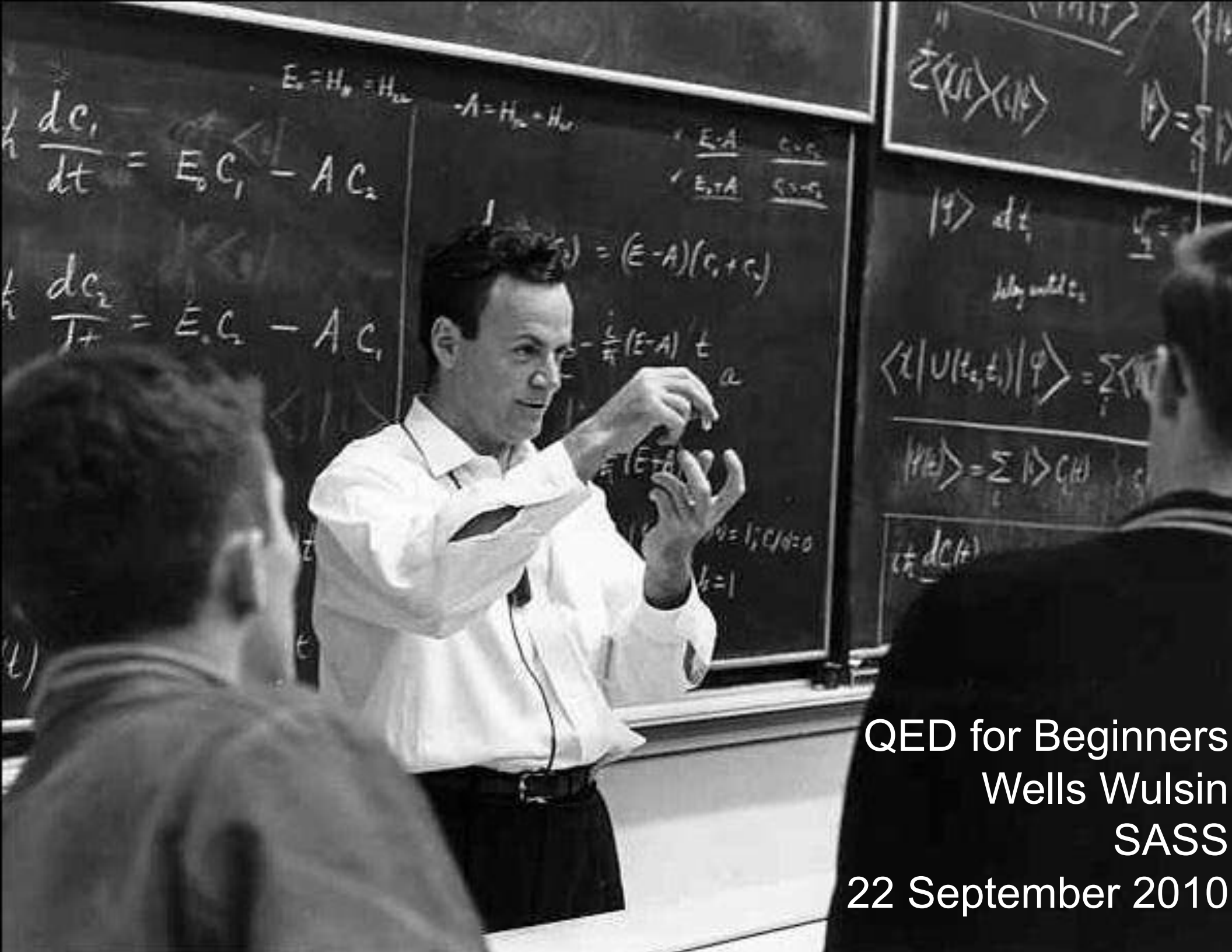


QED for Beginners

Wells Wulsin

SASS

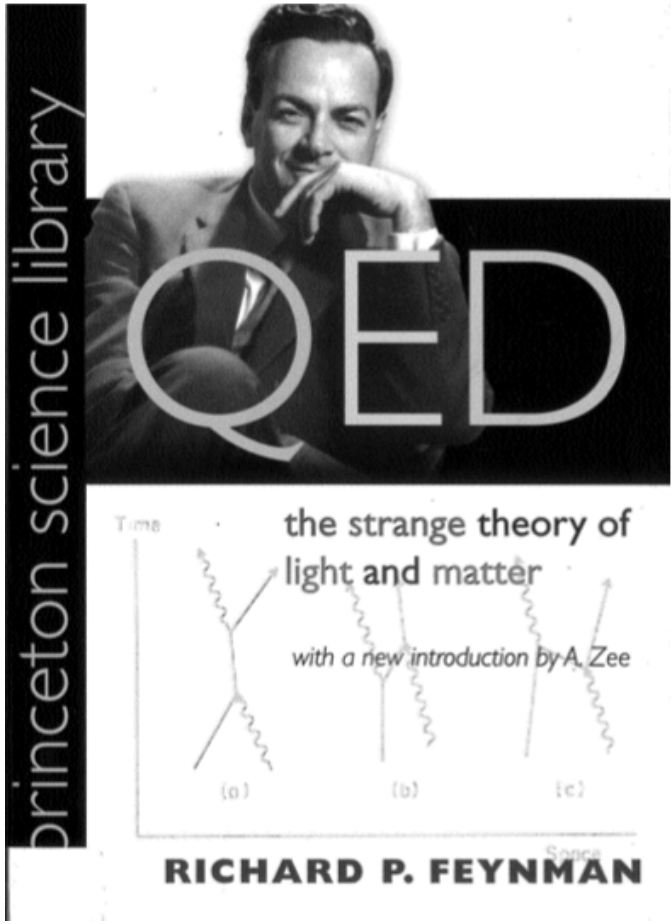
22 September 2010

Mt. Lassen

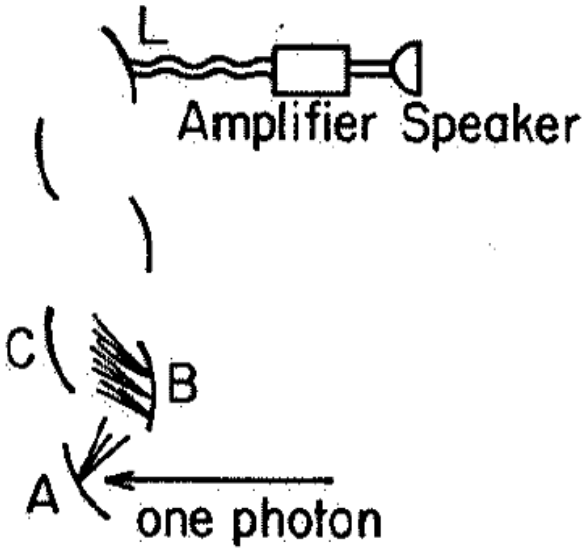
the Cinder Cone

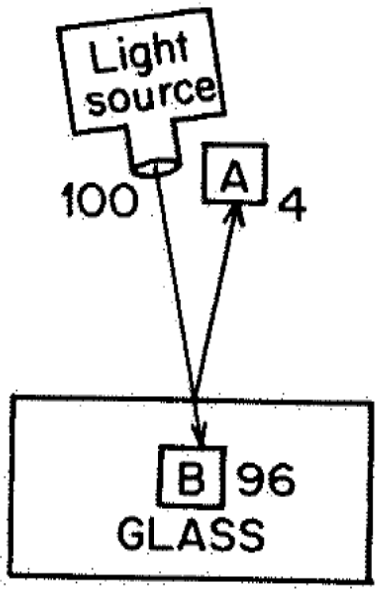
Introduction

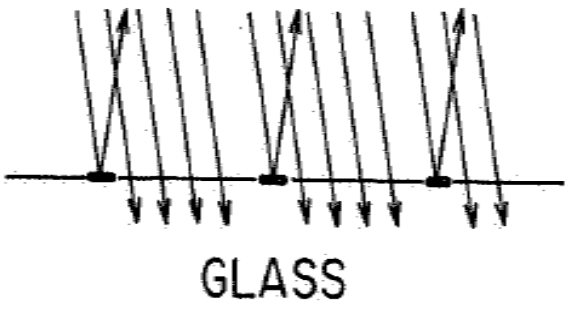
- QED: The Strange Theory of Light and Matter by Richard Feynman (Princeton University Press, 2006 edition).
- 4-90 minute New Zealand lectures available at http://vega.org.uk/video/subseries/8
- QED explains interactions of light and matter: all of chemistry and biology!
- Rules are simple
  - Many calculations are difficult
- Not explained by QED:
  - Gravitation
  - Nuclear interaction (e.g., radioactivity)

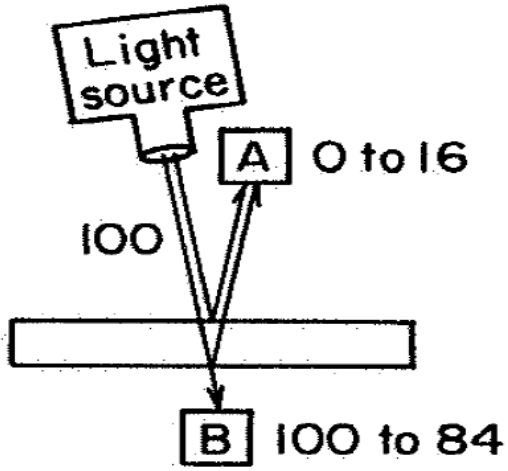


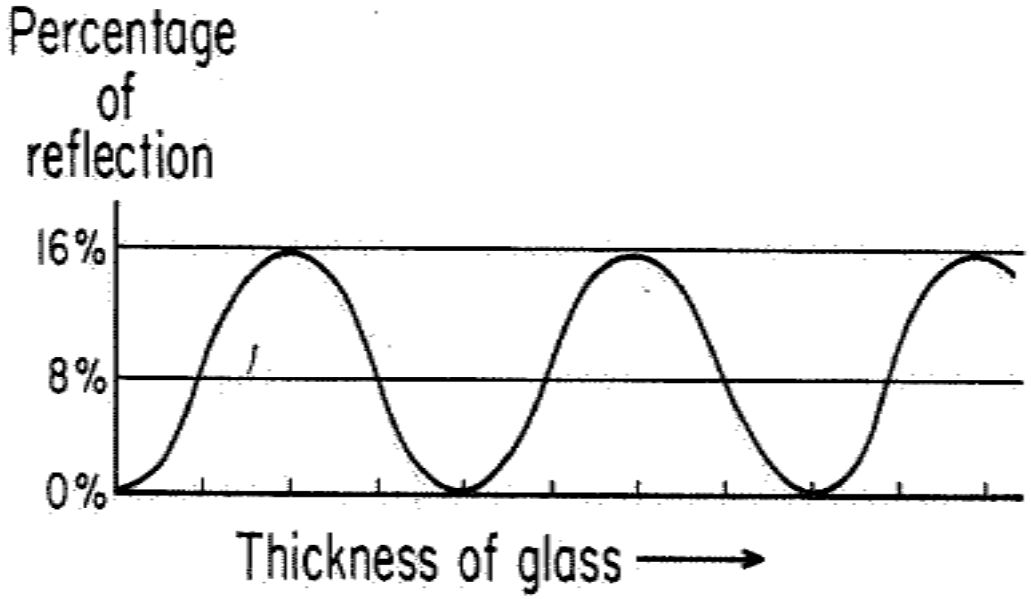
Light comes in chunks







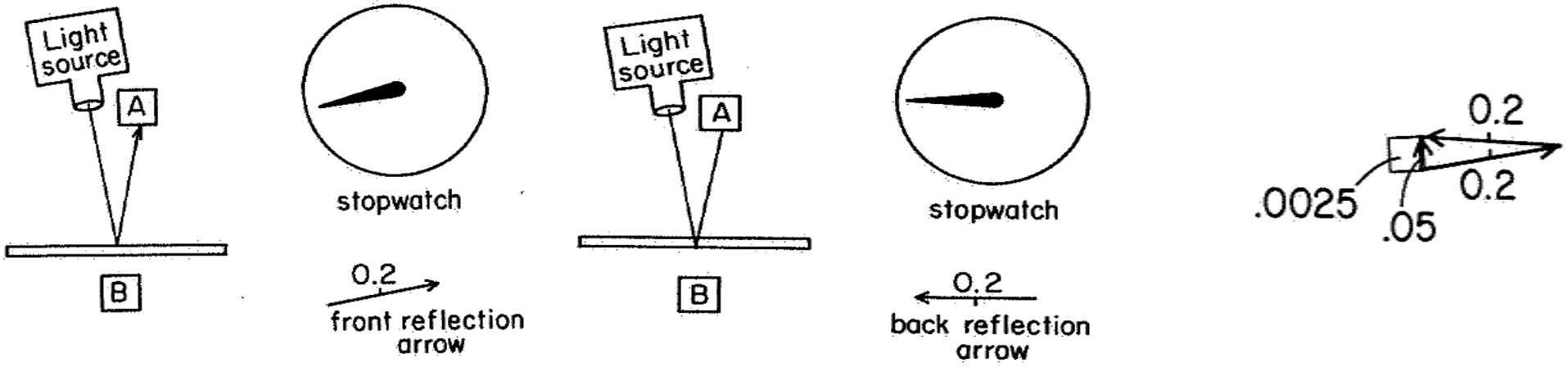




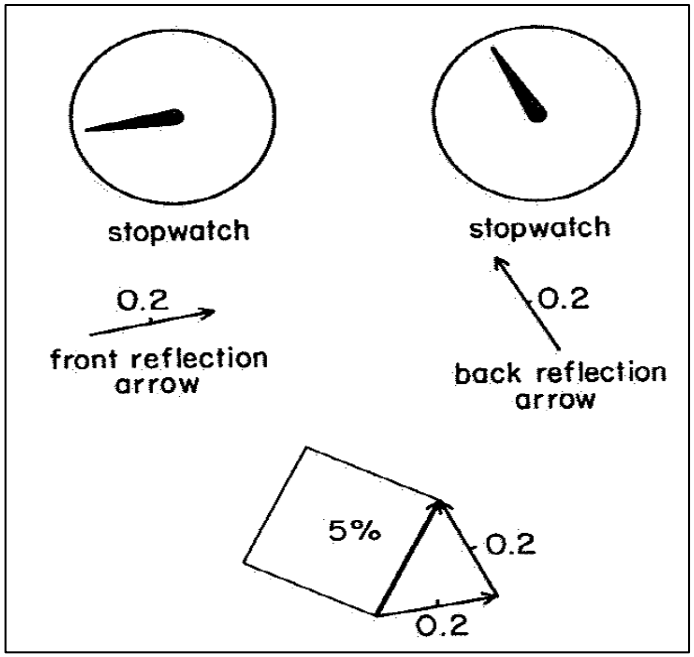
Rules of QED

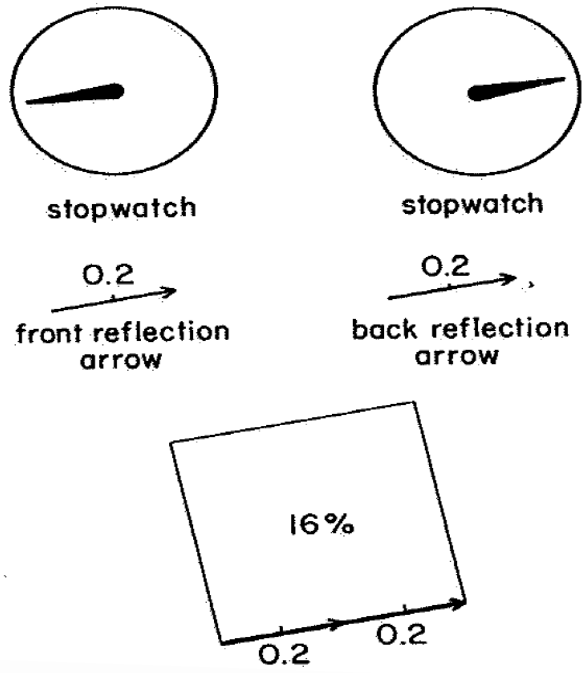
Grand Principle: The probability of an event is equal to the square of the length of an arrow called the "probability amplitude".

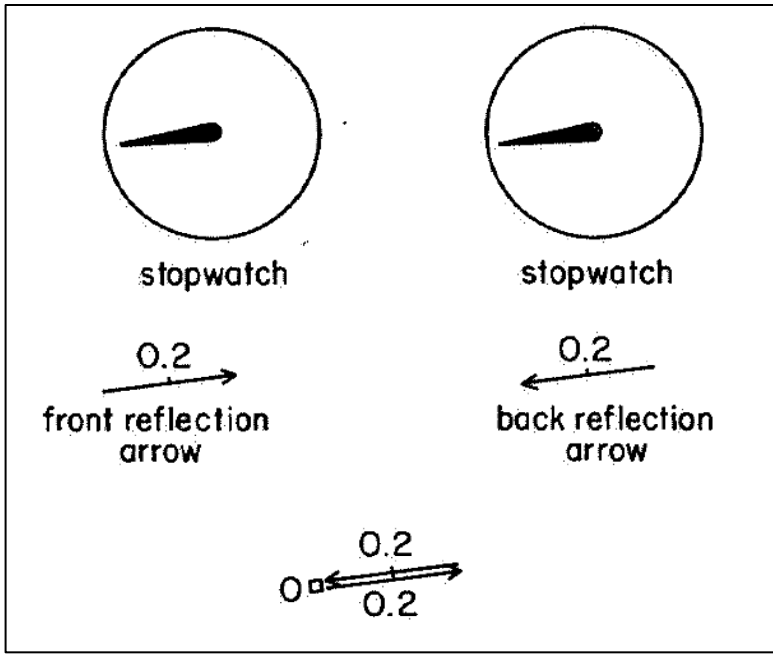
General Rule for drawing arrows if an event can happen in alternative ways: Draw an arrow for each way the event can happen, and then add the arrows by hooking the head of one to the tail of the next. The final arrow is drawn from the tail of the first arrow to the head of the last one.

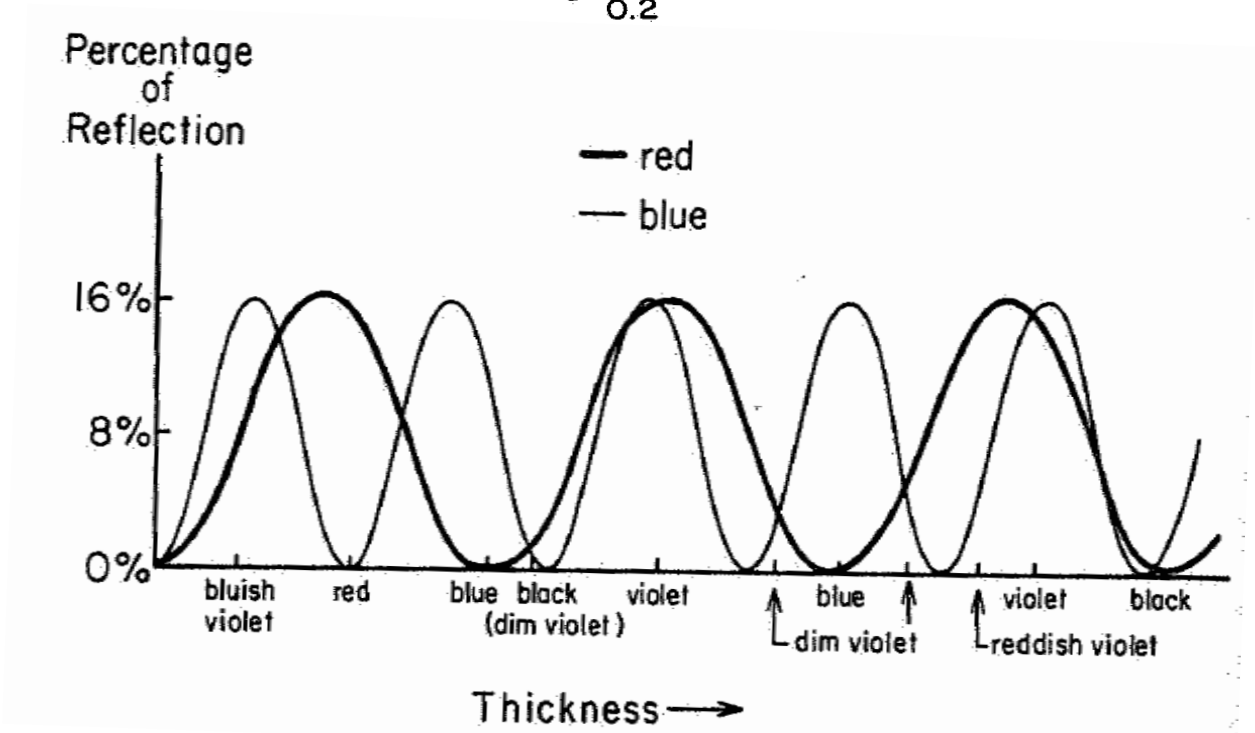


Colors from an oil film

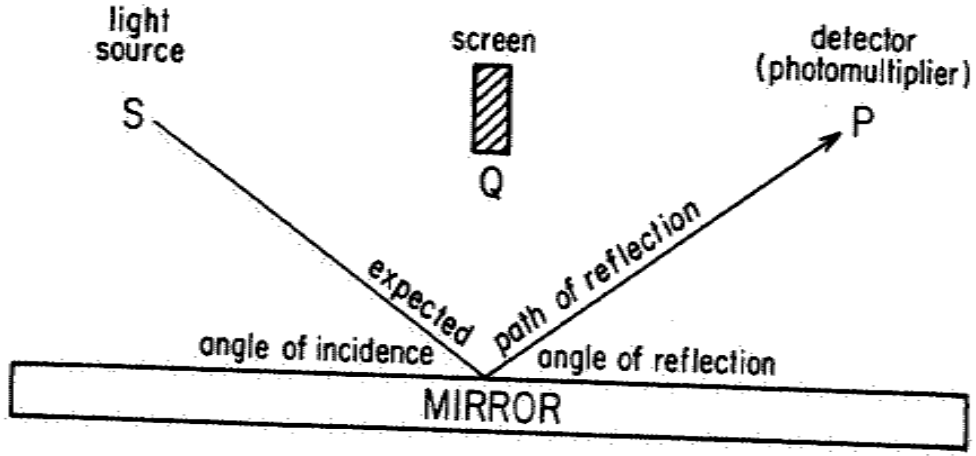


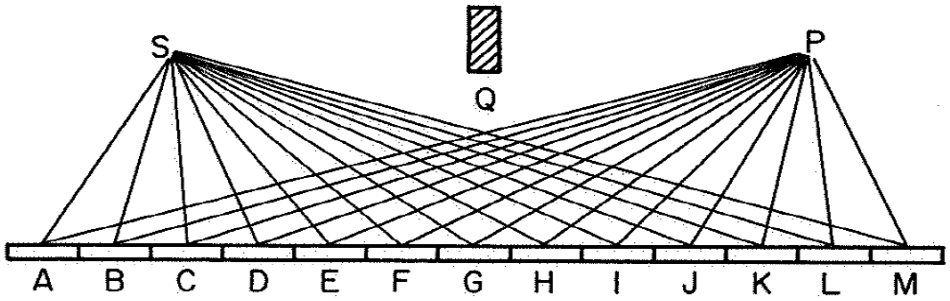


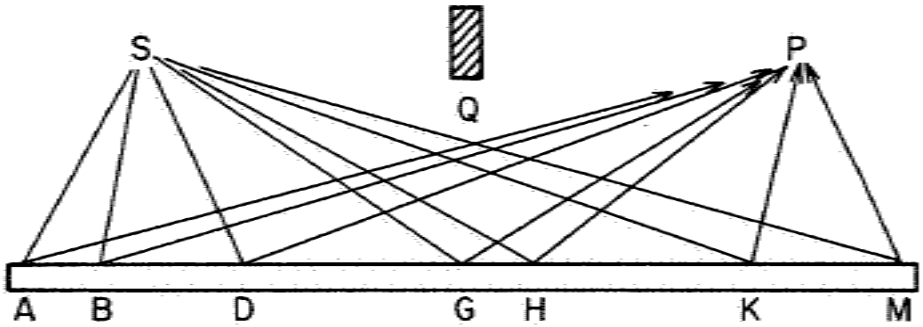


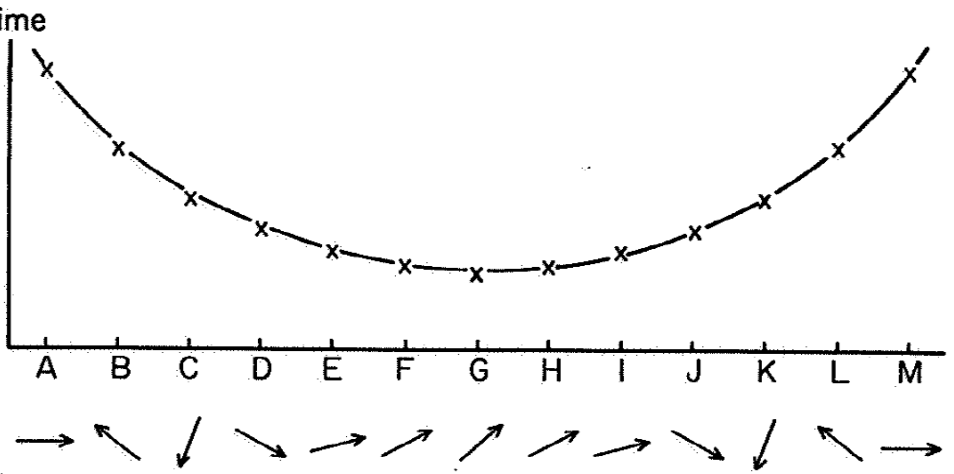


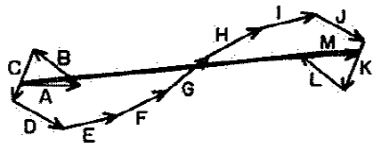
Mirror reflection



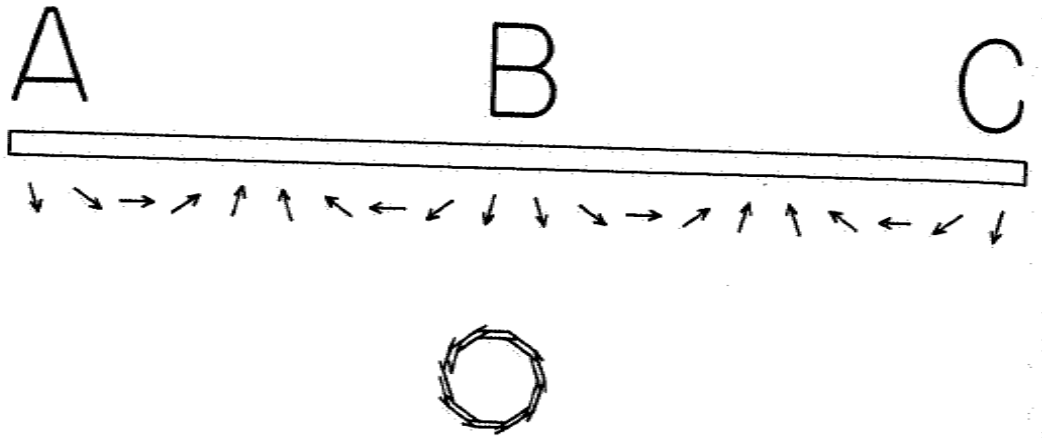


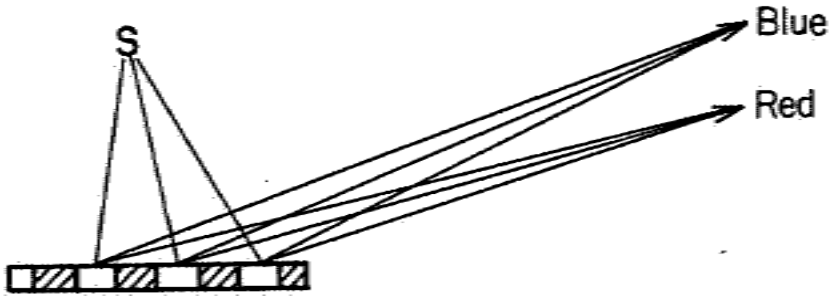


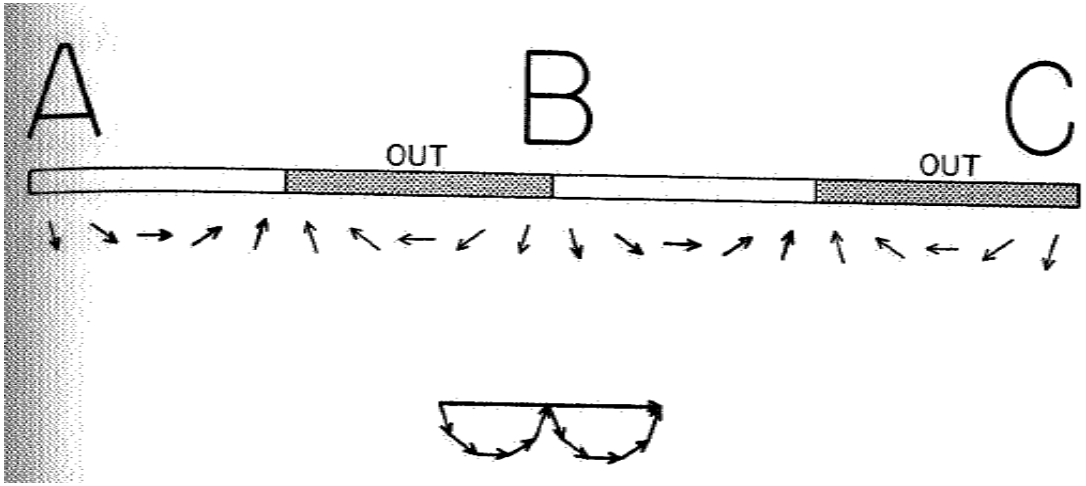


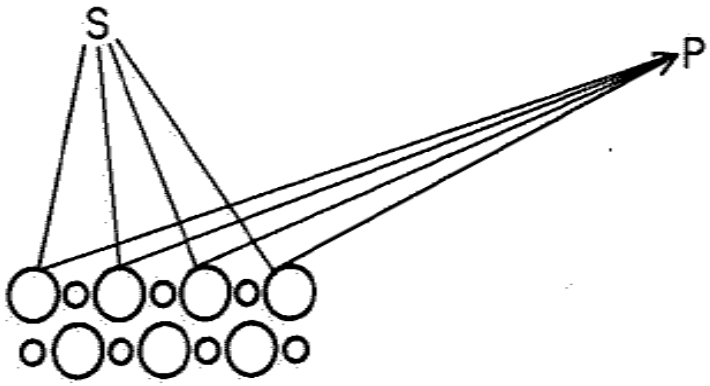


Light reflects at odd angles

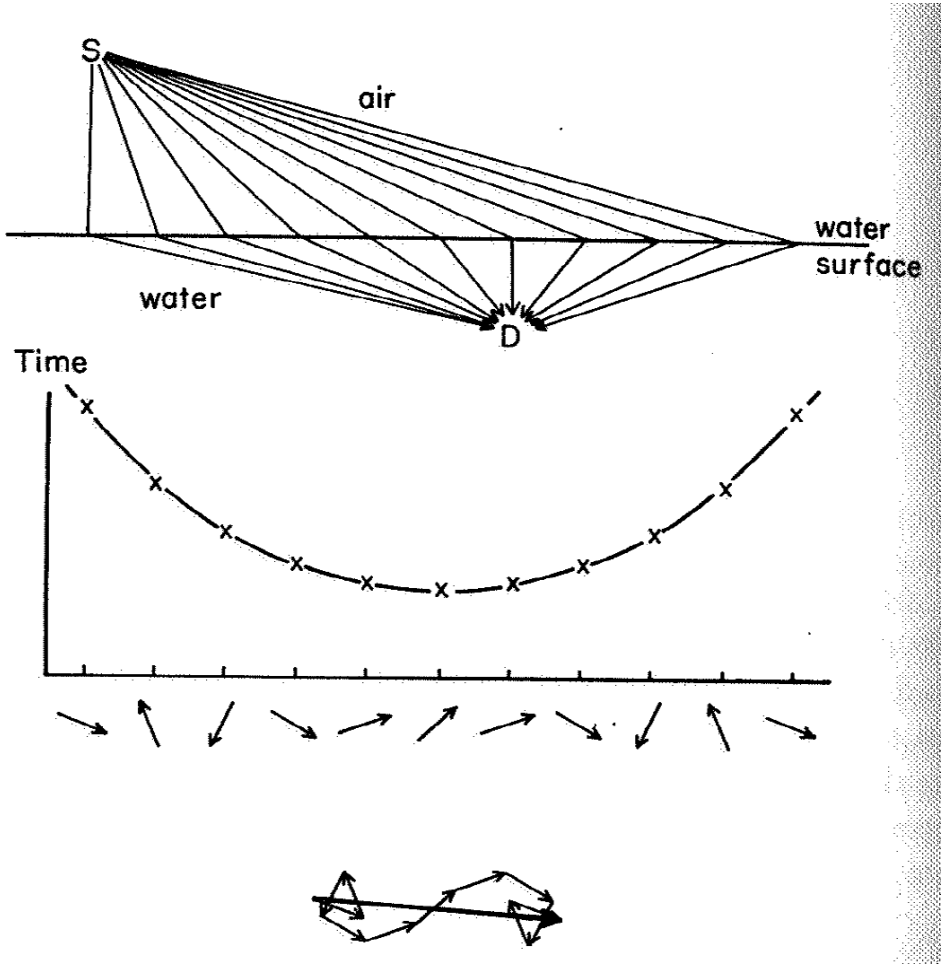


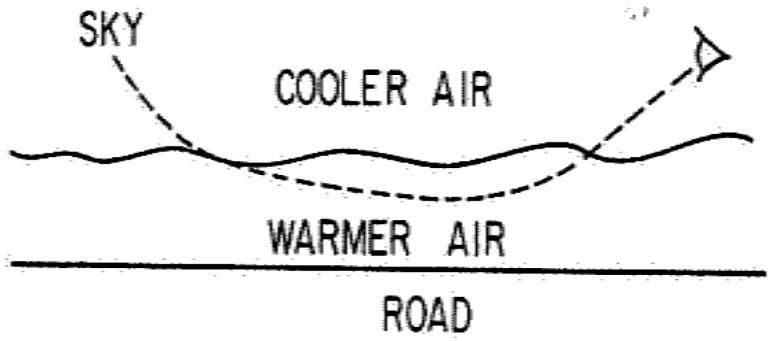




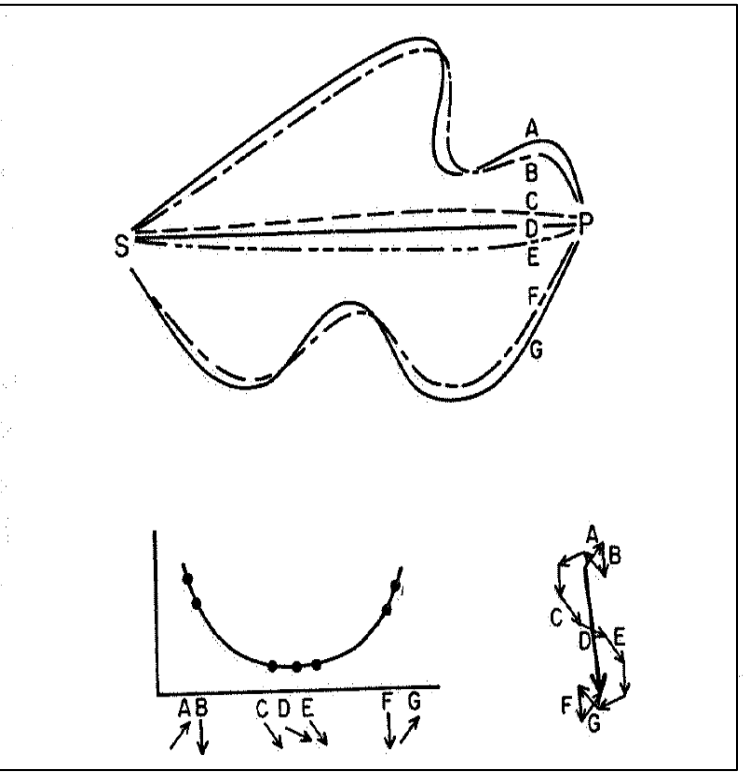


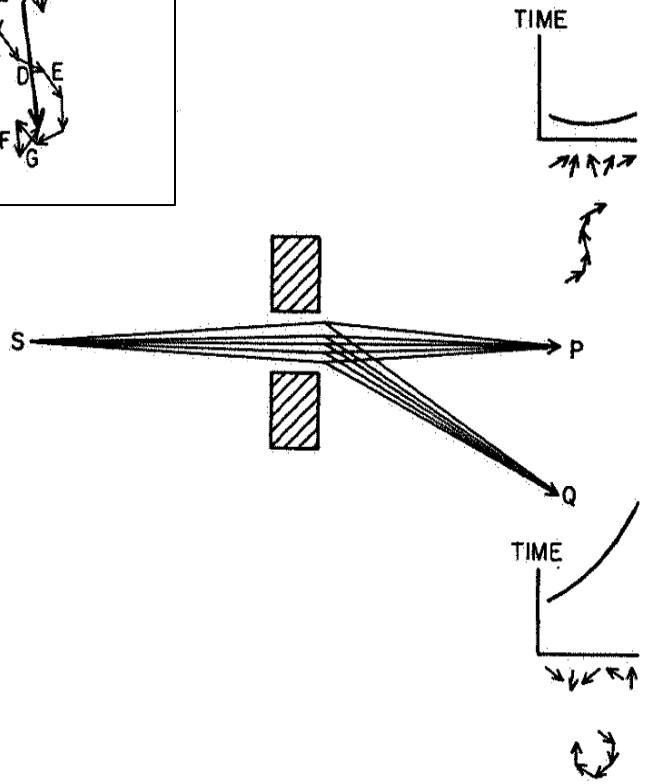
Water and mirages

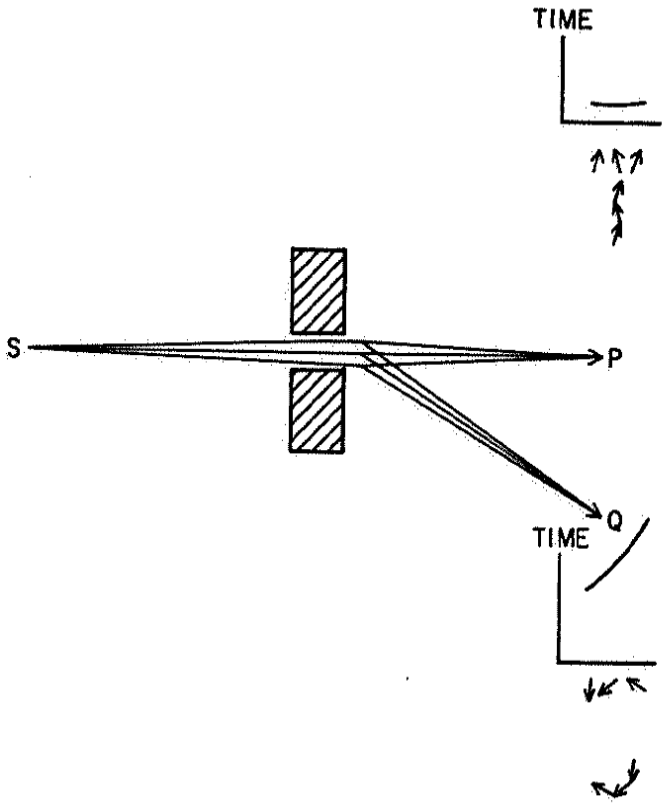




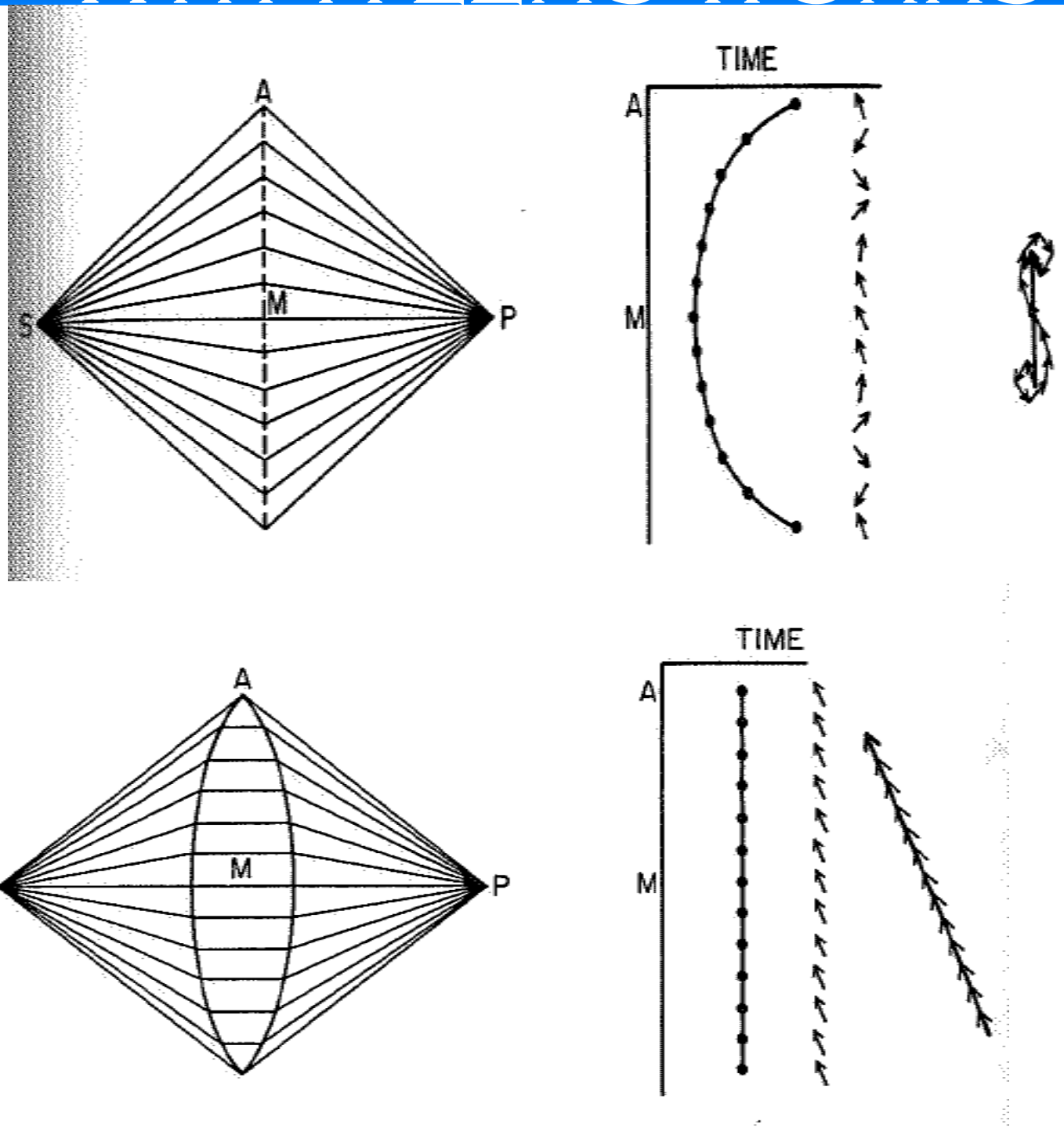
Light travels in straight liens



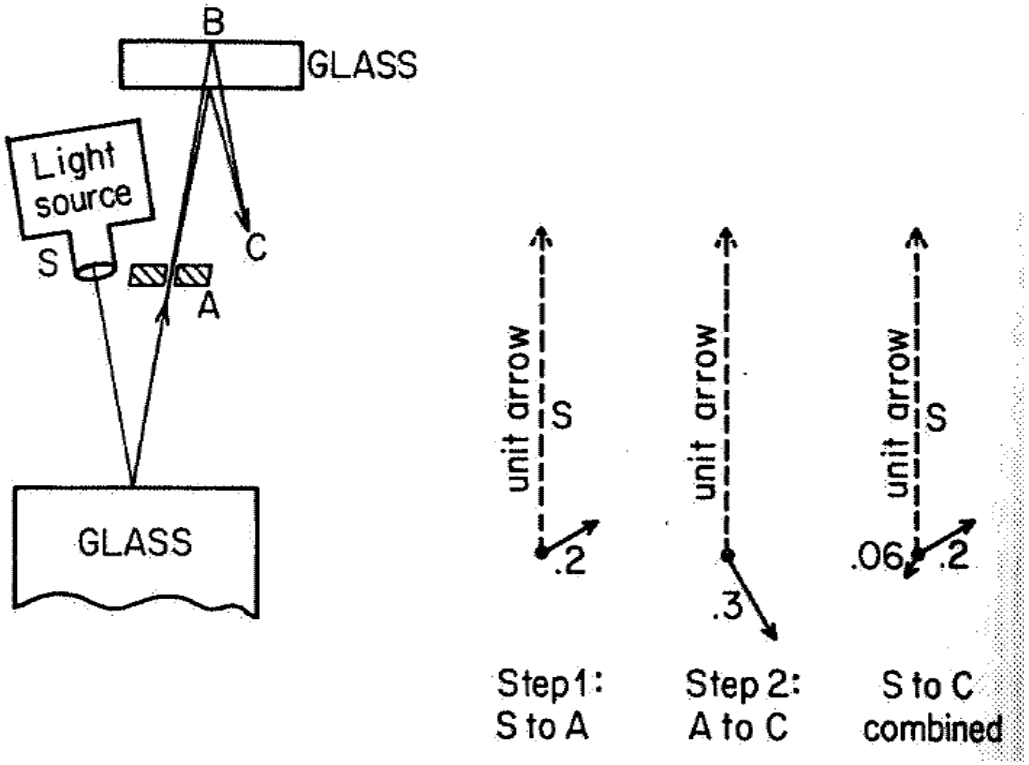


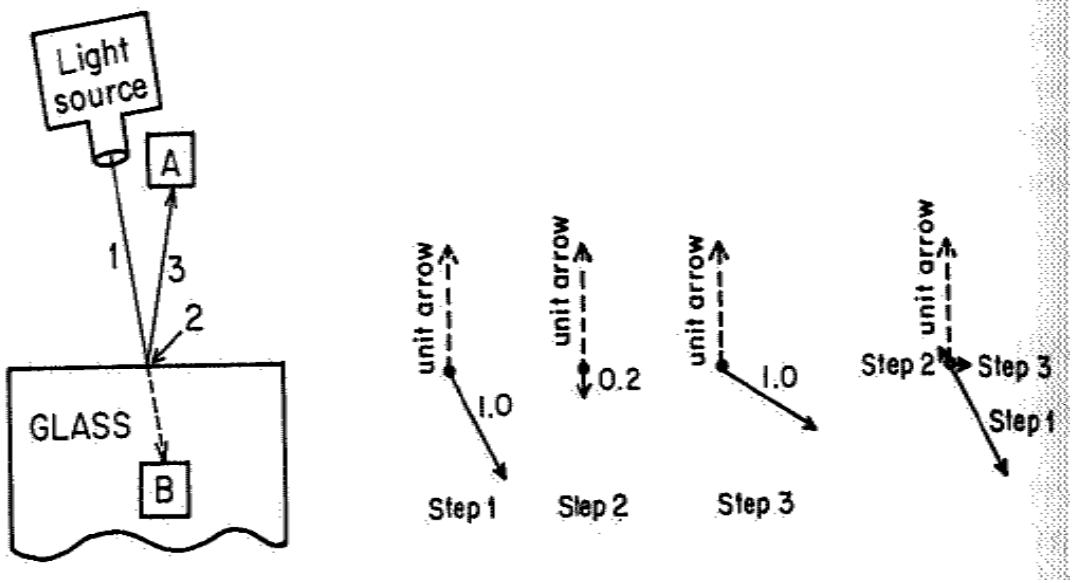


Why a lens works

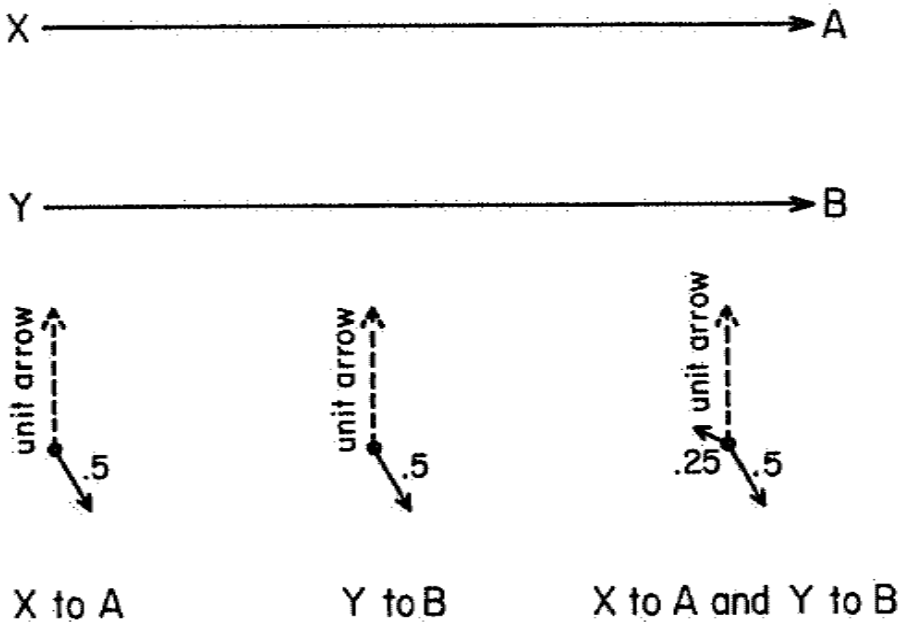


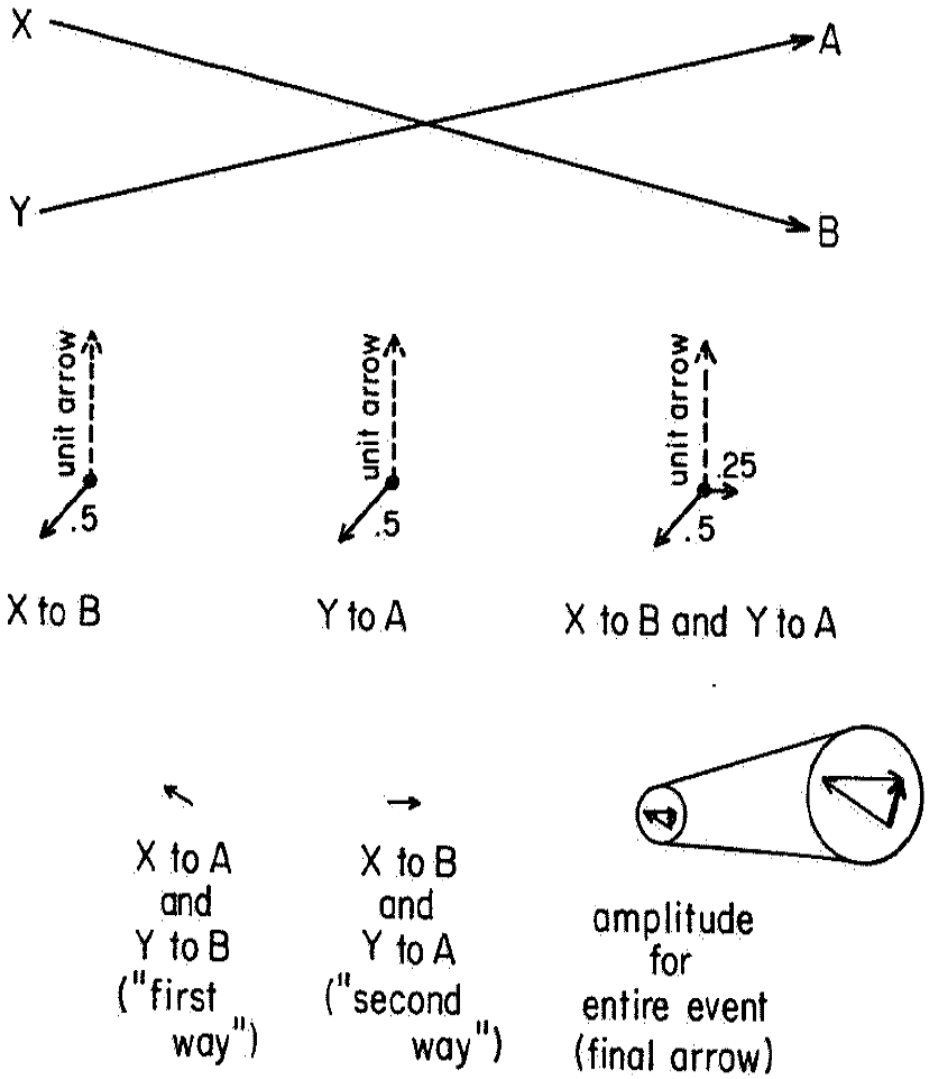
Events with multiple steps



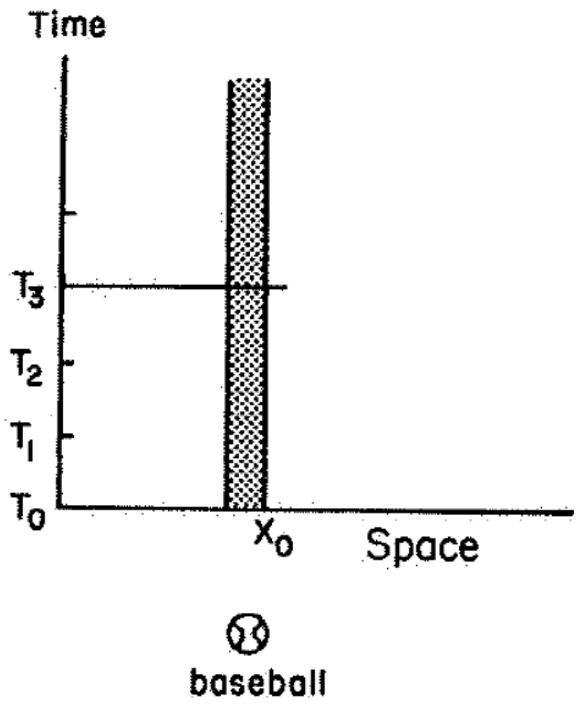


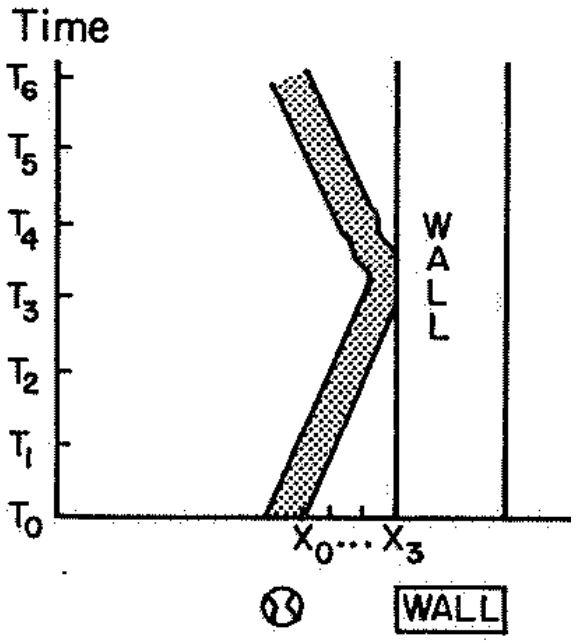
Two things happening simultaneously

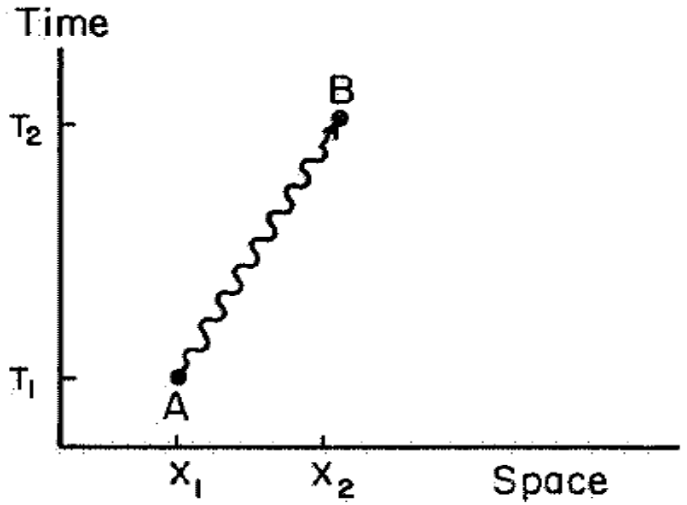


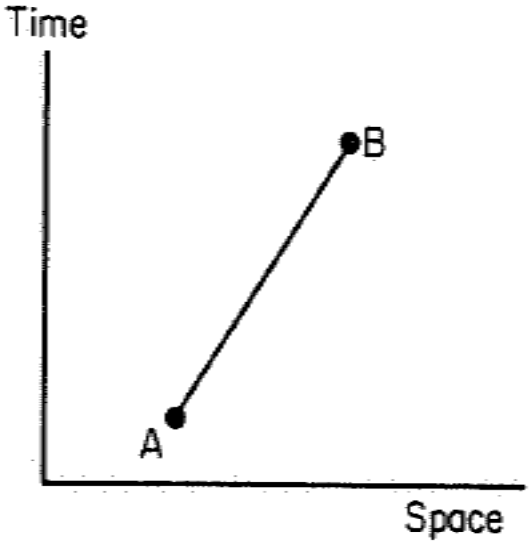


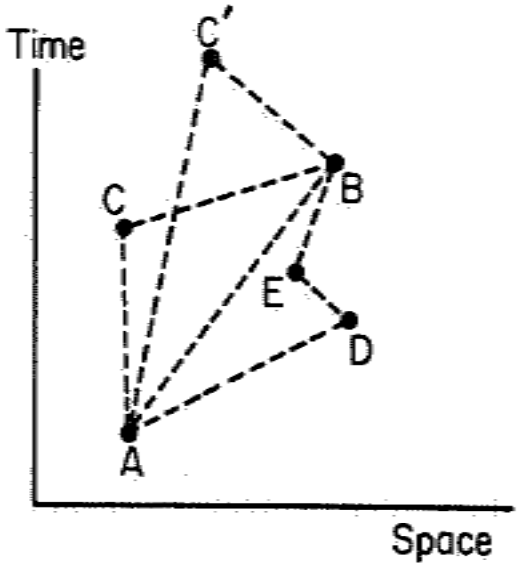
Spacetime diagrams

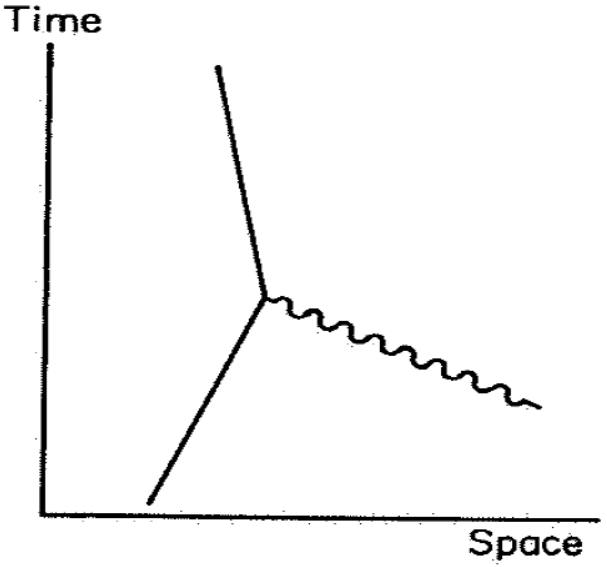






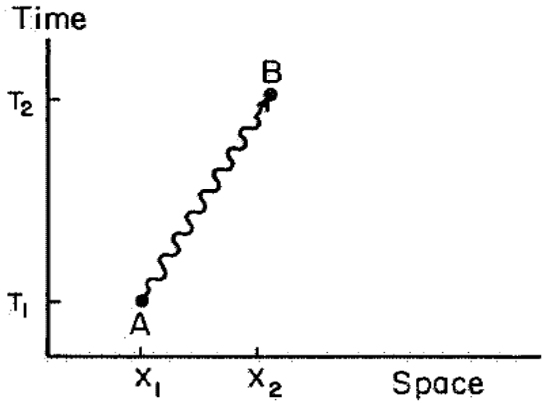




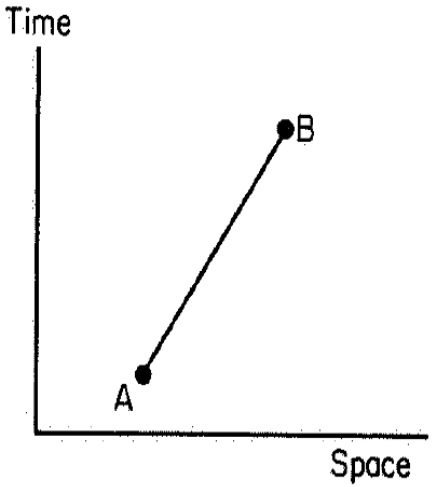


The 3 QED actions

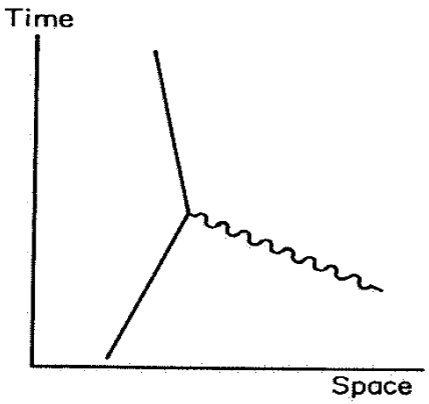
- A photon goes from place to place: P(A to B)



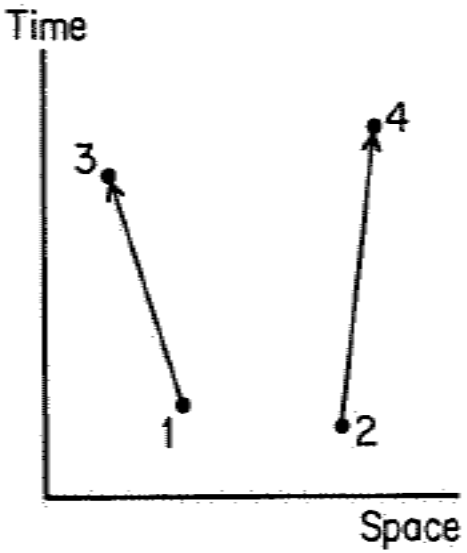
- An electron goes from place to place: E(A to B)



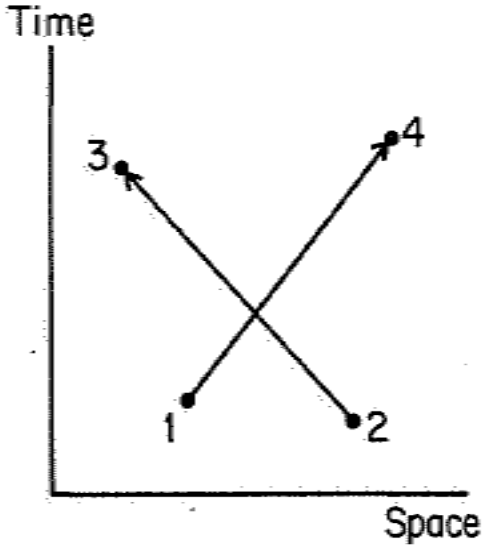
- An electron emits or absorbs a photon: j ~= -0.1



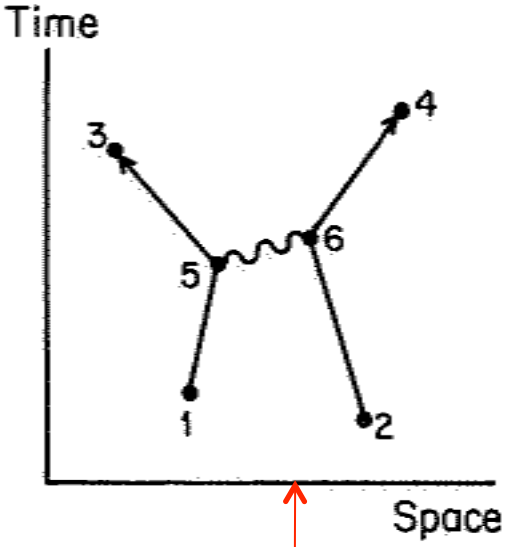
Two electrons move

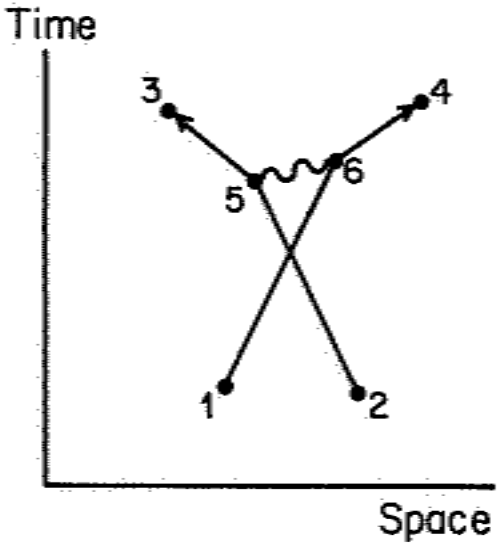


E(1 to 3)*E(2 to 4)

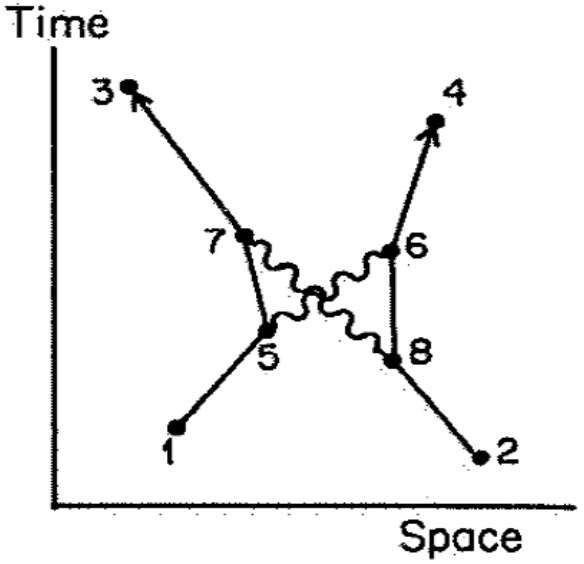


E(1 to 4)*E(2 to 3)



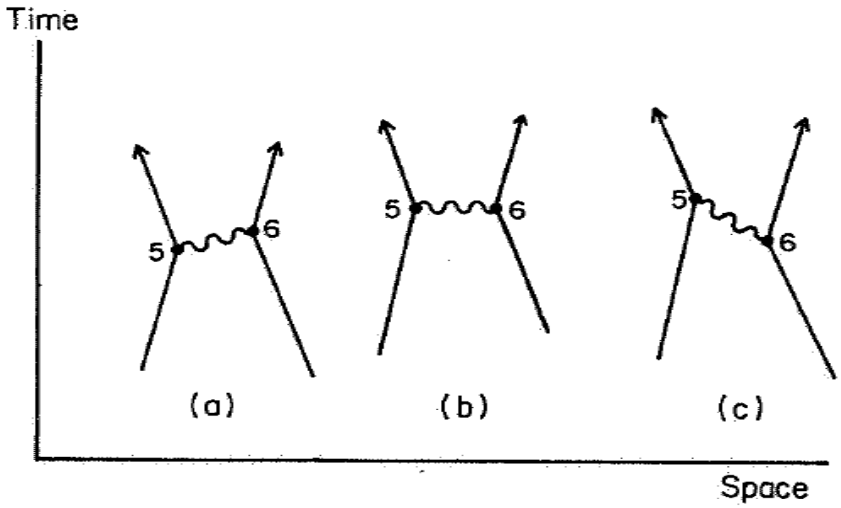


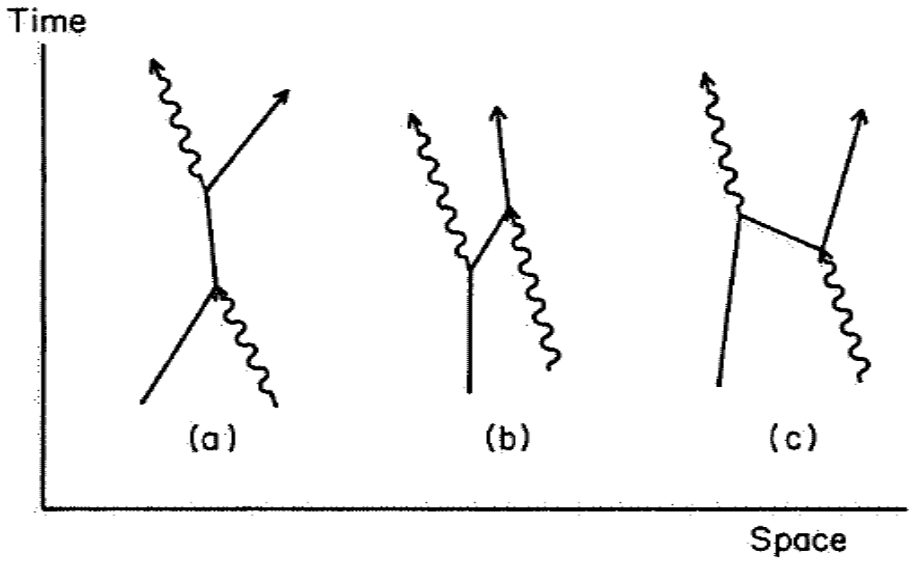
E(1 to 5)*j*E(5 to 3) * E(2 to 6)*j*E(6 to 4) * P(5 to 6)

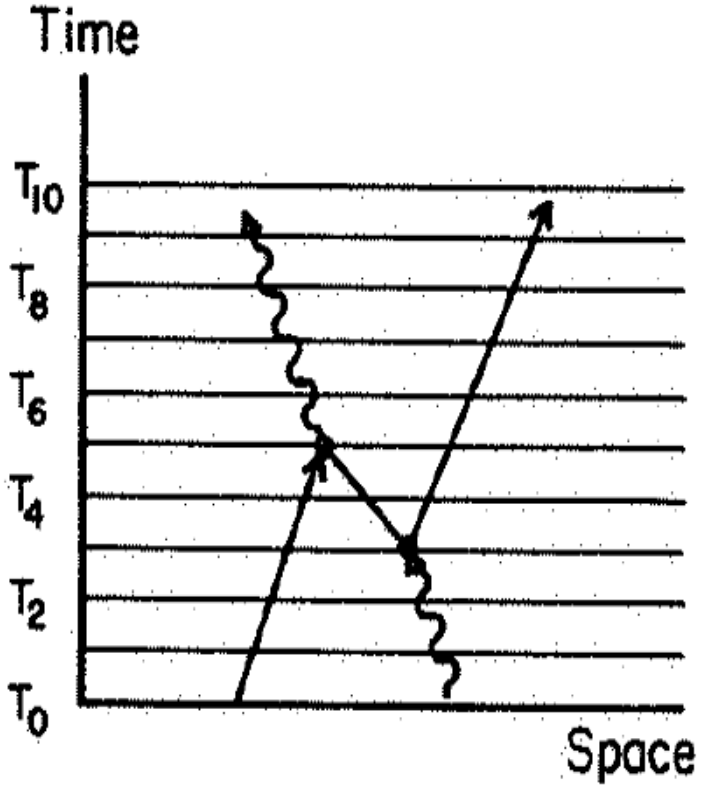


$\alpha\ j^4$

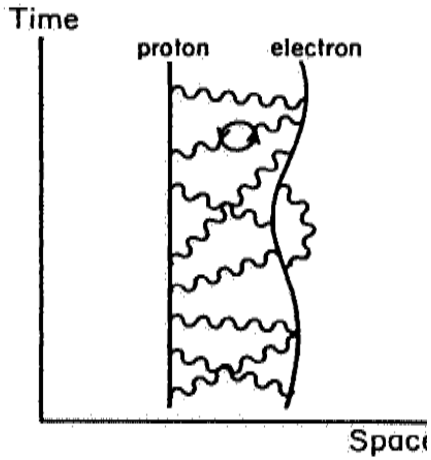
The positron

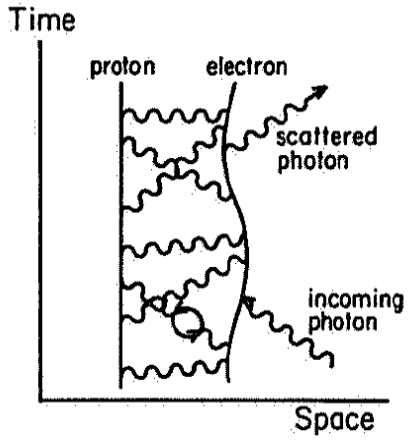


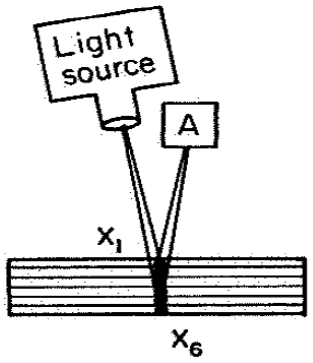


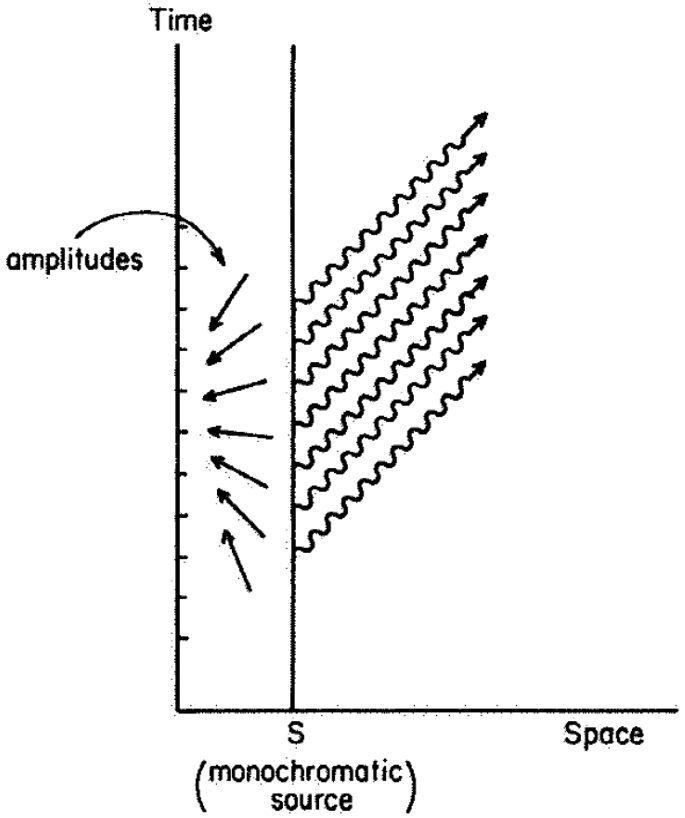


Reflections revisited

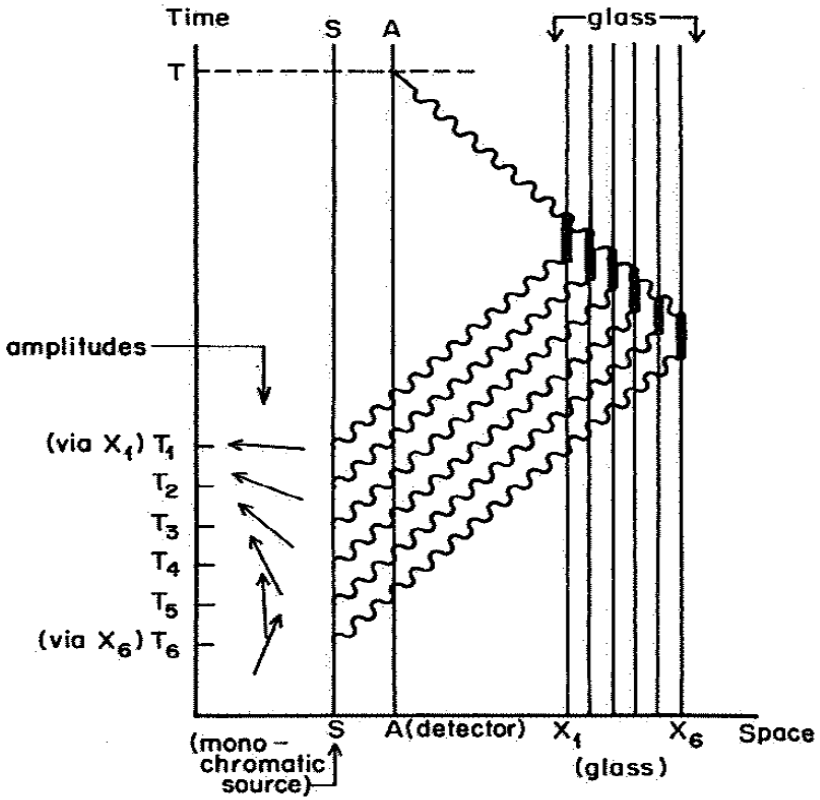




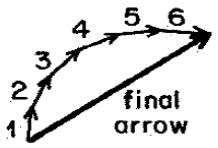




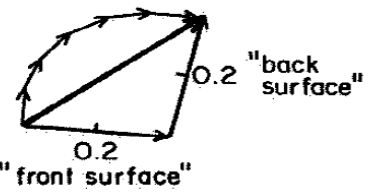
(b)



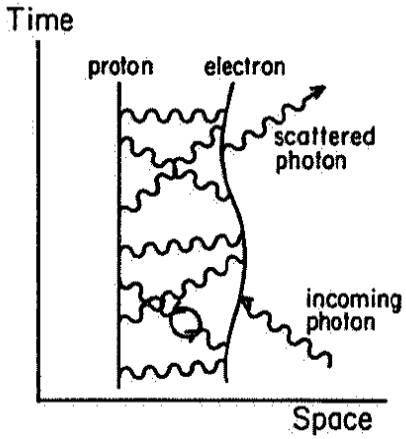
(c)

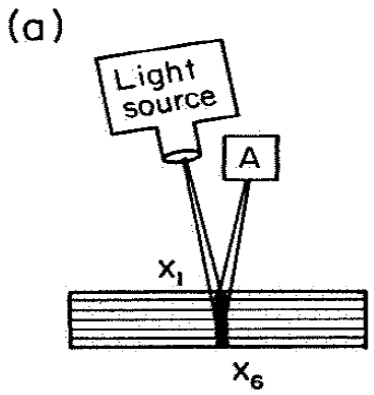


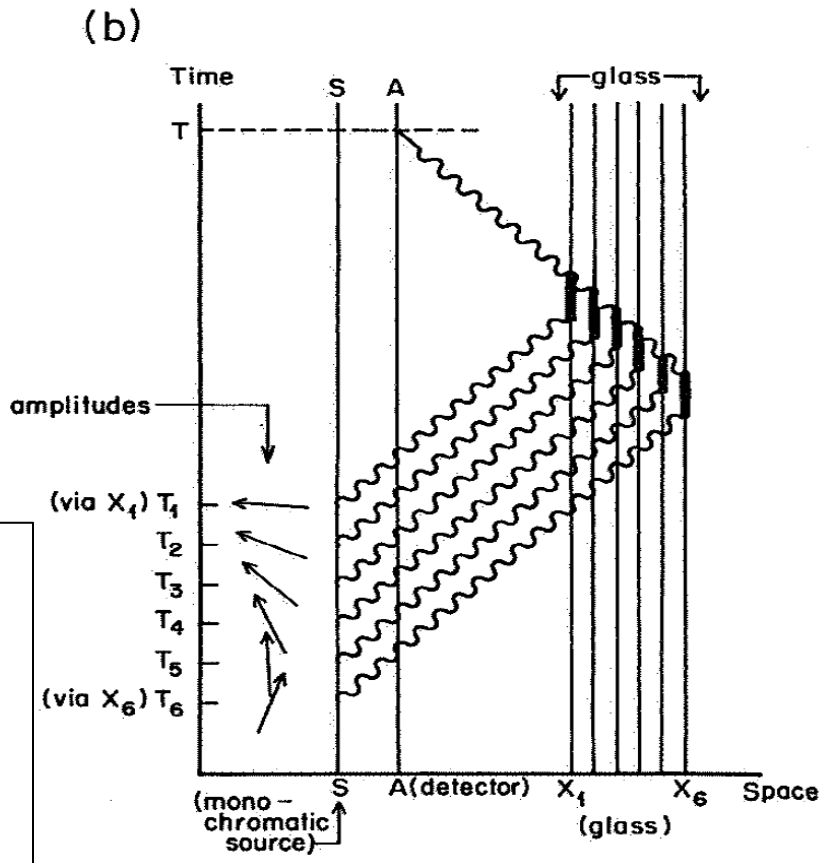
(d)

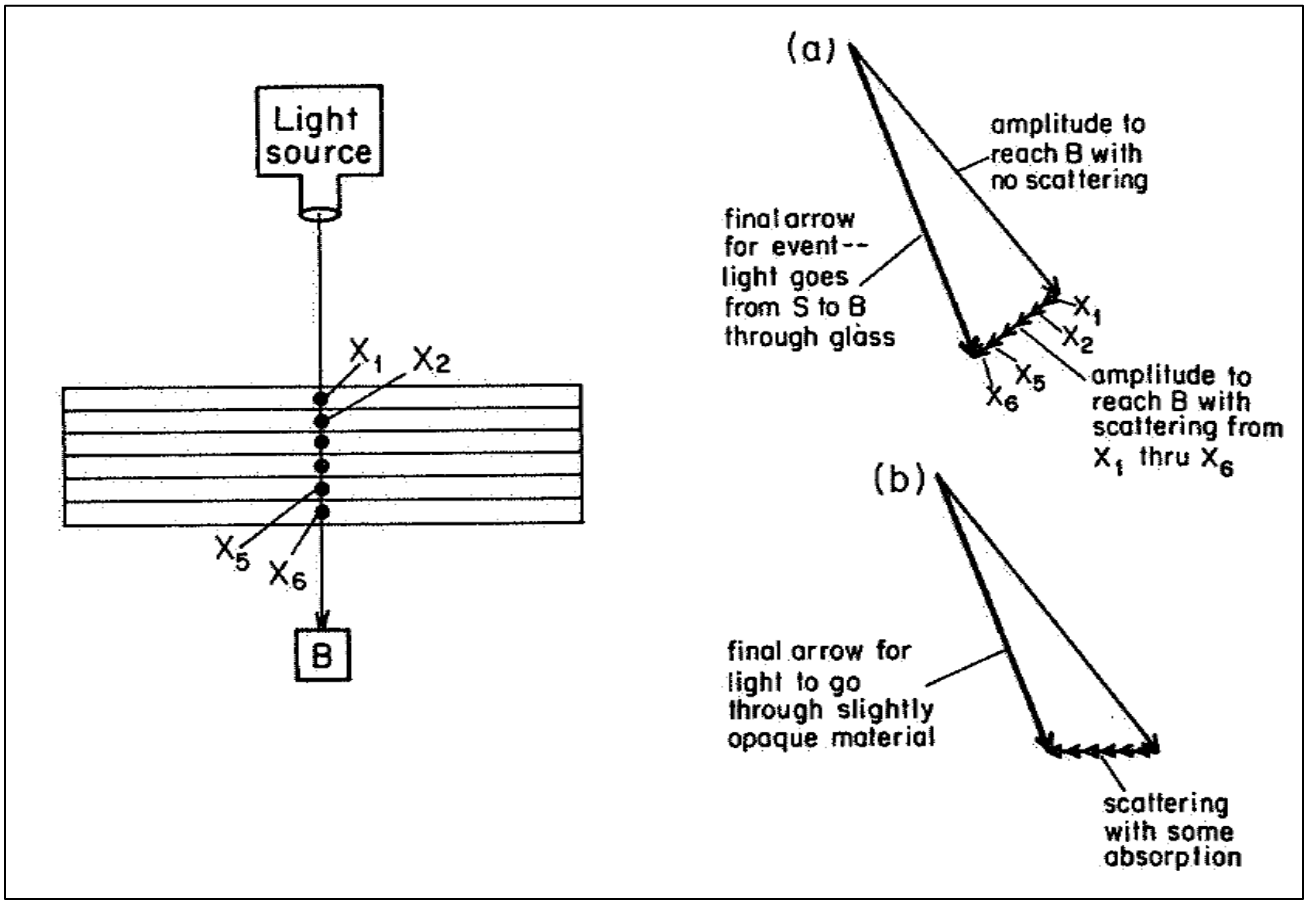


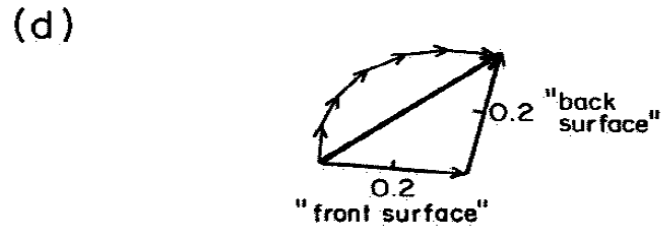
Transmission



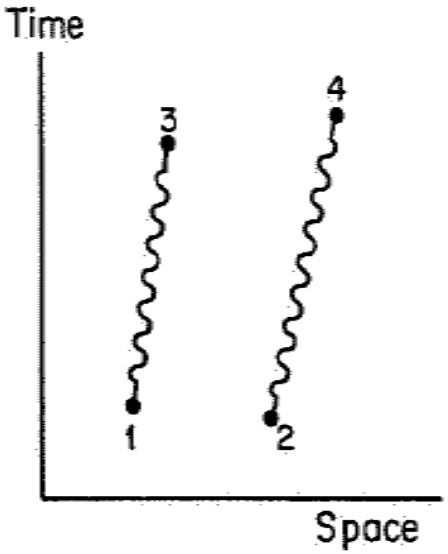


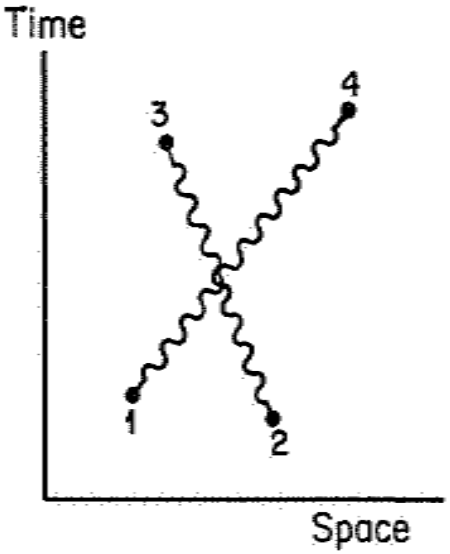


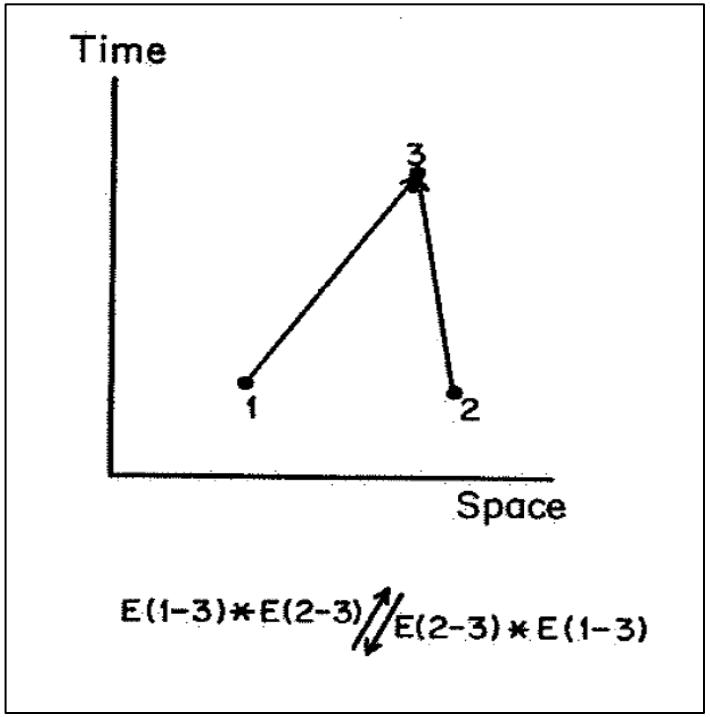


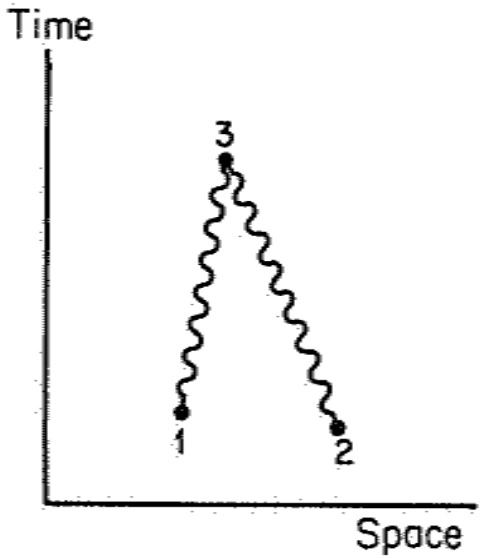


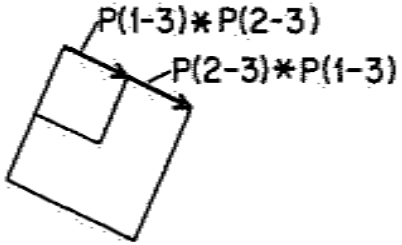
Lasers and chemistry



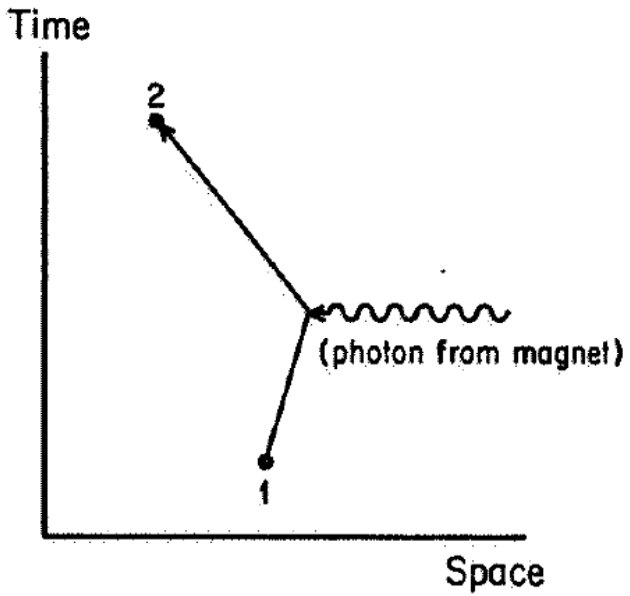


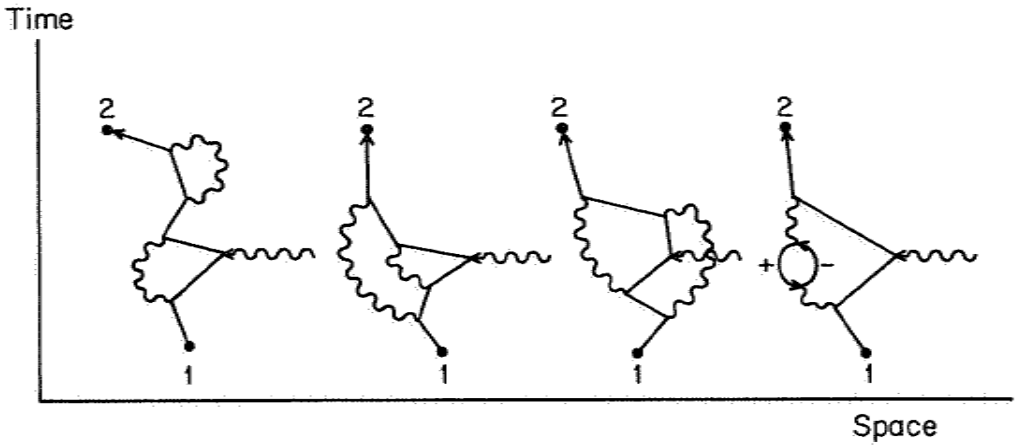


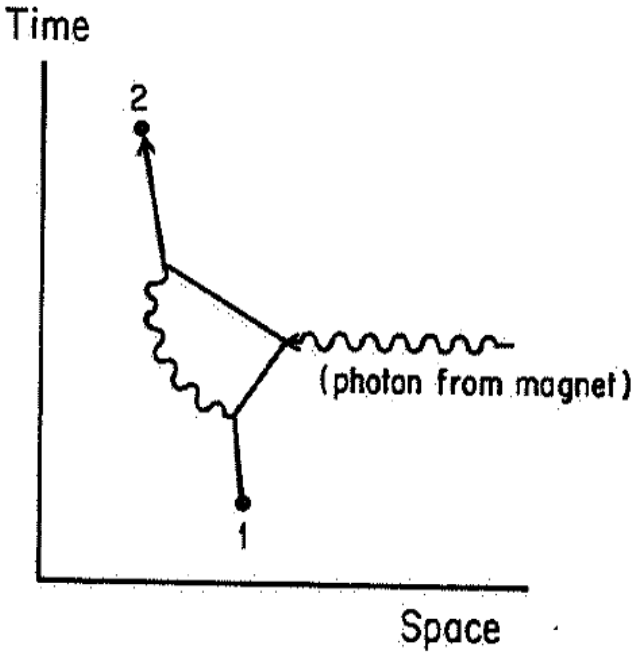


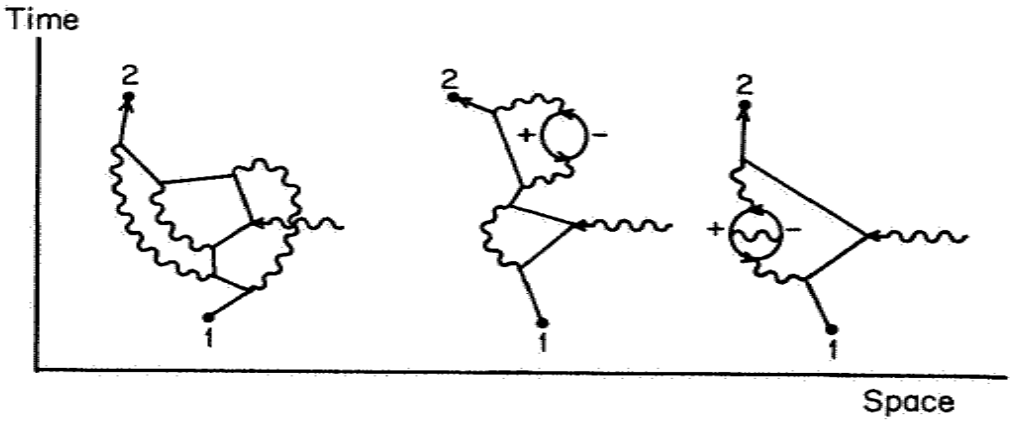


Magnetic moment of electron









Theory: 1 159 652 182.79 (±7.71) × 10^{-12}
(PRD **77** 053012 (2008))
Experiment: 1 159 652 180.85 (±0.76) ×10^{-12}
(http://en.wikipedia.org/wiki/Precision_tests_of_QED)

QED works!