03.Overview2 Refractive index, lighting

8/25/2022

Today

Admin

Previsualization: Have a goal, think about what you want it to look like.
Make CHOICES:

1. Flow phenomenon: Water boiling? Faucet dripping?
2. Visualization technique: Add dye? See light distorted by air/water surface?
   a. Seeded Boundary
   b. Refractive Index
   c. Particle Tracking
3. Lighting: Continuous? Strobe? Sheet?
4. Image acquisition: Still? Video? Stereo? Time lapse? High speed?
5. Post processing, final output. Edit, at least crop the image and set contrast.

Admin

Syllabus and copyright agreements due. On pile, or in Canvas.
Office hours: 10 minutes before and after class, and by appointment?
Demonstration: How To Post
https://www.youtube.com/watch?v=R6iD1yf0mqc Suggested by Will Harris

Overview Continued: Types of Flow Vis

Seeded Boundary Technique

http://www.colorado.edu/MCEN/flowvis/galleries/2009/Team-1/FV_popup1-21.htm

Lucy Dean, Joseph Duggan, Tim Jarrell, Melissa Lucht

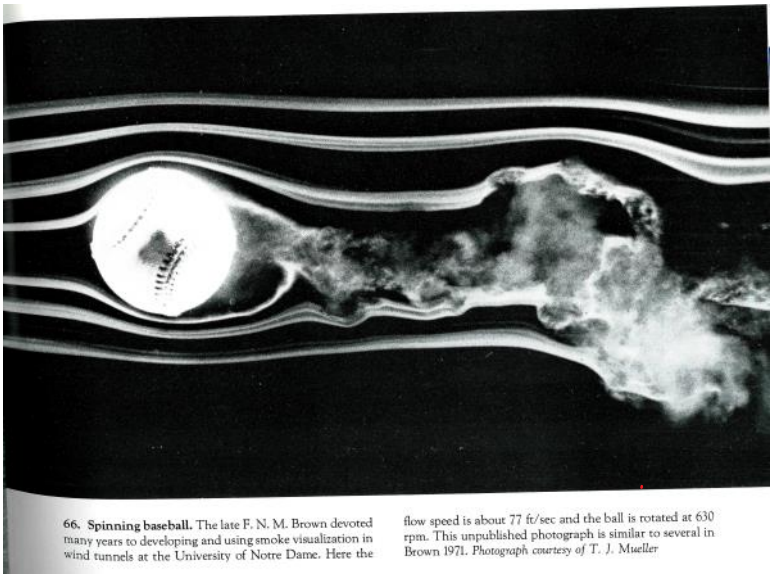
White gas (naptha) pool flame.
Team 1 Spring 2009

Light emission shows hot soot region
Black body radiation: Red to yellow to white

Blue = specific emission from C_2 or CH radicals

Seeded boundary technique is characterized by dense seeding, can't see individual particles:

Food dye = food coloring
Hydrogen bubbles (in water)
Smoke
Water droplets (clouds, fog, vape)



66. **Spinning baseball.** The late F. N. M. Brown devoted many years to developing and using smoke visualization in wind tunnels at the University of Notre Dame. Here the flow speed is about 77 ft/sec and the ball is rotated at 630 rpm. This unpublished photograph is similar to several in Brown 1971. *Photograph courtesy of T. J. Mueller*

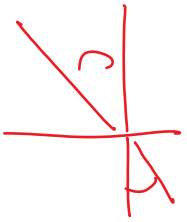
Van Dyke, Milton. *Album of Fluid Motion*. 10th ed. Parabolic Press, Inc., 1982.
Everybody who does fluid mechanics owns a copy. I have three. Out of print now.
http://courses.washington.edu/me431/handouts/Album-Fluid-Motion-Van-Dyke.pdf

In conclusion, this is a relatively easy technique.
Remember, choose environmentally benign fluids: foods, personal care products. No chemicals down the drain here.

b. Index of refraction techniques

Minute paper, in groups: What is the index of refraction?

$\frac{Vel_1}{Vel_2}$ $\frac{V_{med}}{C}$



Index of refraction = refractive index = η = eetah = $\frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}} = \frac{c}{v} = \frac{\lambda_{vacuum}}{\lambda_{medium}}$

η always > 1

η = 1.5 for glass
= 1.3 for water, plexiglas, approximately
=1.00029 in air

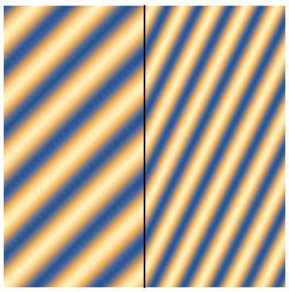
Frequency and color do not change.
Speed slows in a denser medium and wavelength shrinks

$V = \lambda f$

$= [L][\frac{1}{t}]$

$\frac{L}{t}$

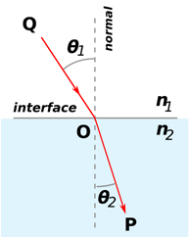
https://upload.wikimedia.org/wikipedia/commons/5/5c/Snell_law.gif



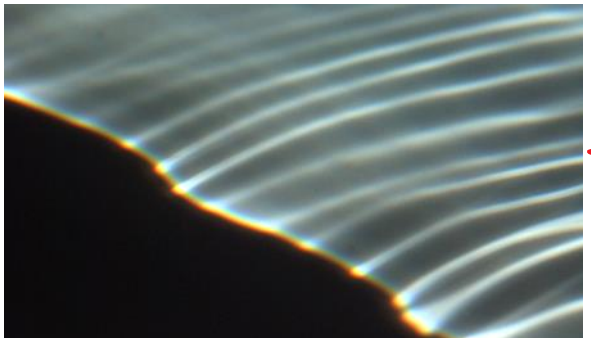
SNELL'S LAW

$\frac{\eta_1}{\eta_2} = \frac{\sin\theta_2}{\sin\theta_1}$

← Here, $\eta_1 < \eta_2$ →



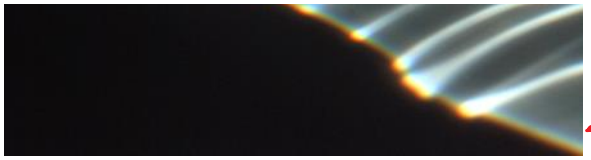
Specific techniques: schlieren, shadowgraphy, interferometry, holography,
Free liquid/gas surfaces, thin film effects (soap bubbles), oil on puddles



CAUSTICS

DISPERSION

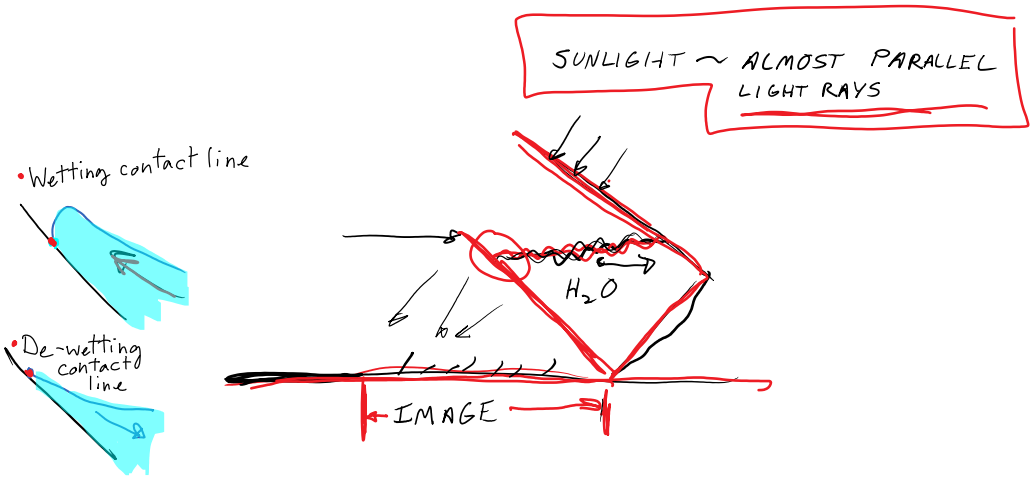
$\eta(f)$ depends on frequency of



Pasted from <http://www.colorado.edu/MCEN/flowvis/galleries/2007/assignment4/Hnath.jpg>

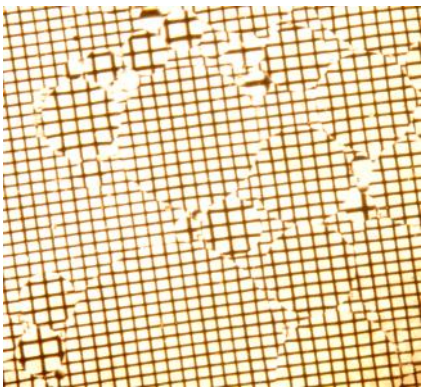
A rectangular tank, partially filled with water, was tipped on edge. Sunlight projected through the waters' edge to the ground, resulting in Moiré interference patterns : CAUSTICS.

Owen Hnath, Gordon Browning, Tracy Eliasson, Travis Gaskill, Trisha Harrison 2007



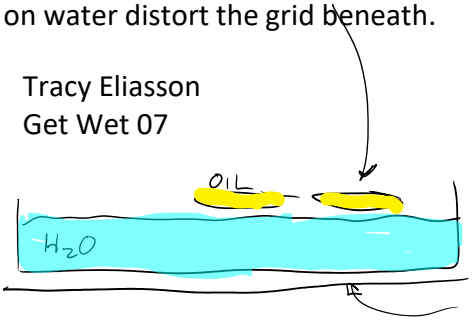
Contact line: solid, fluid and gas meet together. Mathematically makes a singularity; very interesting to applied math folks.

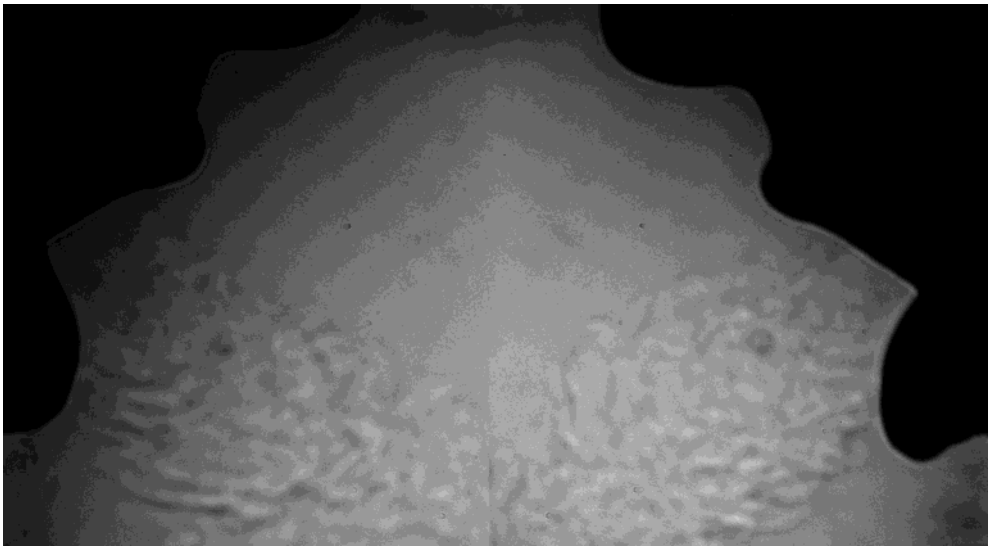
Inserted from: <file://C:\Users\hertzber\Documents\01CLASSES\FlowVis\StudentWork07\GetWet\Eliasson\GetWet.tif>



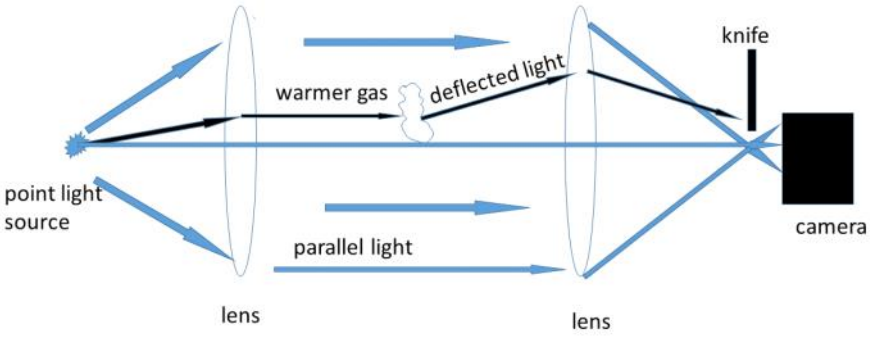
Liquid lenses formed by oil floating on water distort the grid beneath.

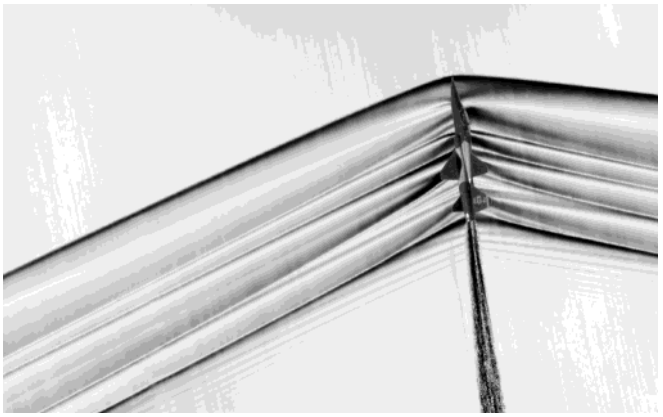
Tracy Eliasson
Get Wet 07





Schlieren composite of two human exhalations. Owen Hnath, Group Alpha, Team 3, Fall 2007
http://www.colorado.edu/MCEN/flowvis/galleries/2007/assignment6.html





BOS=Background Oriented Schlieren
Uses sky light, and distance to get parallel light
Aircraft: T-38, F-18 or F-15

http://www.nasa.gov/centers/armstrong/features/shock_and_awesome.html