

Today:

Admin

*particle tracking*

Choices in imaging: Index of refraction, Lighting, Imaging

Admin

Please make a table tent with your name on it. Write Large and dark! Bring to class every day. Thanks!

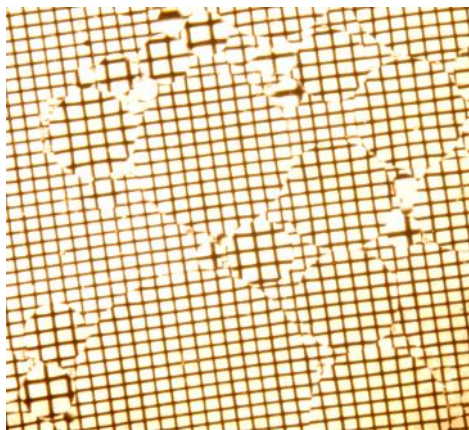
*both sides*



- Best of Web due now! Do ASAP if you haven't. Cyron will start checking this afternoon. Next, read through everybody else's and award your prizes (1st, 2nd, 3rd) in the comments. Awards due Friday Feb 2.
- One request: if you are posting a video from YouTube please add the following code to the end of the Youtube link: ?rel=0
- When posting, watch out for homonyms: words that sound the same but are spelled differently with different meaning. Roll is not role.

## Overview Continued: Types of Flow Vis Index of Refraction techniques

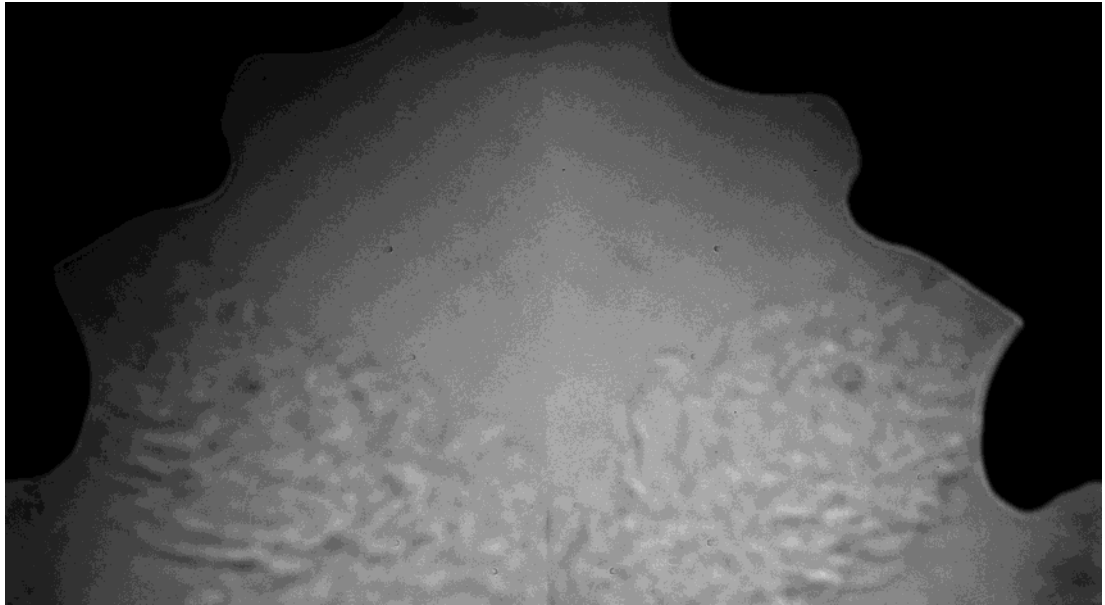
Inserted from: <file:///C:/Users/hertzber/Documents/01CLASSES/FlowVis/StudentWork07/GetWet/Eliasson/GetWet.tif>



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>

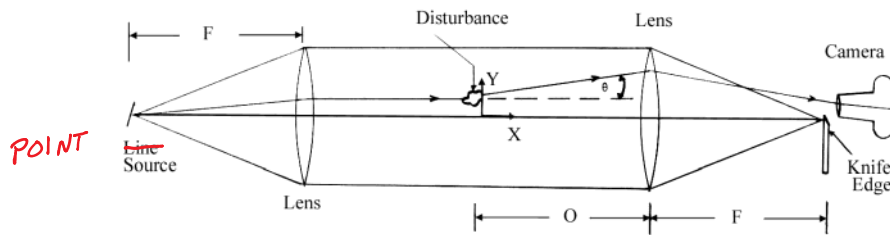
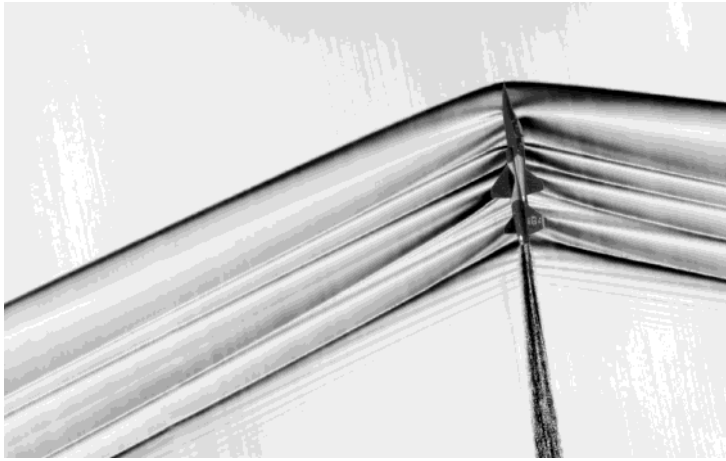


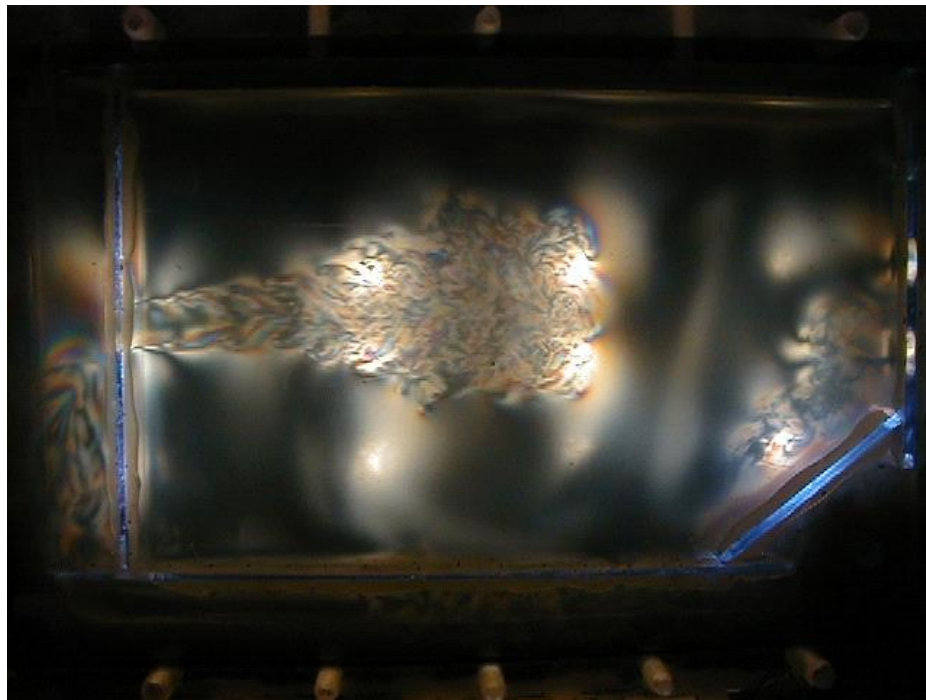
Figure 3. Schlieren System with a Small Disturbance

Copyright J. Kim Vandiver, 2002



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



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

<http://www.laminarsciences.com/>

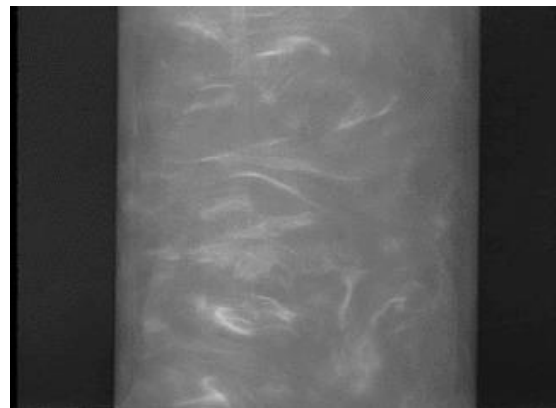
## Rheoscopic Fluids

<http://www.stevespanglerscience.com/pearl-swirl-rheoscopic-concentrate.html>

'Pearl Swirl' \$5/gallon  
 Shiny opaque or translucent particles, crystal flakes, ~  
 10  $\mu\text{m}$  size, aligns with shear gradient. Used in soaps,  
 shampoos  
 Kalliroscope also sells it.

<https://www.youtube.com/watch?v=vrTM9O6owII>

Check out the Taylor Couette Instability demo in the



<https://www.youtube.com/watch?v=VF1M9U60WII>

Check out the Taylor Couette Instability demo in the ITLL Lobby. Tall blue column.



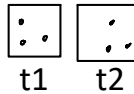
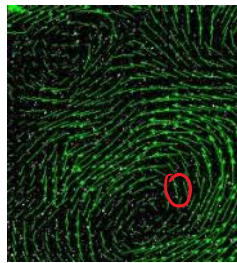
<http://buphy.bu.edu/~duffy/thermo/4B2077.html>

### c. Particle tracking techniques

Individual particles are seen. Can be qualitative or quantitative (Particle Image Velocimetry, PIV).

Two images made, close together in time

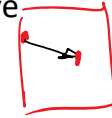
[http://fiji.sc/wiki/index.php/File:Surface\\_wave.gif](http://fiji.sc/wiki/index.php/File:Surface_wave.gif)



Divide image into subwindows

Cross-correlation give displacement vector

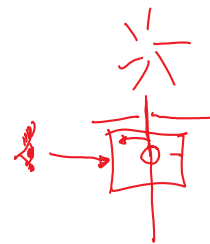
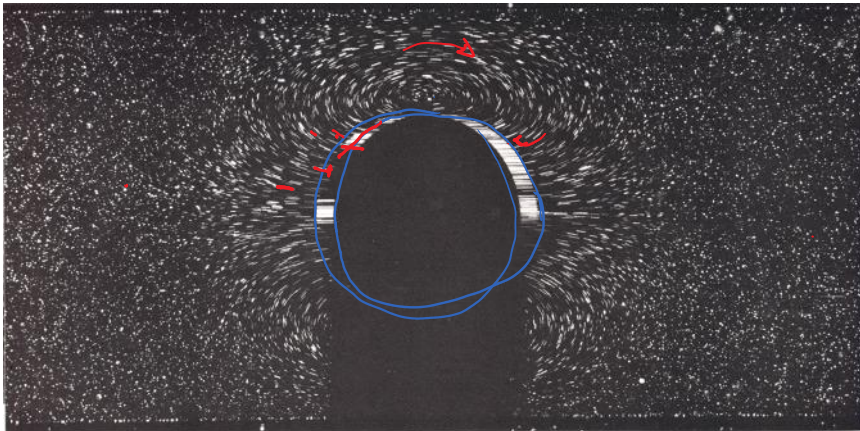
$$\frac{\Delta \vec{x}}{\Delta t} = \text{VELOCITY}$$



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=0CBAQAUoAQ&biw=993&bih=412](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=0CBAQAUoAQ&biw=993&bih=412)

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

From Van Dyke's Gallery 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. Coustancau 1968

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, not plastic, maybe safer for environment. Don't breathe it, or any dust, or

get it in your eyes.

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### OVERVIEW Part 3: Lighting

Your camera can only see light. Think about where it comes from and how (reflection, refraction, scattering) it gets into your lens.

For now, let's look at some examples from the Best of Web selections. More on light/matter interactions on next iteration.