Diffraction

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Thursday, May 4, 2006

Outline

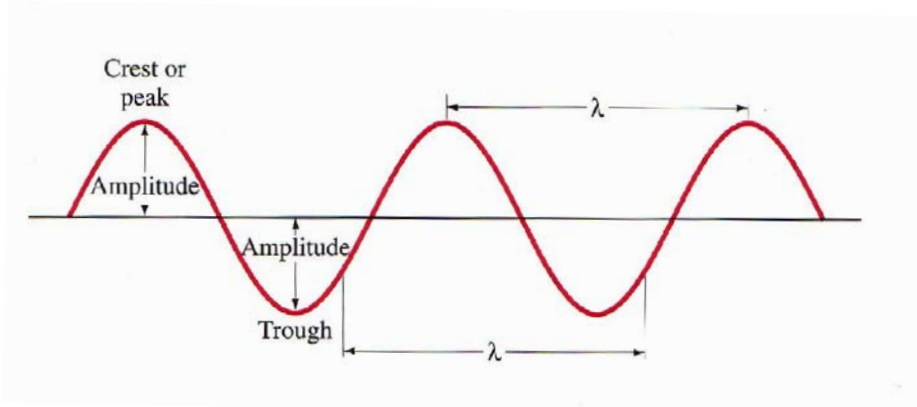
- Introduction
  - Waves
  - Light
- Multiple Slit Diffraction and Interference
  - Double Slit
  - Diffraction Grating
- Activity
  - Diffraction Grating
  - CD
  - DVD
- Resolution
- Conclusion

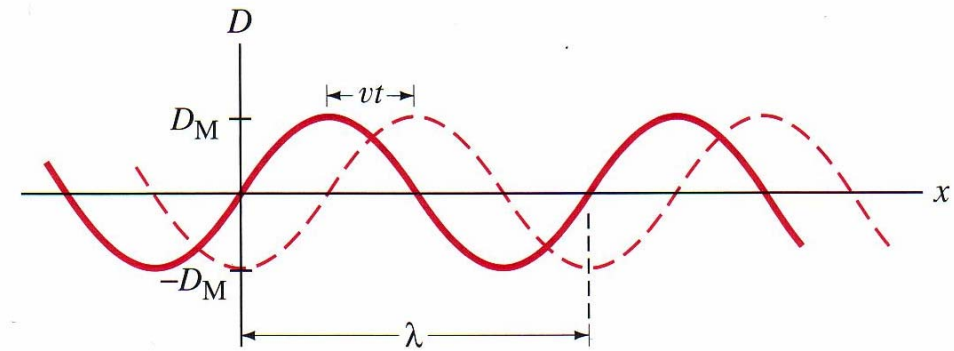
Waves

Frequency – the number of complete cycles that pass a given point per unit time

Period – the time required for one complete cycle of a wave to pass a given point along the line of travel

$$v = f\lambda \qquad f = \frac{1}{T}$$





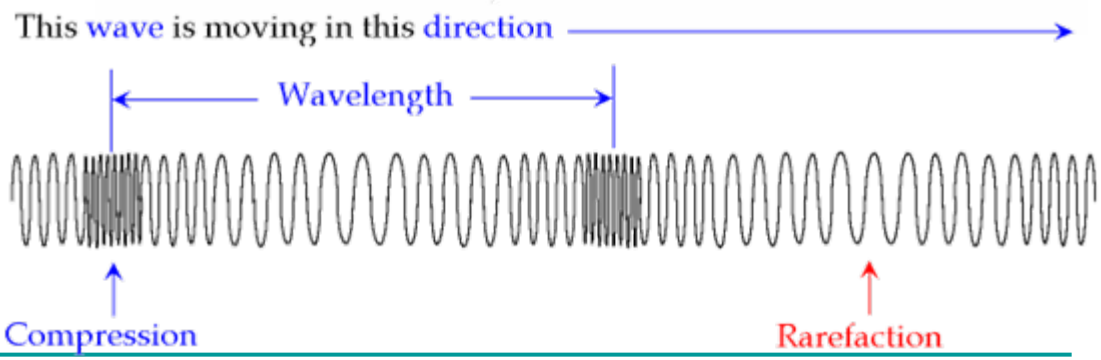


Diagram Source (upper right): D. C. Giancoli, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 2000).

Light

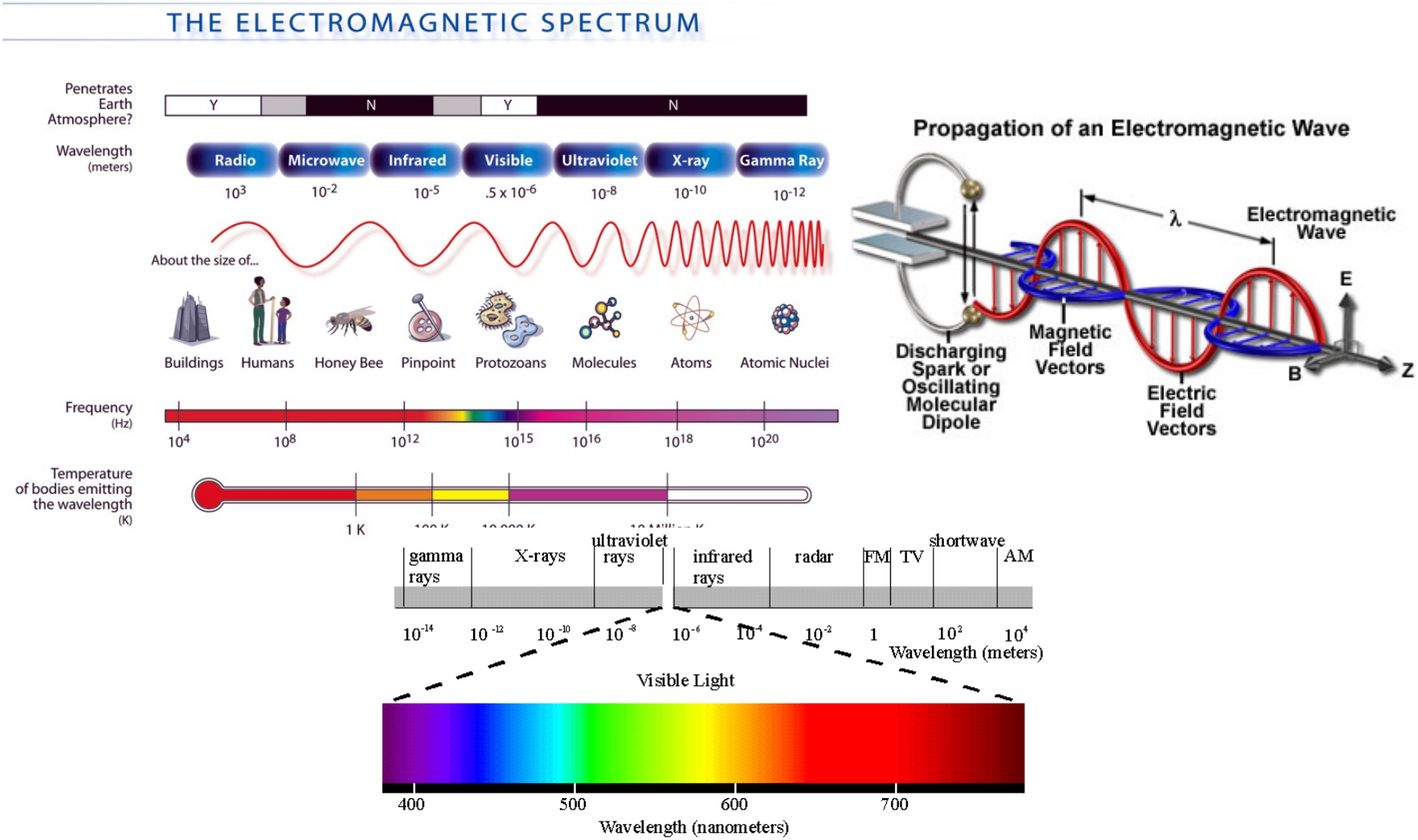


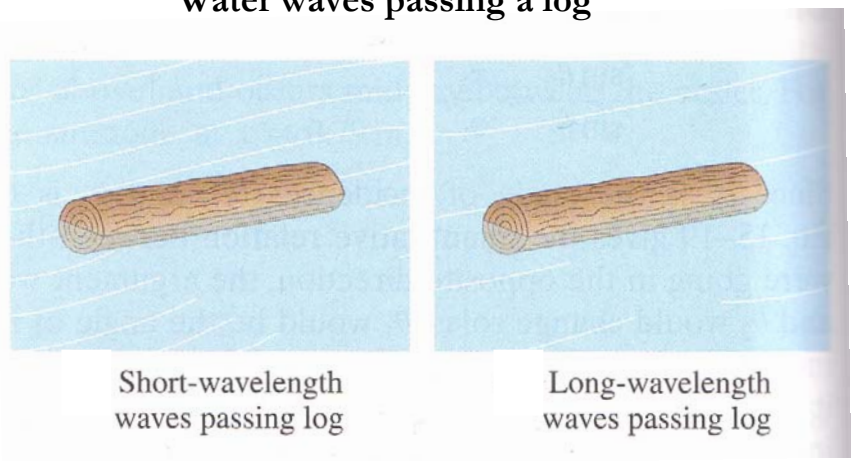
Diagram Source (upper right): Molecular Expressions Optical Microscopy Primer, http://micro.magnet.fsu.edu/primer/index.html

Diffraction

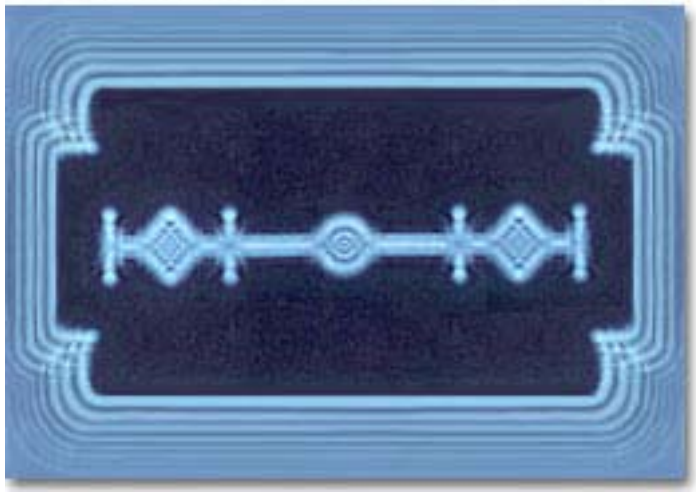
Diffraction – The spreading of light into a region behind an obstruction

Diffraction is more pronounced when the wavelength is smaller than the size of the obstruction or slit

Water waves passing a log



Light Diffraction by a Razor Blade



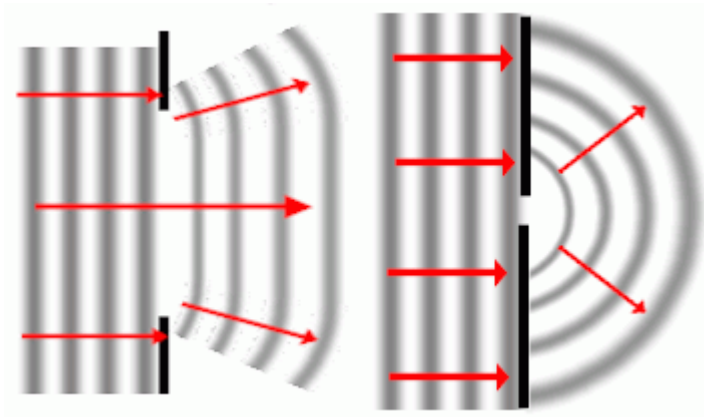
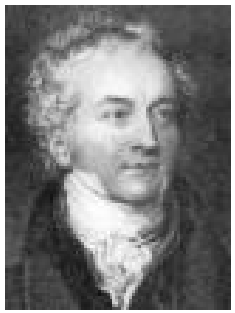
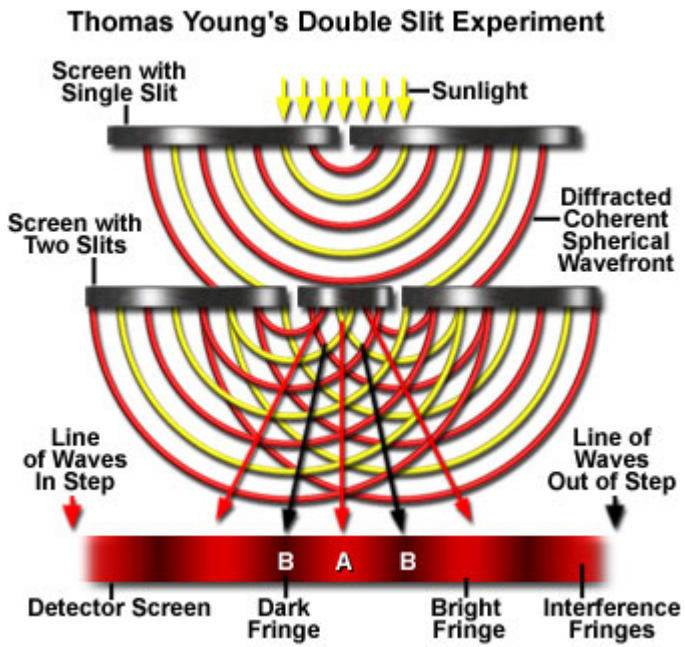


Diagram Source (lower left): D. C. Giancoli, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 2000).

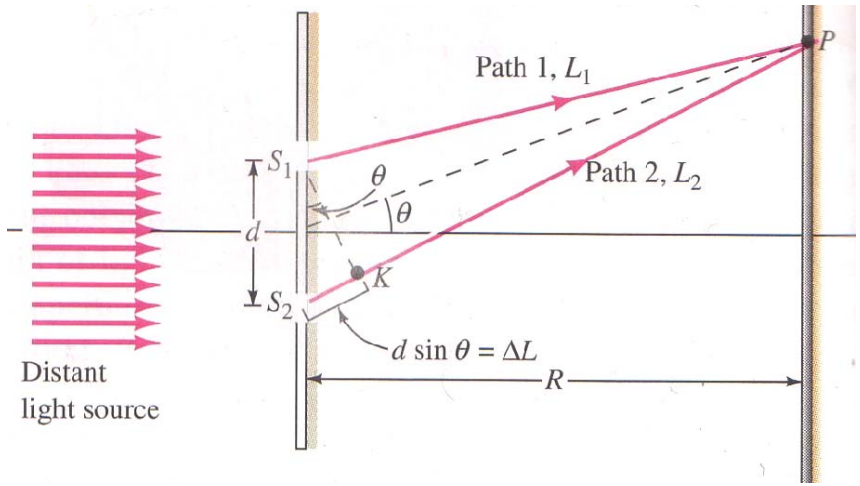
Double Slit Experiment



Thomas Young



The geometry used to find the interference pattern conditions for the light that reaches point P



Constructive interference

$$\Delta L = m\lambda$$

$$d\sin\theta = m\lambda$$

Destructive interference

$$\Delta L = d\sin\theta$$

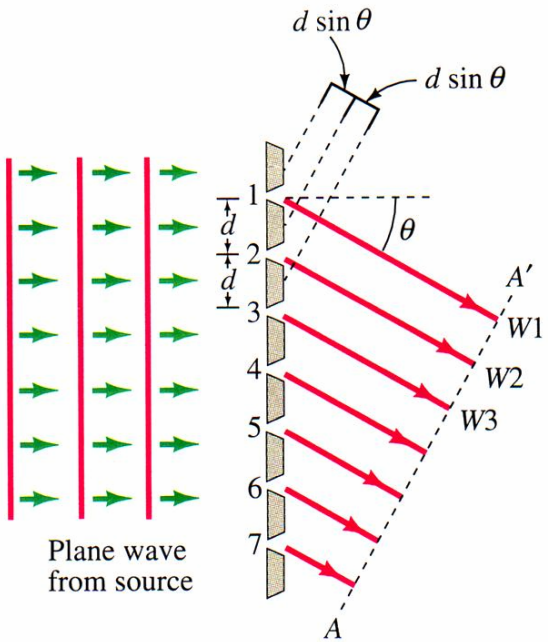
$$d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$$

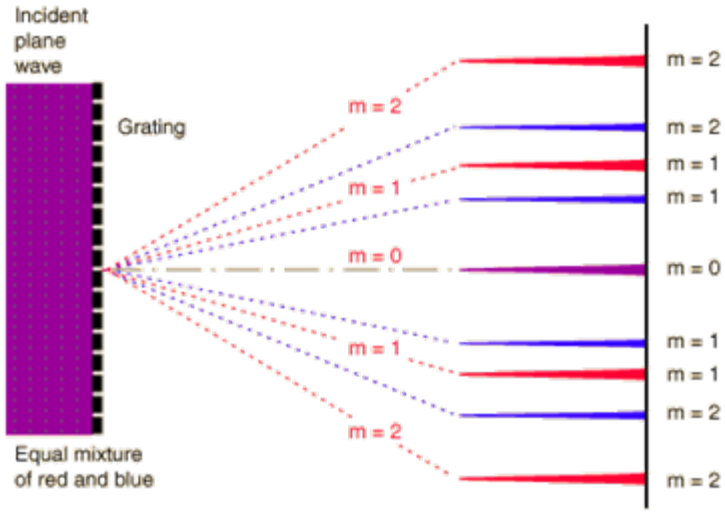
Diagram Source (left): Molecular Expressions Optical Microscopy Primer, http://micro.magnet.fsu.edu/primer/index.html

Diagram Source (right): P. M. Fishbane, S. Gasiorowicz, and S.T. Thornton, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 1996).

Diffraction Grating

The geometry of a diffraction grating





More slits leads to higher and sharper principal maxima

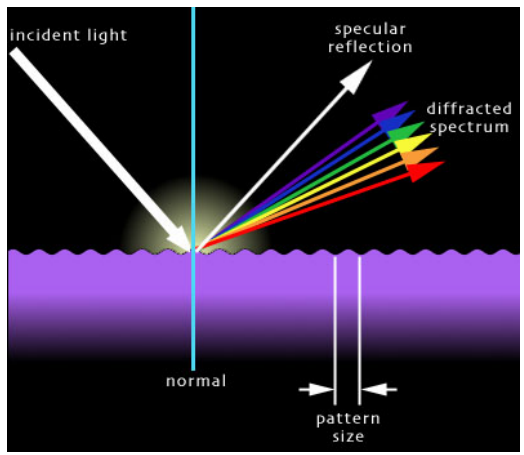
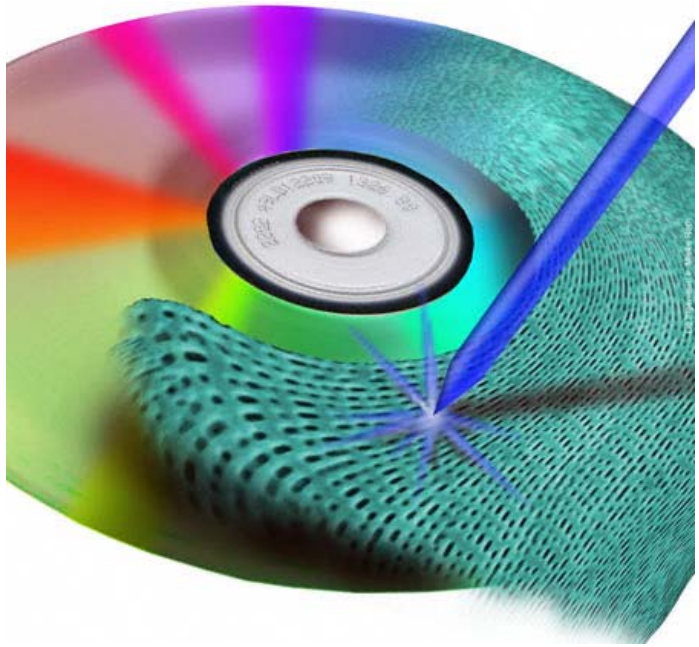


Diagram Source (left): P. M. Fishbane, S. Gasiorowicz, and S.T. Thornton, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 1996).

Diagram Source (upper right): HyperPhysics Concepts, http://hyperphysics.phy-astr.gsu.edu/Hbase/hph.html

Image Source (lower left): Wikipedia, www.wikipedia.com

CD



View of a track through the polycarbonate layer

Memory: 650-700 MB

CD is read with a 780 nm laser

The wavelength of the laser is selected so that he height difference between pits and lands leads to destructive interference between light reflected off a pit and light reflected off a land.[5]

Side view of a CD

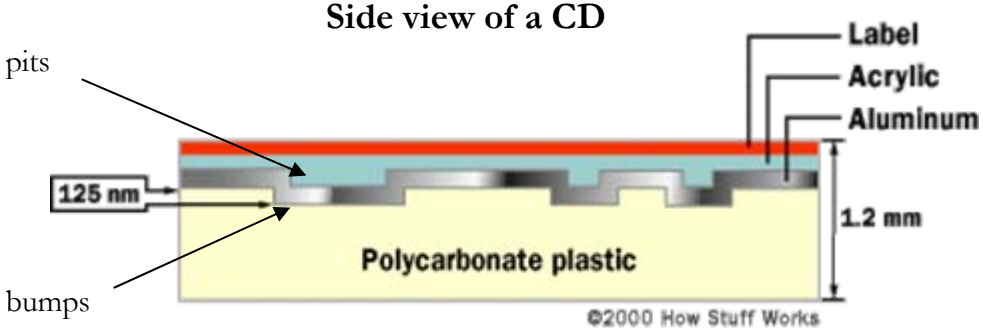
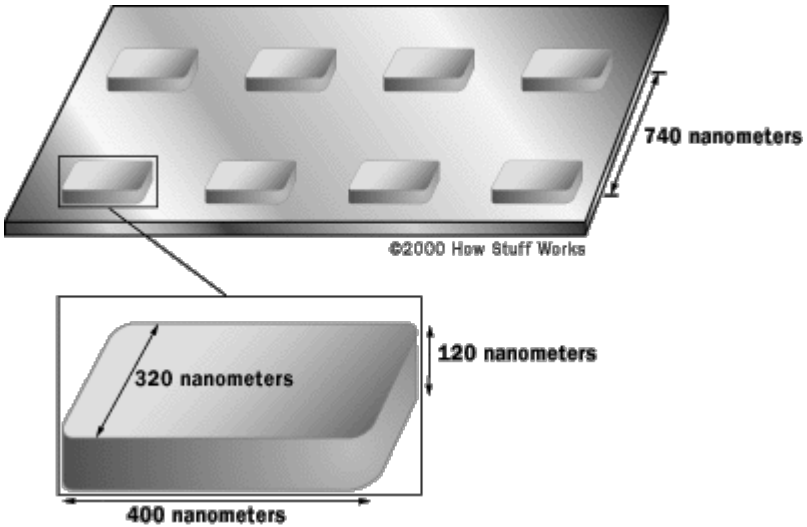


Diagram Source (lower left and upper right): How Stuff Works, www.howstuffworks.com

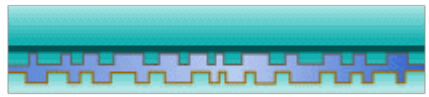
DVD

View of a track through the polycarbonate layer

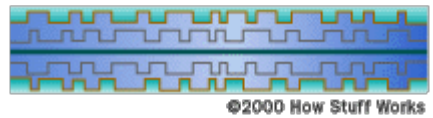


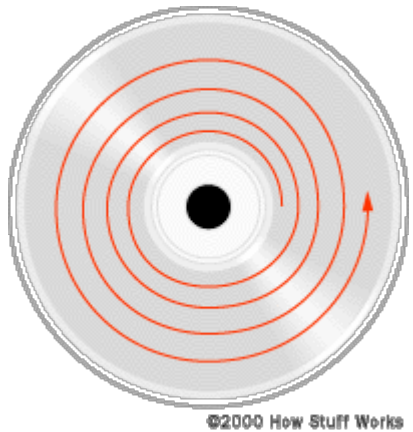
Single-sided, single layer (4.7GB)

Single-sided, double layer (8.5GB)



Double-sided, double layer (17GB)





Memory: 4.7-17 GB

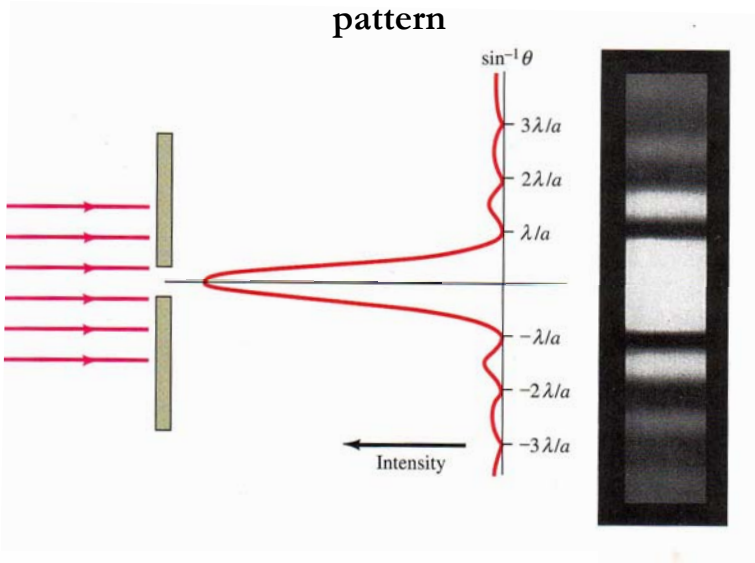
DVD is read with a 640 nm laser

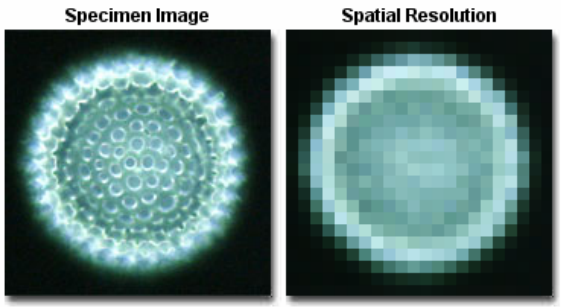
Diagram Source: How Stuff Works, www.howstuffworks.com

Resolution

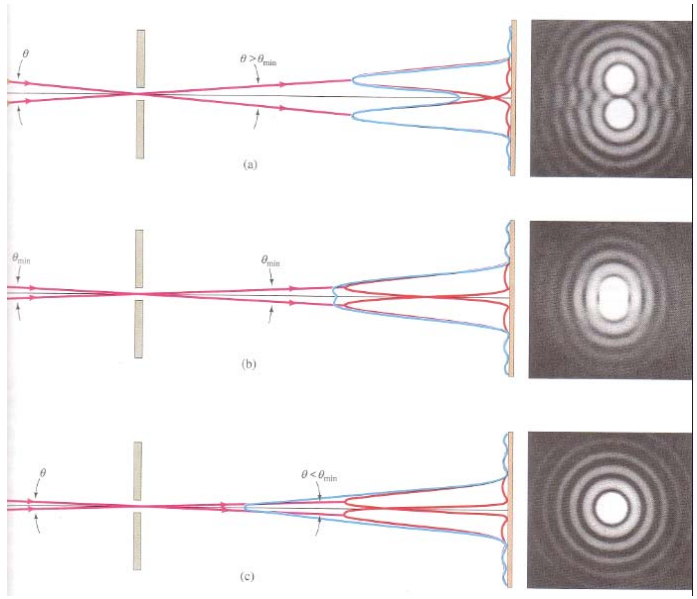
A smaller wavelength leads to better resolution!

The interference pattern of single-slit diffraction and the relative intensities of such a pattern





Light from two sources passes through an aperture



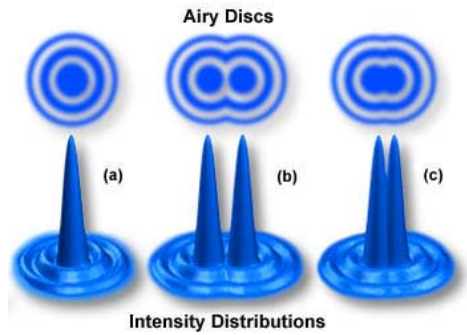


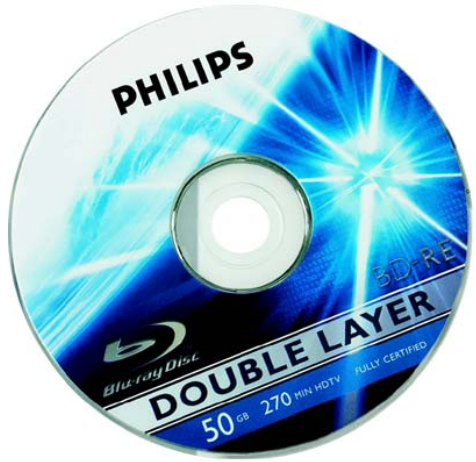
Diagram Source (top two): P. M. Fishbane, S. Gasiorowicz, and S.T. Thornton, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 1996).

Diagram Source (bottom two): Molecular Expressions Optical Microscopy Primer, http://micro.magnet.fsu.edu/primer/index.html

Resolution


PS2


PLAYSTATION 3


PHILIPS
BD-RE
Blu-ray Disc
DOUBLE LAYER
50 GB
270 MIN HDTV
FULLY CERTIFIED


XBOX


XBOX 360


HD DVD
HD DVD
HD DVD
30GB
Dual Layer
TOSHIBA

Conclusion

- Diffraction – the spreading of light into a region behind an obstruction
- All waves can be diffracted, not just light waves
- Wave diffraction affects us every day!

References

1. D. C. Giancoli, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 2000).
2. Molecular Expressions Optical Microscopy Primer, http://micro.magnet.fsu.edu/primer/index.html
3. P. M. Fishbane, S. Gasiorowicz, and S.T. Thornton, Physics for Scientists and Engineers, Volume I (Prentice Hall, Upper Saddle River, 1996).
4. HyperPhysics Concepts, http://hyperphysics.phy-astr.gsu.edu/Hbase/hph.html
5. Wikipedia, www.wikipedia.com
6. How Stuff Works, www.howstuffworks.com