20.DyeTech

Friday, November 08, 2019 2:55 PM

SPECIFIC FV techniques

Boundary techniques. Boundary between 'seeded' and unseeded fluid.
Choice depends on physics desired
I DYES **Today**. Mostly in water.
Light/matter interactions in general
2 Index of refraction techniques
3 Light emitting fluids
4 Particles. In air (aerosols, fog, smoke)
5 Particles in water

2)Want dye to show up - HIGH VISIBILITY

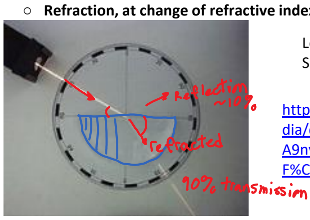
High Visibility: Want good contrast between dyed and ambient fluid.

Ambient fluid = transparent = NO interaction with light
Dyed fluid = want MAXIMUM interaction with light
Example: Alberto Seveso:
http://www.burdu976.com/phs/portfolio/2-colori-disatro-medicina/

Minute paper: list the ways that dye (or any molecule) can interact with light (from external source, later will talk about emitted light)

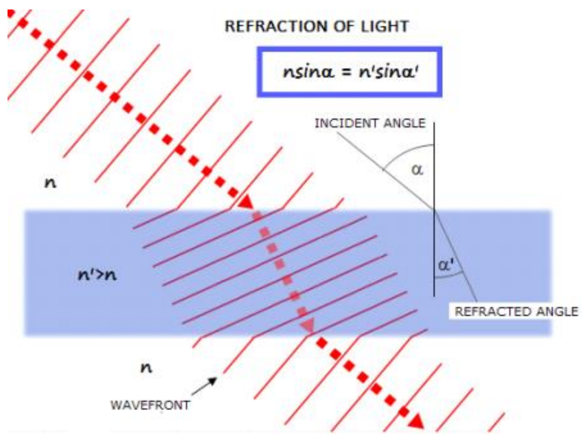
Refraction	Emission
Absorption	Fluorescence
Diffraction	Excitation
Reflection	
Scattering/diffusion	
Transmission	
Dispersion	

1) **Transmission**
   - **Refraction, at change of refractive index**



Lecture 02 Overview2
Snell's law

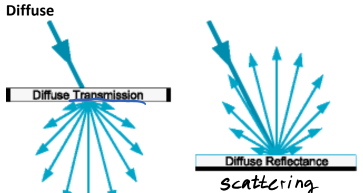
http://upload.wikimedia.org/wikipedia/commons/thumb/1/13/F%C3%A9nyt%C3%B6r%C3%A9s.jpg/220px-F%C3%A9nyt%C3%B6r%C3%A9s.jpg



https://www.telescope-optics.net/reflection.htm

There are many flow vis techniques based on refraction; will cover later.

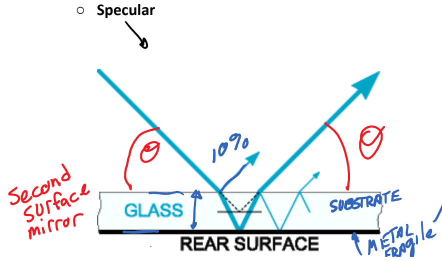
   - **Diffuse**

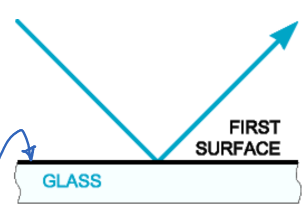


Diffuse transmission and reflectance.
http://library.thinkquest.org/26162/manili.htm

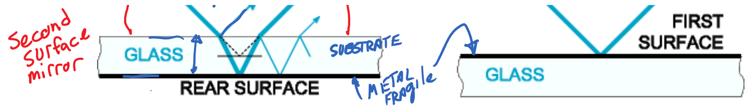
2) **Reflectance**
   - **Diffuse, scatter**
   - **Specular**

Edmund Scientific





http://library.thi

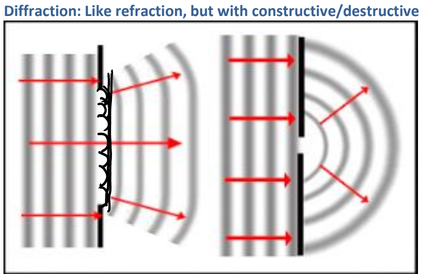


Reflection from a second surface and first surface mirror.

http://library.thinkquest.org/26162/manili.htm

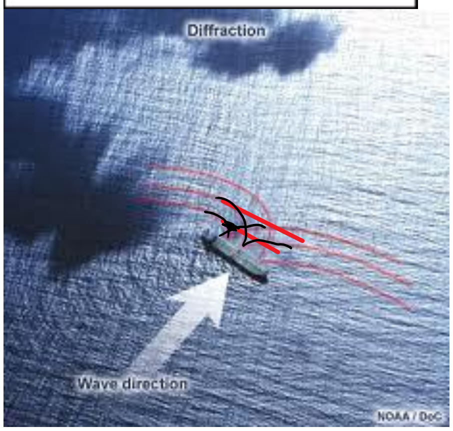
3) Diffraction: Like refraction, but with constructive/destructive interference

Fraunhofer diffraction, for incoming plane waves
Fresnel diffraction, for incoming spherical waves (light source very close)

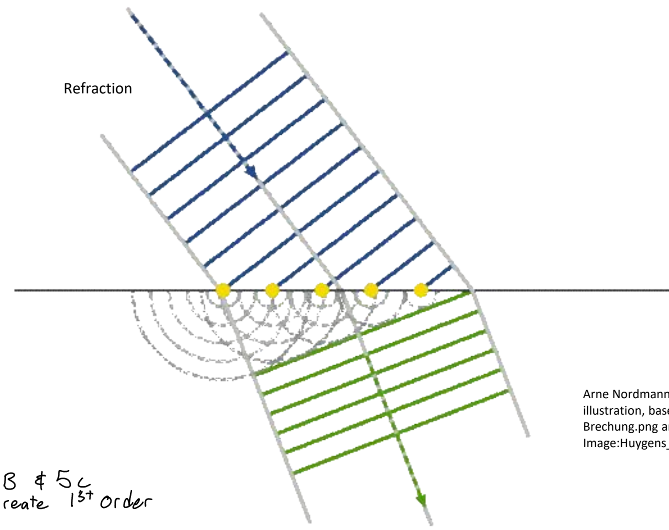


HUYGEN

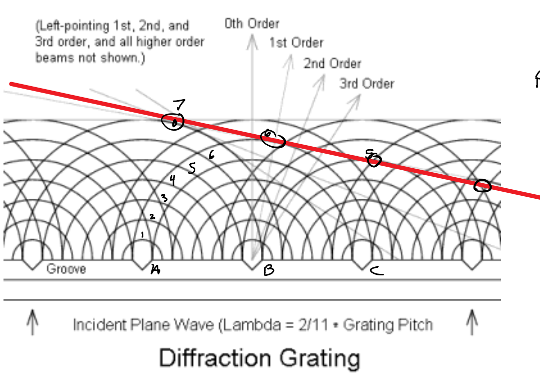
http://www.meted.ucar.edu/marine/ripcurrents/NSF/media_gallery.php



http://www.meted.ucar.edu/marine/ripcurrents/NSF/media_gallery.php



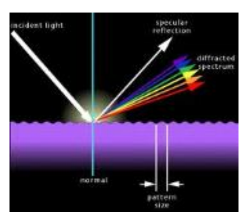
Arne Nordmann (norro) - Own illustration, based on Image:Wellen-Brechung.png and Image:Huygens_brechung.png



Peaks 7A, 6B & 5c line up to create 1st order

http://exoplanet.as.arizona.edu/~lclose/a302/lecture14/lecture_14.html

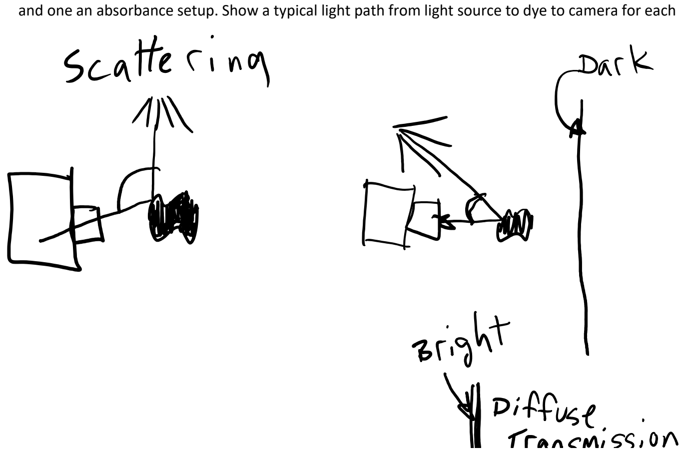
Dispersion

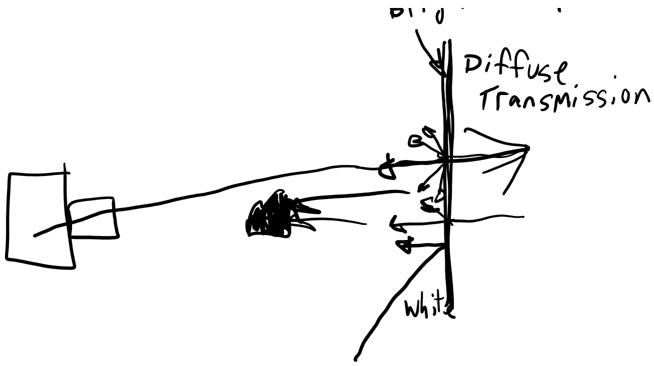


1st orders

https://wiki.metropolia.fi/display/Physics/Diffraction

Minute Paper:
Sketch two setups showing how light interacts with dye: One a scattering setup (the dye scatters light), and one an absorbance setup. Show a typical light path from light source to dye to camera for each



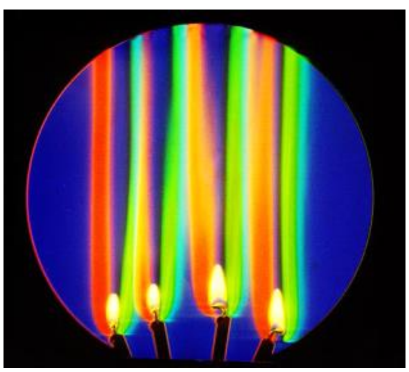


Dyes: water soluble
propylene glycol

Index of refraction techniques

Requires no seed. Can visualize differences and gradients in temperature and chemical concentration,
as both change the index of refraction of the media.
Examples first, then techniques discussed in detail: schlieren and shadowgraphy

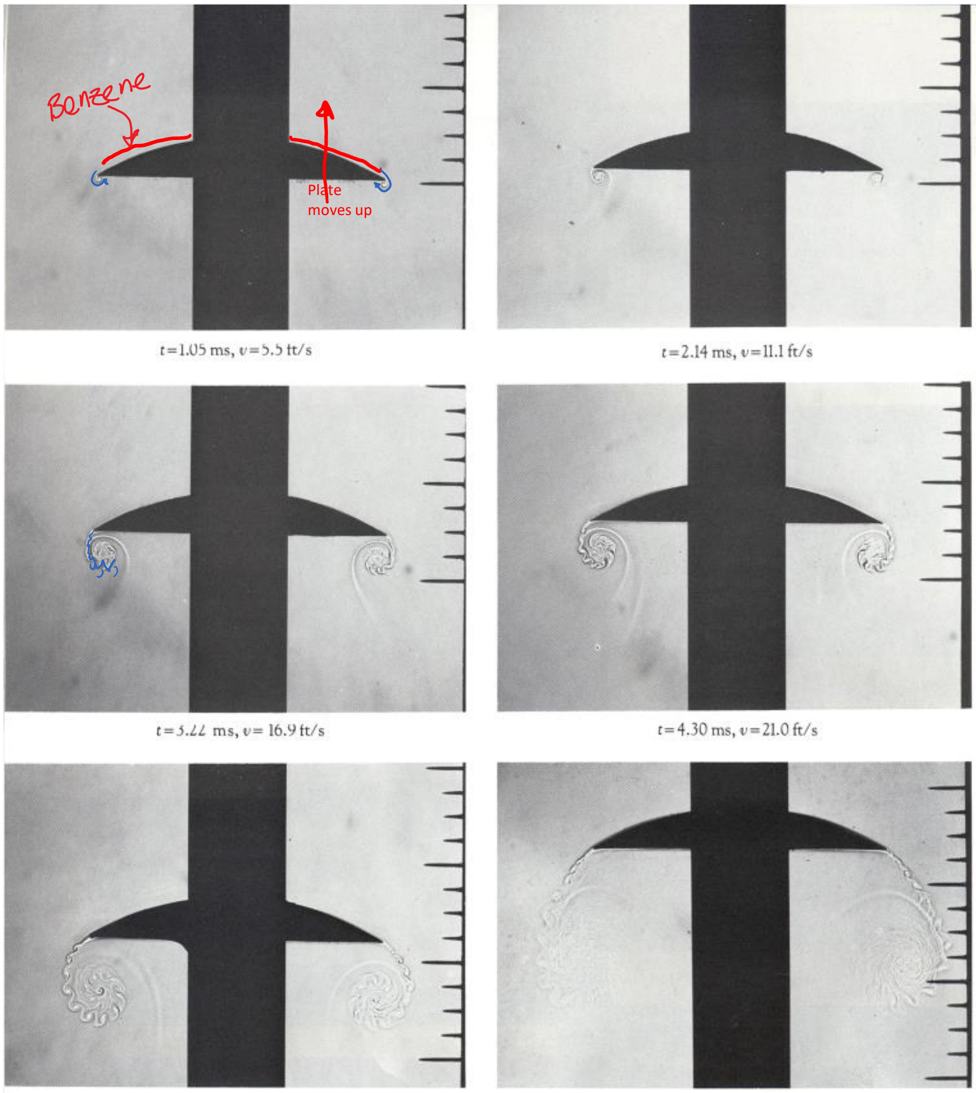
Color schlieren



Pasted from <http://www.compadre.org/informal/images/features/schlierenlarge-11-29-06.jpg>

Andrew DAVIDHAZY (retired now),
RIT = Rochester Institute of Technology,
offers engineering and BS through PhD in
Imaging Science.

SHADOWGRAPH



$t = 1.05$ ms, $v = 5.5$ ft/s

$t = 2.14$ ms, $v = 11.1$ ft/s

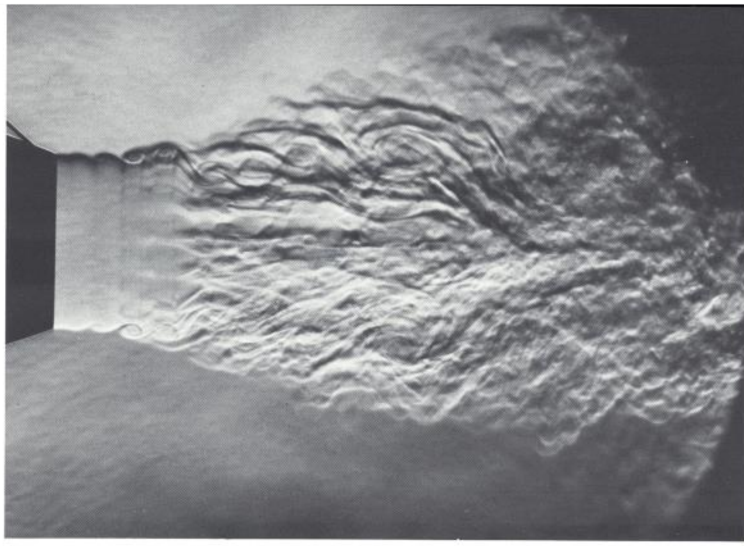
$t = 3.22$ ms, $v = 16.9$ ft/s

$t = 4.30$ ms, $v = 21.0$ ft/s

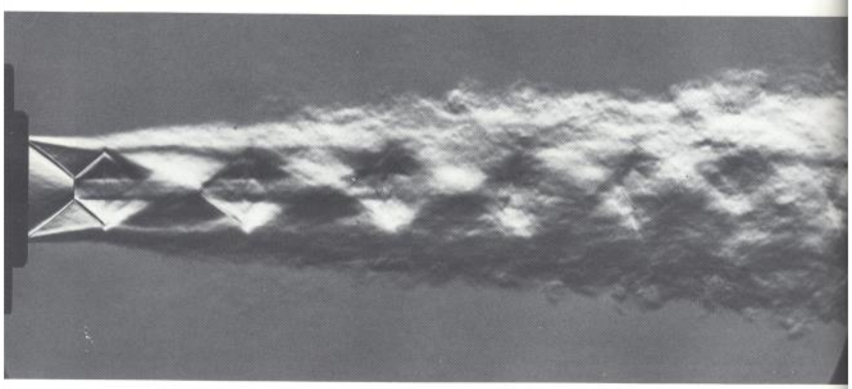
$t = 6.53$ ms, $v = 24.0$ ft/s

$t = 10.66$ ms, $v = 24.0$ ft/s

81. Growth of vortices on an accelerated plate. Spark shadowgraphs show the history of a 3-inch-square plate in air, accelerated from rest to 24 ft/s. The sharp edge of the plate is initially opposite the first of a series of pins spaced ¼ inch apart. The motion is actually vertical, and the flow is visualized by painting a narrow band of benzene across the center of the balsa-wood plate, so that when the plate accelerates benzene vapor is drawn into the vortex sheet. The difference in density between the vapor and the air makes the paths of their boundaries visible. Care was taken to ensure that the undulations observed in the vortex sheet were not caused by vibrations of the model. *Pierce 1961*

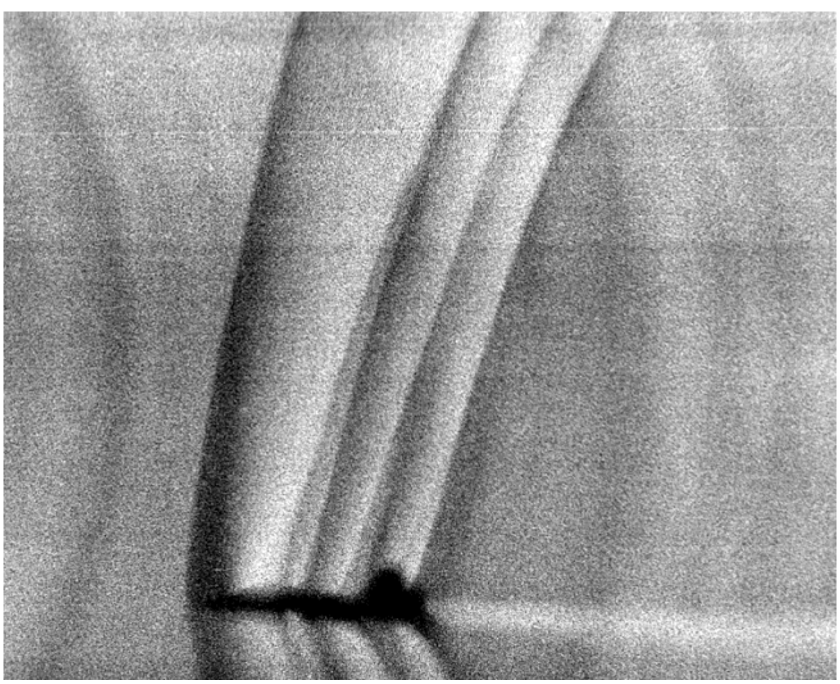


167. Subsonic jet becoming turbulent. A jet of air from a nozzle of 5-cm diameter flows into ambient air at a speed of 12 m/s. The laminar interface becomes unstable as in figure 102, and the entire jet eventually becomes turbulent. *Bradshaw, Ferriss & Johnson 1964*



168. Supersonic jet becoming turbulent. At a Mach number of 1.8 a slightly over-expanded round jet of air adjusts to the ambient air through a succession of oblique and normal shock waves. The diamond-shaped pattern persists after the jet is turbulent. *Oertel 1975*

98



Pasted from <http://commons.wikimedia.org/wiki/File:Schlieren_photograph_of_T-38_shock_waves.jpg>

Mach 1.1, full size T-38 in flight, 1993. L. Weinstein, NASA
example of Background Oriented Schlieren (BOS). Correlate patterned background from image to get schlieren

http://fuckyeahfluiddynamics.tumblr.com/post/47622561173/this-high-speed-video-shows-schlieren-photography

CO_2 bottle rocket video. Shows Mach diamonds and expansion fans.

How it works:

http://www.npr.org/2014/04/09/300563606/what-does-sound-look-like
Michael Hargather, New Mexico Tech

speed of light

$$\eta = \frac{C_{VACUUM}}{C_{MEDIUM}}$$

eetah

n = index of refraction

Light is deflected towards more dense medium

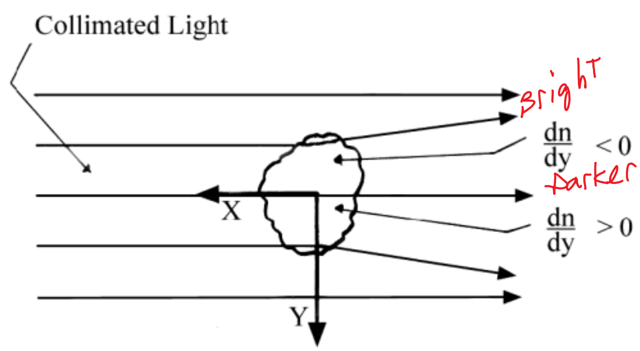


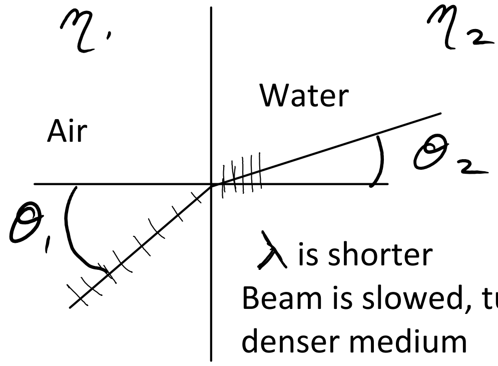
Figure 1. Disturbance in Collimated Beam

Shadowgraphy:
constructive and destructive interference from disturbed parallel light

$$\frac{1}{\eta}\frac{\partial \eta}{\partial y} = \frac{\partial^2 y}{\partial x^2}$$

curve of disturbed line = $y(x)$

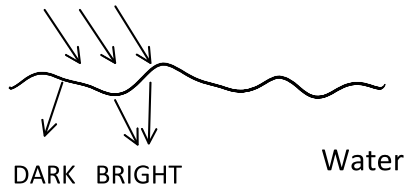
SNELL'S LAW



λ is shorter
Beam is slowed, turns into, i.e towards the denser medium

like a caustic

sunlight



http://www.shutterstock.com/video/clip-3174052-stock-footage-dappled-pool-water-ripple-background-swimming-pool-water-abstract-background-with-seamless-loop.html