05 Overview B

Friday, September 8, 2023 12:45 PM

Today:

- Admin
- Finish techniques overview
- Lighting

Admin

- Monday: Download and install Darktable for image processing. https://www.darktable.org/ . Virtual light table for organizing your still images and darkroom for modifying them. Open source, please make a donation.
- BOW due now. Vote on BOW Monday midnight.
- Office hours: Here after class and by appointment. Quicker answers on Slack. Plus, other students may have the same questions, or know the answer.
- Three minutes in breakout. Show your cameras. Talk about your BOW, Get Wet or Clouds 1 progress

Overview:

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; rheoscopic
    c. Particle Tracking
3. Lighting (source of worst image problems). Match to vis technique.
4. Image acquisition: Still? Video? Stereo? Time lapse? High speed?
5. Post processing, final output. Edit, at least crop the image, consider contrast. We'll skip ahead to this Monday and Weds.

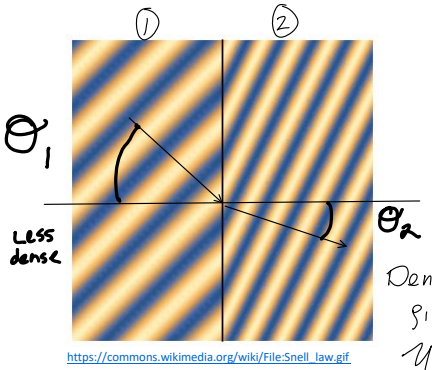
Index of refraction = refractive index = η = eetah = $\frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}} = \frac{c}{v} = \frac{\lambda_{vacuum}}{\lambda_{medium}}$

η

η always > 1

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

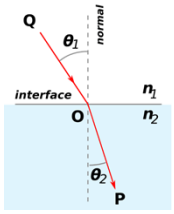
https://upload.wikimedia.org/wikipedia/commons/5/5c/Snell_law.gif



https://commons.wikimedia.org/wiki/File:Snell_law.gif

SNELL'S LAW

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

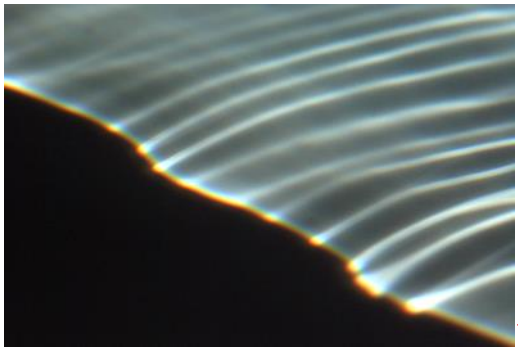


Denser
$\rho_1 < \rho_2$
$\eta_1 < \eta_2$

In a denser medium:
Speed slows down, direction changes, wavelength shrinks but frequency and color do not change.
Photon energy stays the same.

vel wavelength freq
$V = \lambda f$
$= [L][\frac{1}{t}]$
$\frac{L}{t}$

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



CAUSTICS

DISPERSION

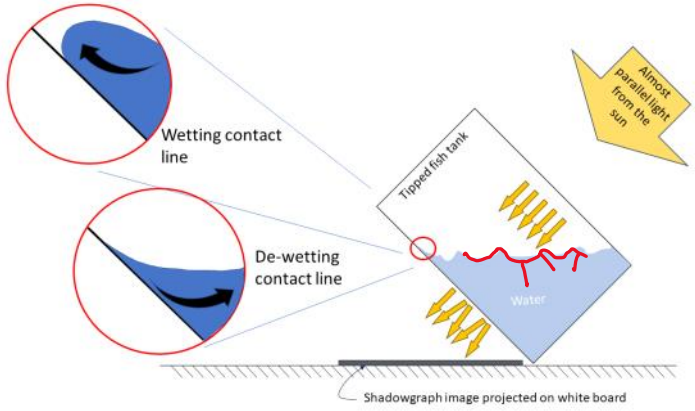
$n(f)$

depends on frequency of light

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

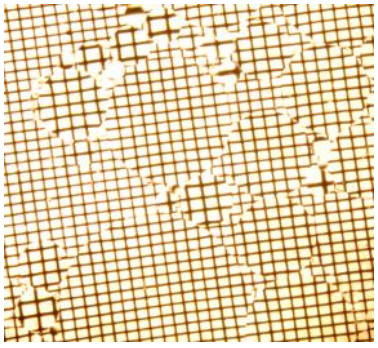
A rectangular tank, partially filled with water, was tipped on edge. Sunlight projected through the waters' edge to the ground, resulting in Moiré interference patterns : CAUSTICS.

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

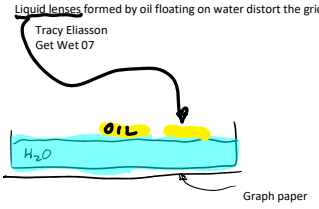


https://www.flowvis.org/Flow%20Vis%20Guide/refractive-index-techniques/

Contact line: solid, fluid and gas meet together. Simple model mathematically makes a singularity; very interesting to applied math folks. Now more sophisticated theories:
Wang, Hao. "From Contact Line Structures to Wetting Dynamics." *Langmuir* 35, no. 32 (August 13, 2019): 10233–45. https://doi.org/10.1021/acs.langmuir.9b00294.



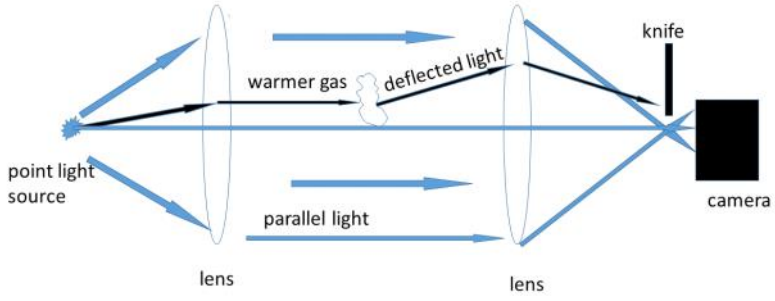
Liquid lenses formed by oil floating on water distort the grid beneath.

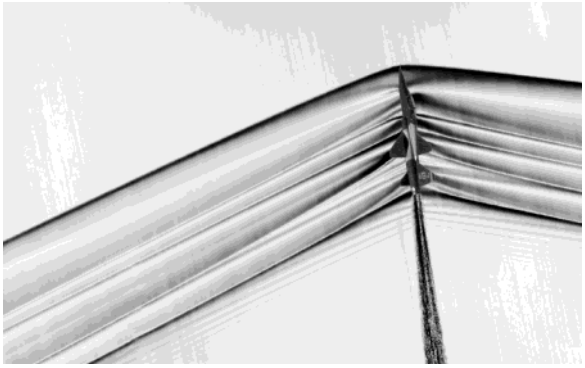


Inserted from: <file://C:\Users\hertzber\Documents\01CLASSES\FlowVis\StudentWork07\GetWet\Eliasson\GetWet.tif>

Acoustic Shockwaves Exiting A Trumpet Bell

schlieren





BOS=Background Oriented Schlieren
Uses sky light, and distance to get parallel light
Subtracts out background (earth's surface in this case, view is looking down) and renders distortions as b/w
Aircraft: T-38 Talon

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

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Rheoscopic Fluids

An in-between technique. Mostly qualitative
Low contrast, doesn't often show physics

Rheoscopic means 'current showing'
http://www.stevespanglerscience.com/pearl-swirl-rheoscopic-concentrate.html
'Pearl Swirl' $5/gallon
Shiny opaque or translucent particles, crystal flakes, ~10 µm size, aligns with shear gradient. Used in soaps, shampoos
Kalliroscope used to be the only available type, made from fish scales.

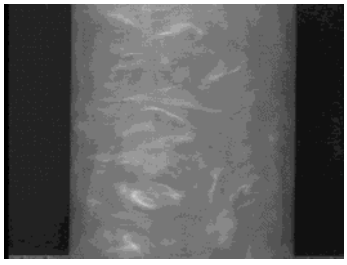
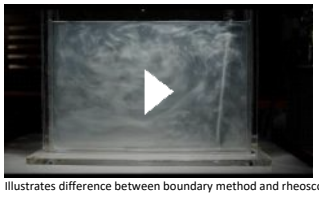


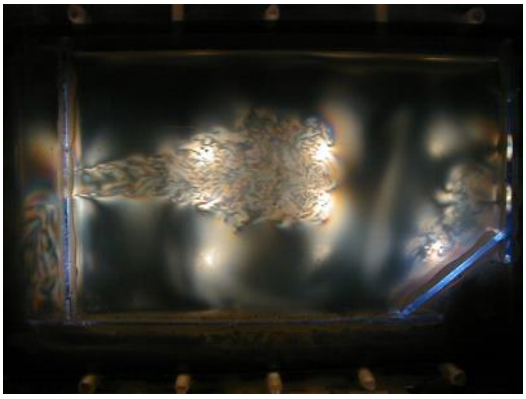
Image credit http://buphy.bu.edu/~duffy/thermo/4B20_77.html

Convection Cell "Sea Breeze" Visualization
https://www.youtube.com/watch?v=22zVmRYOW10



Illustrates difference between boundary method and rheoscopic

Easy to make from shaving cream: stearic acid crystals
Borrero-Echeverry, Daniel, Christopher J. Crowley, and Tyler P. Riddick. "Rheoscopic Fluids in a Post-Kalliroscope World." *Physics of Fluids* 30, no. 8 (August 1, 2018): 087103. https://doi.org/10.1063/1.5045053.



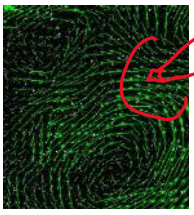
Streaming birefringence
'Blackstock fluid' has 2 indices of refraction
Suspension of microscale mica flakes.

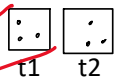
http://www.laminarsciences.com/

c. Particle tracking techniques

Individual particles are seen. Can be qualitative or quantitative (Particle Image Velocimetry, PIV).
Two images made, close together in time
http://fiji.sc/wiki/index.php/File:Surface_wave.gif

Rayleigh-Bénard





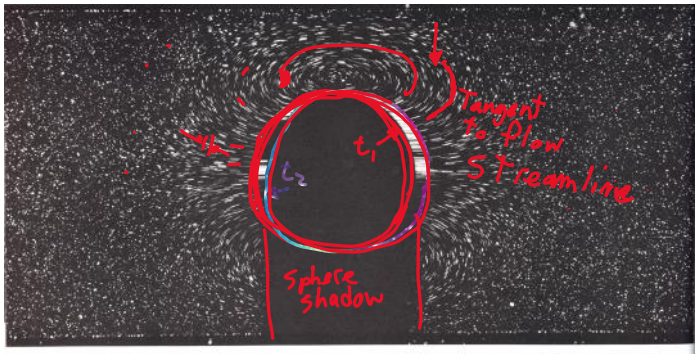
Cross-correlation gives displacement vector

$\frac{\Delta \vec{x}}{\Delta t}$ = VELOCITY

Pasted from <http://www.google.com/images?q=particle+image+velocimetry&hl=en&client=firefox-a&hs=NUI&rls=org.mozilla:en-US:official&prmd=ivnsb&source=lnms&tbs=isch:1&ei=9CY3TcyNH8L7lweQ2uSMAw&sa=X&oi=mode_link&ct=mode&cd=2&ved=0CBAQ_AUoAQ&biw=993&bih=412>

Or, with motion blur, length of track can indicate speed.

From Van Dyke's Album of Fluid Motion



9. Sphere moving through a tube at $R = 0.10$, absolute motion. In contrast to the photograph above, here the camera remains fixed with respect to the distant fluid. During the exposure the sphere has moved from left to right less than a tenth of a diameter, to show the absolute motion of the fluid. At this small Reynolds number the flow pattern, shown by magnesium cuttings in oil, looks completely symmetric fore-and-aft. *Coutanceau 1968*

Length scale Reynolds

$Re = \frac{\rho U d}{\mu}$

Dynamic or absolute viscosity

$\nu = \frac{\mu}{\rho}$ (nu)

Kinematic viscosity. Scaled by density.

$Re = \frac{Ud}{\nu} = \frac{\text{momentum}}{\text{viscous}}$

Re< 2000 or so flow is LAMINAR, smooth, in layers. Viscosity is important
Re> 2000 or so flow is TURBULENT, full of eddies, much mixing.
Momentum is important, viscosity not so much.
https://www.omnicalculator.com/physics/reynolds-number
Makes units, fluid properties easy.
Everybody should do this for their reports.

Good particles in water:
Small glitter particles: Pearl-Ex. Sold as iridescent pigment in art supply stores. McGuckin's or Guiry's, at Pearl and Folsom.
Pearl-Ex is mineral (TiO2 coated mica), not plastic, maybe safer for environment. Don't breathe it, or any dust, or get it in your eyes.

Streamline
=everywhere TANGENT
Close together = fast flow

Lighting

Continuous vs Strobe

Continuous: Good for video or long time exposure, particle tracks

Sunshine

Almost parallel light rays. Various availability. Hot.

Incandescent light bulbs: Hot, smooth, no flicker, continuous spectrum

A) I have owned or purchased incandescent light bulbs
B) I have seen them
C) I'm not sure, it's hard to tell them from LEDS
D) No, I've always had either LEDs or CFL/fluorescents

Fluorescents:

flicker @120 hz, specific wavelengths blended to look white-ish. Cool.

Hazmat to dispose of.

LEDs:

Need a high quality power supply to avoid flicker

Laser:

Diode lasers give single, pure color. Coherent, narrow beam, can be spread into sheet with a cylindrical lens.
SAFETY IS A BIG ISSUE. Eyes are easy to damage permanently. Training available.

Strobe = Flash: Good for still images

"Freezes" motion

Strobes and Speedlights

AKA 'electronic' flash.
Xenon flashtube technology 1931.
Common in studios and built into cameras (but NOT cellphones)
Durations: 1 to 10 microseconds (1/100,000 to 1/10,000 sec)
More powerful than cellphone flash

LED Strobes

Found on cellphones. Low power, small size. Specs not available.
Big LED strobes in red and blue are used on emergency vehicles.

Pulsed Lasers

Durations as short as femtoseconds (10^-15, a millionth of a billionth of a second.
Picosecond (10^-12) common for tattoo removal, but low power.
Nanosecond (10^-9) common for micromachining and flow vis, good power, 100mJ per pulse. Very dangerous...