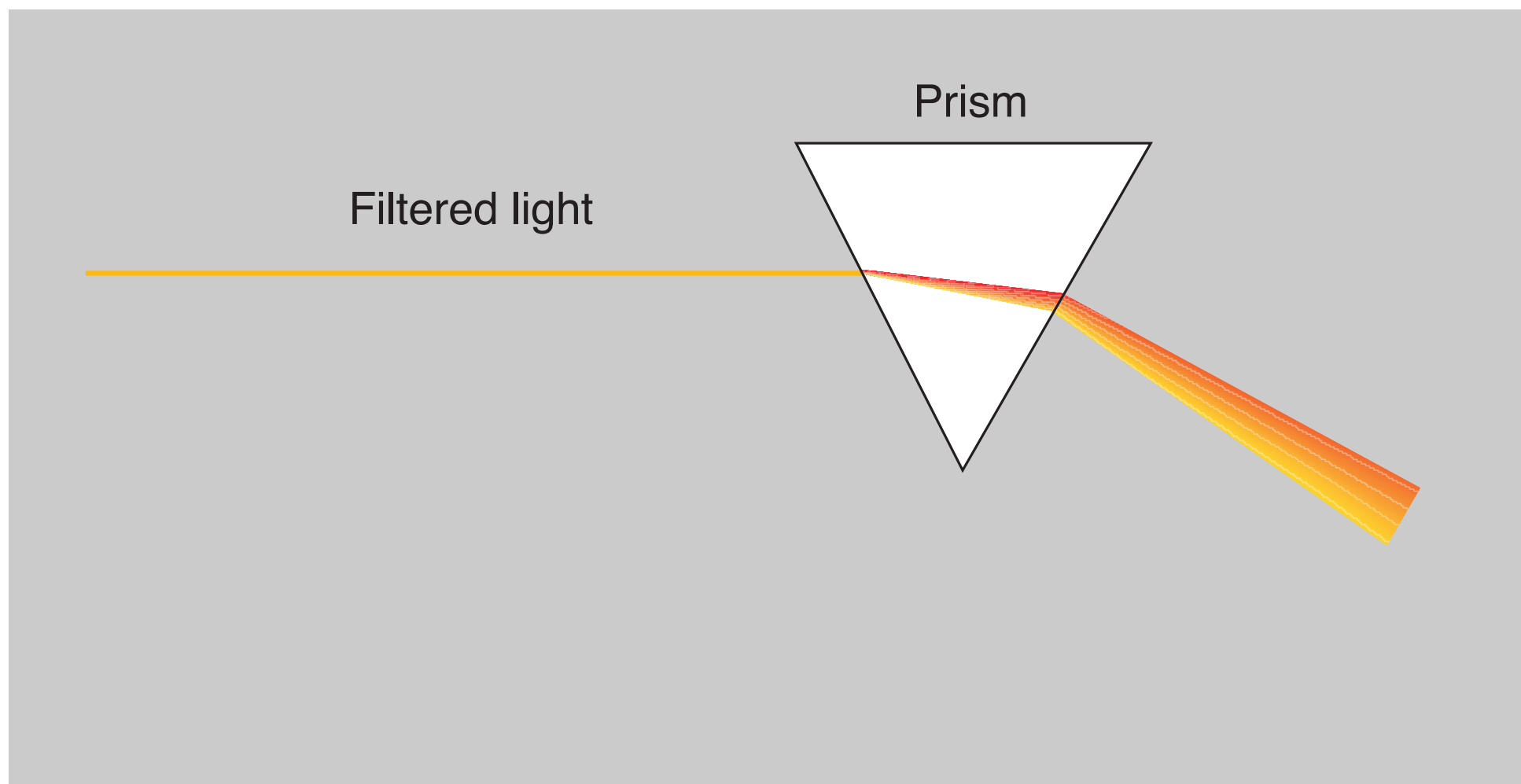
Lasers, neon lamp, sodium streetlight

- narrow range of color
- Long ripple



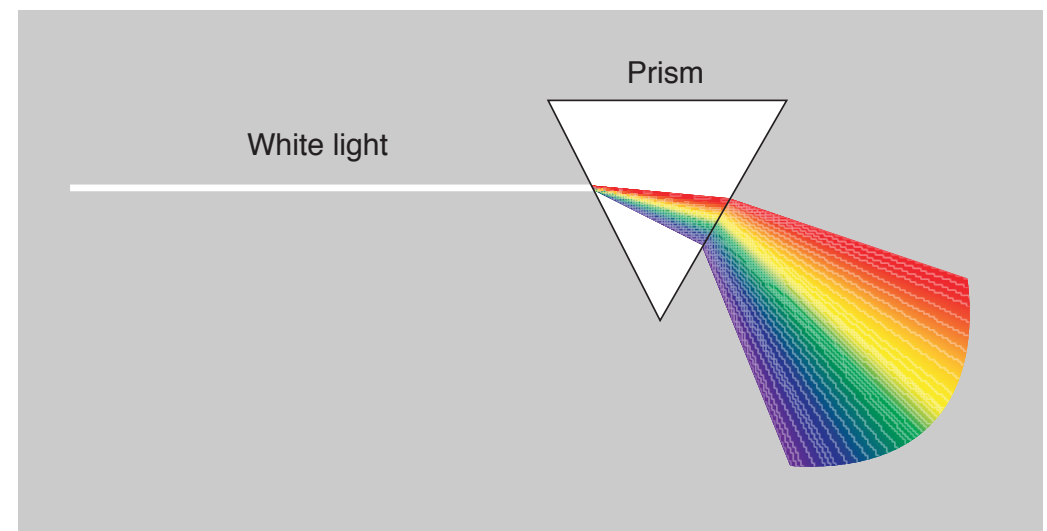
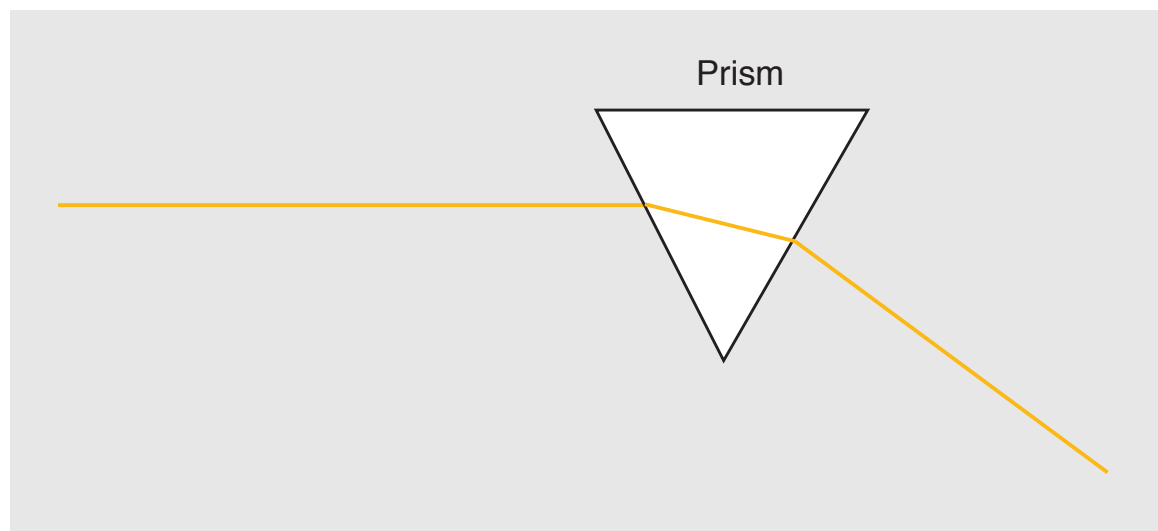
Filtered starlight, light reflected off of paint

- Intermediate range of color
- Intermediate ripple



Hints

- Long ripple is a narrow range of color
- Short ripple is wide range of color



Ripples

