03.Overview2

Tuesday, January 18, 2011
3:55 PM

Today: Overview Continued. Choices.

1. Flow phenomenon: Water boiling? Faucet dripping?
2. Visualization technique: Add dye? See light distorted by air/water surface?
3. Lighting (source of worst image problems)
4. Image acqusition: Still? Video? Stereo? Time lapse?
5. Post processing, final output. Edit, at least crop the image, consider contrast.

Admin:

- So sorry about missing guest lecturer!!!!!
- Due today, 5 pm
  - Fluids Perception Survey (online, still open)
  - Background survey (online)
  - Copyright agreement(hardcopy)
  - Syllabus agreement (hardcopy)
  - Best of Web (CULearn). Please provide ARTIST/AUTHOR attribution.
- Not 'due' but please complete ASAP: Camera Specs survey (online)15 responses posted. Fixed so you can enter multiple cameras (take survey over again)
- Best of Web voting: do you have clickers?

1. Flow phenomenon: Why does it look like that?

What are the forces? = a framework for interpretation of the image

Minute paper results:

Viscous
Shear
Gravitational
Buoyancy
Magnetic
Inertial
Centripedal/centrifugal
Pressure
Body forces: gravity, buoyancy, EM
Viscosity, shear, friction
Thermal diffusivity
Interaction with other fluids
Surface tension

Air resistance
Cohesion
Adhesion (capillary action)
Normal force
Stress
Strain
Thermodynamic
Electro-magnetic
Compressible
Heat
Convection
Osmosis
Solar radiation

Composition of fluids
Densities of fluids
Chemical reactions
Impact
Wind
Mass
Acceleration
Temperature
Phase change

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Good, inclusive list. Not all are forces, but all can 'drive' a flow via a set of physics or mechanism. Heat, for example.

All forces can be categorized like this: 2 flavors of forces

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Body

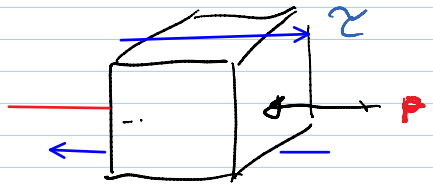
Acts on every molecule equally
a) Gravity
b) Electromagnetics

http://www.youtube.com/watch?v=fAbycqD2UmQ Protrude Flow Ferromagnetic fluid (ferrofluid). Iron nanoparticles suspended in oil, follows magnetic field lines.
http://www.colorado.edu/MCEN/flowvis/galleries/2010/Team-2/FV_popup1-16.htm

Expensive, but you don't need much ($30)
Check Ebay, Craig's list

Surface

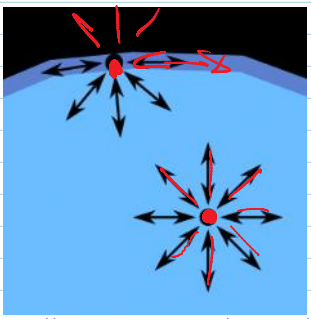
Acts on the surface of a volume of fluid



P Pressure: always perpendicular to surface
τ Shear: always parallel to surface

Any surface force can be decomposed into a shear plus pressure
Note: these are actually STRESSES = Force acting on an area.

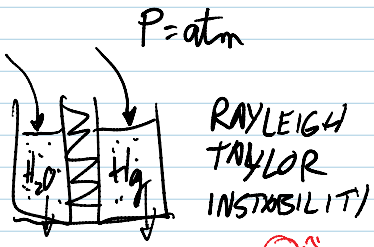
The only force that is not so easily categorized is SURFACE TENSION



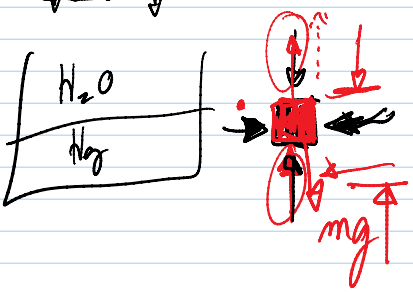
http://upload.wikimedia.org/wikipedia/commons/thumb/f/f9/Wassermolek%C3%BCleInTr%C3%B6pfchen.svg/300px-Wassermolek%C3%BCleInTr%C3%B6pfchen.svg.png

It's the result of intermolecular forces, so it affects every molecule, like a body force

But it is only obvious at interfaces between fluids, kind of like a surface force.



http://www-math.mit.edu/~dhu/Striderweb/striderweb.html Water-walking insects



Conclusion: Whenever you are observing fluids, list the forces that may be acting, ***that make it look like that.***

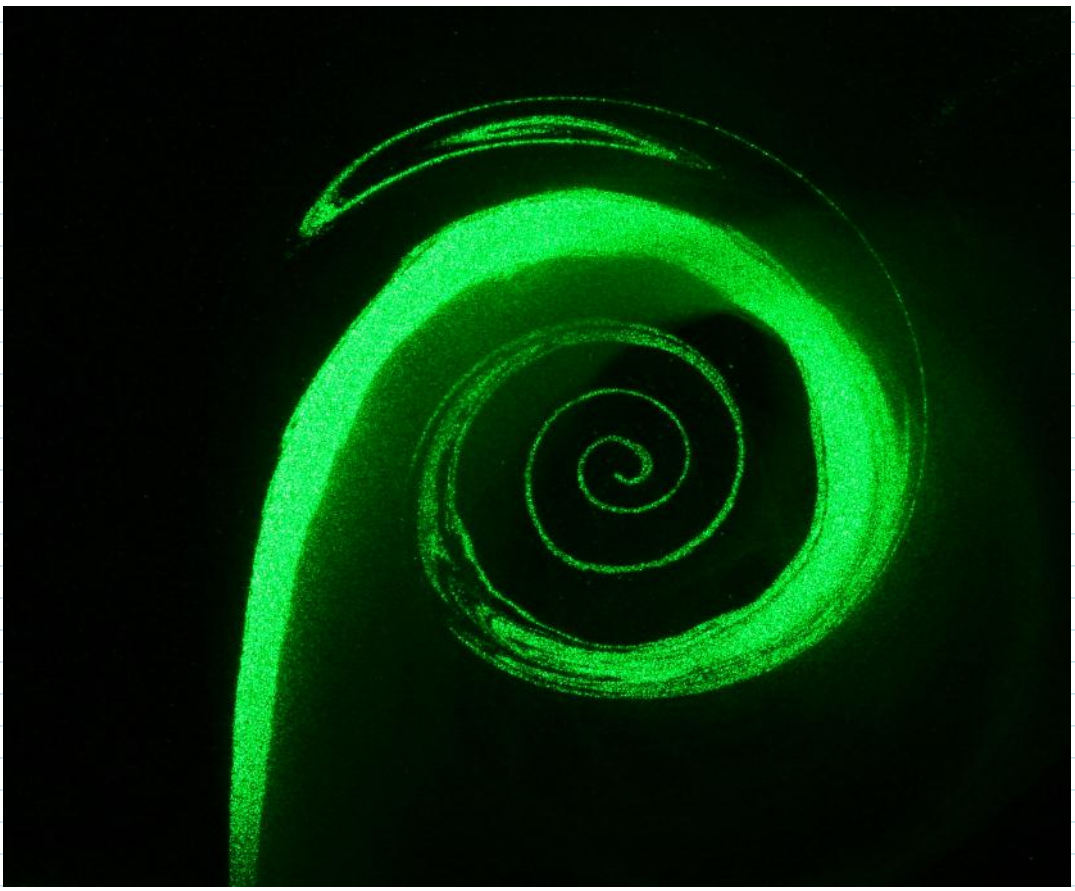
Examples? Let's look at
http://fuckyeahfluiddynamics.tumblr.com/

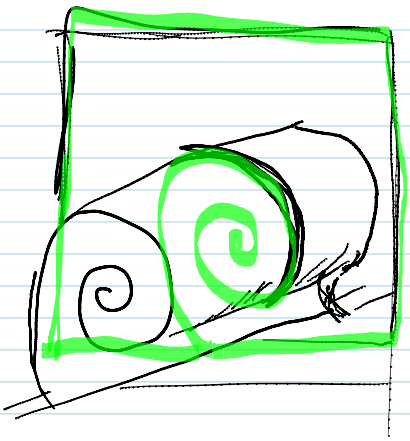
2. Visualization Techniques

a. Seeded Boundary techniques
b. Index of refraction (light bending)
c. Particle tracking

a. Seeded Boundary techniques:

One fluid is seeded with dye or particles which scatter or absorb light. The other fluid is transparent, not scattering or absorbing light. The boundary can be seen.





Stage fog illuminated by a sheet of laser light forms a suddenly started laminar planar jet at Re = 330. Tanner Ladtkow, Geneva Wilkesanders, Tim Read, Andrea Fabri. Team Project 3, 2006

India ink falling through water shows the Rayleigh-Taylor instability. Gordon Browning. Get Wet Fall 07.

Back-lit. Dark ink absorbs light.

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

Lucy Dean, Joseph Duggan, Tim Jarrell, Melissa Lucht

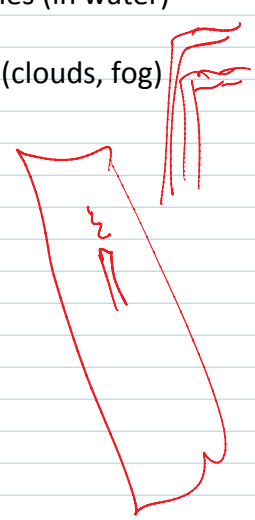
White gas (naptha) pool flame.
Team 1 Spring 2009

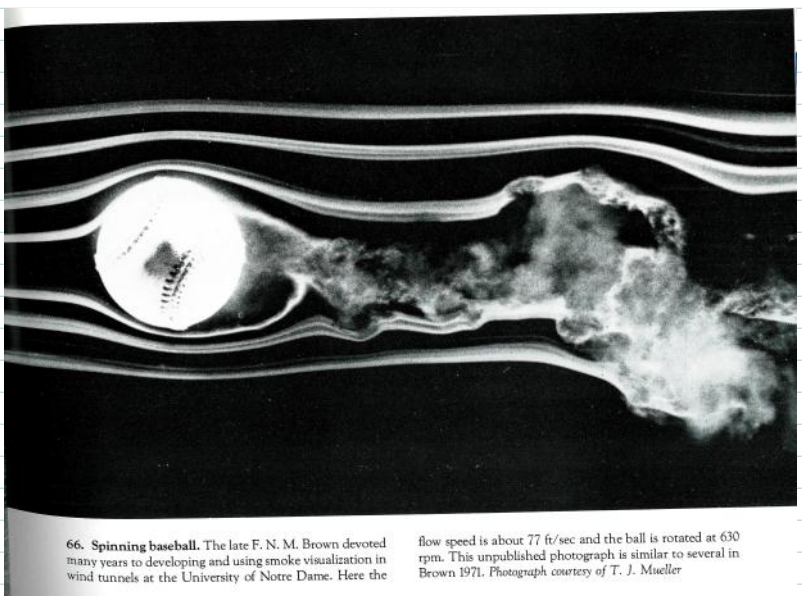
Light emission shows hot soot region

C_2 CH = olne

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

- Dye = food coloring
- Hydrogen bubbles (in water)
- Smoke
- Water droplets (clouds, fog)





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*

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?

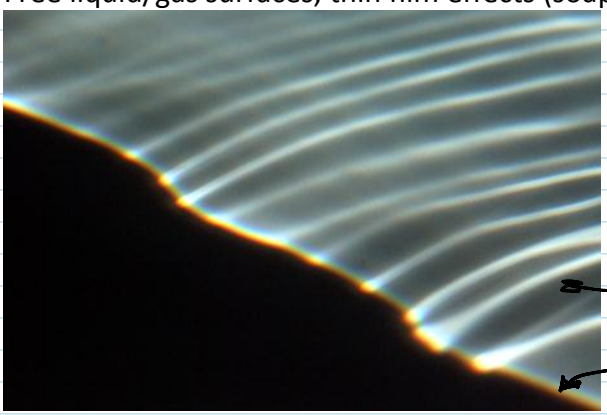
Got to here

$$\eta = \frac{c}{v} = \frac{\text{Speed of light in vaccuum}}{\text{Speed of light in medium}}$$

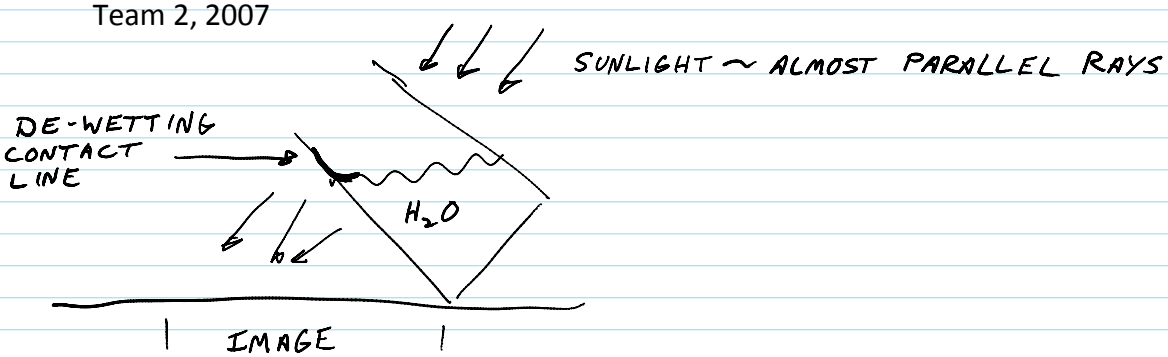
eetah

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

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



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 Moire interference patterns : CAUSTICS.
Owen Hnath, Gordon Browning, Tracy Eliasson, Travis Gaskill, Trisha Harrison
Team 2, 2007



GetWet

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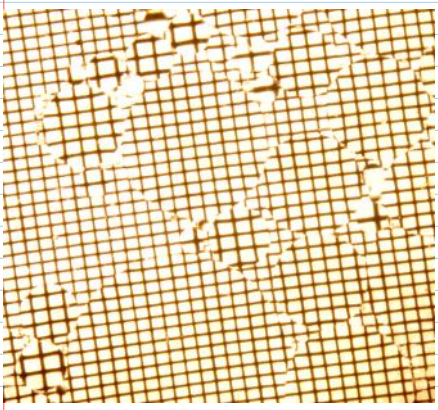
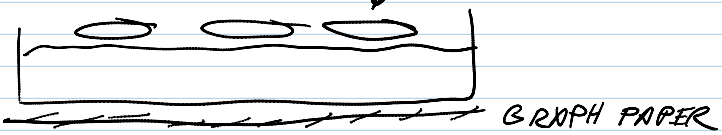
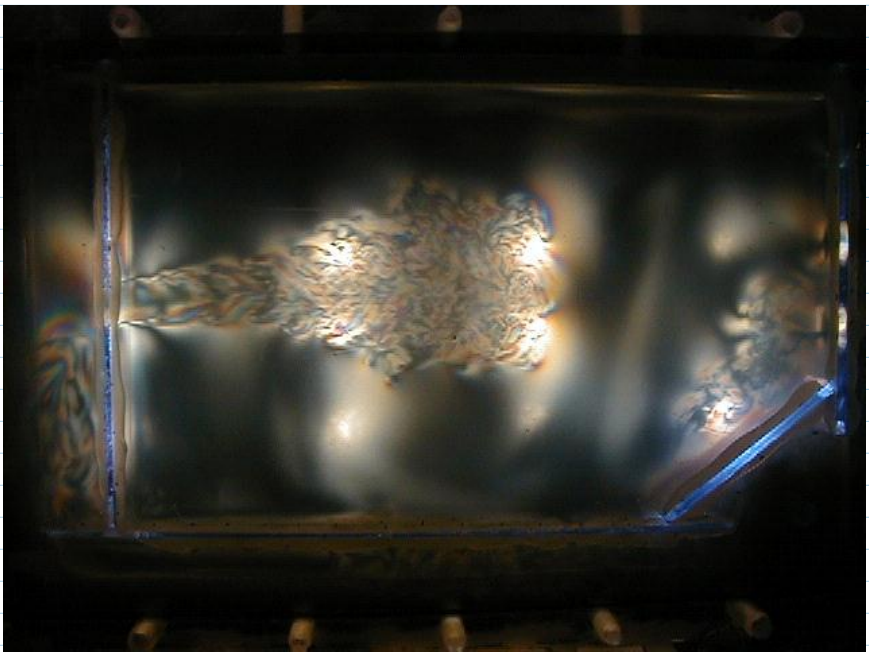


Liquid lenses formed by oil floating on water distort the grid beneath.

Tracy Eliasson
Get Wet 07



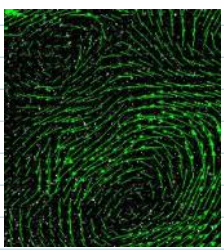


Streaming birefringence
'Blackstock fluid'
Suspension of mica flakes.

http://www.laminarsciences.com/

c. Particle tracking techniques

Individual particles are seen. Can be qualitative or quantitative (Particle Image Velocimetry, PIV).
With motion blur, length of track can indicate speed.



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>