

# Fluid Dynamics

Physics 472B

Spring 2018

# Static vs Dynamic



[https://www.google.com/url?  
sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjBlTP4rfZAhUU82MKHdHHDAYQjRx6BAGAEAY&url=https%3A%2F%2Fpixabay.com%2Fen%2Flake-mirror-scenery-water-blue-239223%2F&psig=A0vVaw2mrdKYVsefvNj\\_Z0\\_Iu7VX&ust=1519328561338229](https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwjBlTP4rfZAhUU82MKHdHHDAYQjRx6BAGAEAY&url=https%3A%2F%2Fpixabay.com%2Fen%2Flake-mirror-scenery-water-blue-239223%2F&psig=A0vVaw2mrdKYVsefvNj_Z0_Iu7VX&ust=1519328561338229)

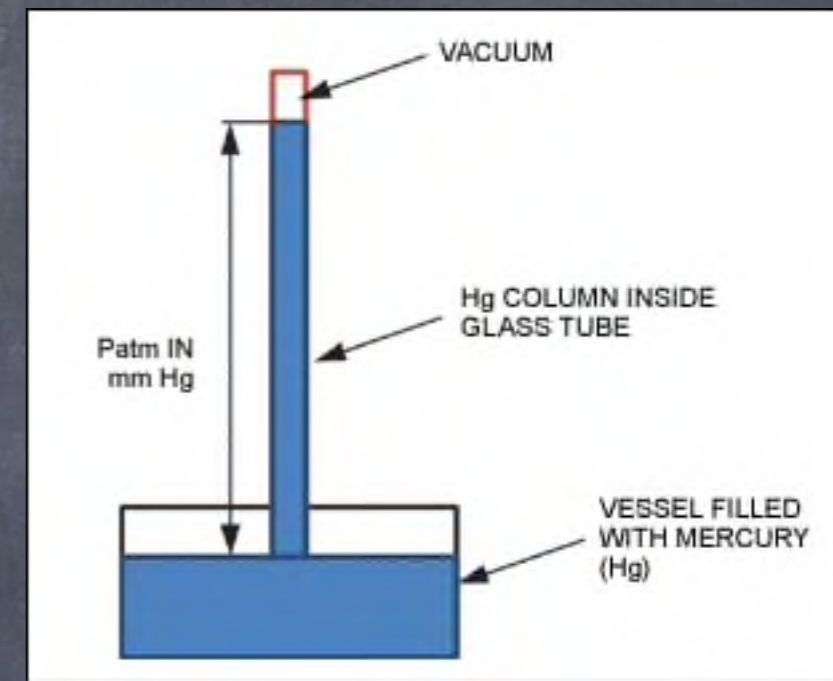
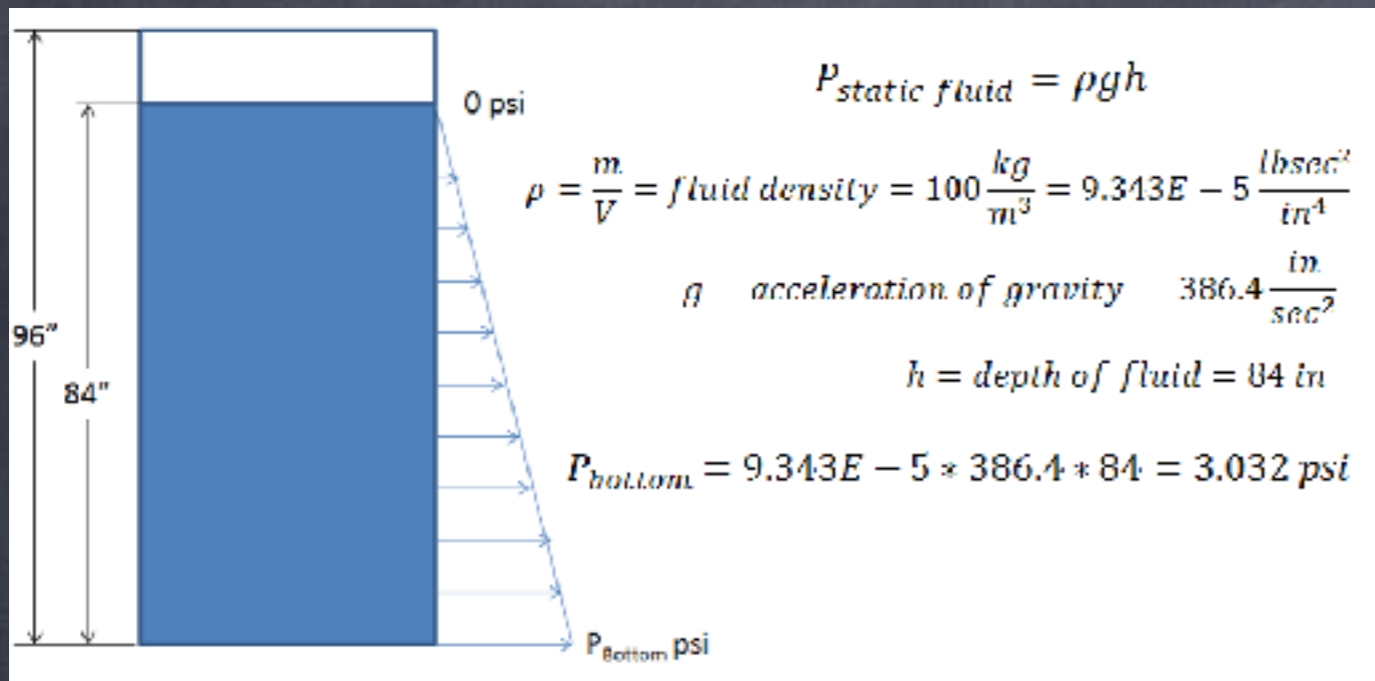


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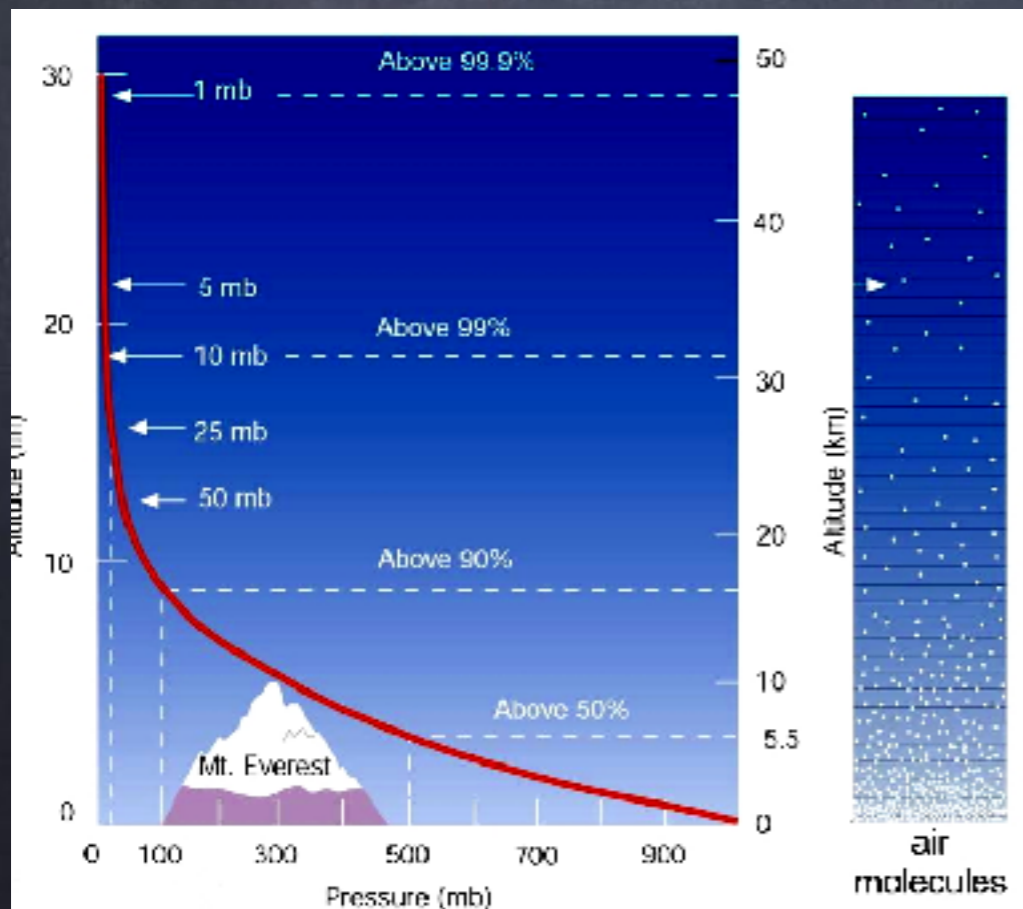
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# Hydro-Statics

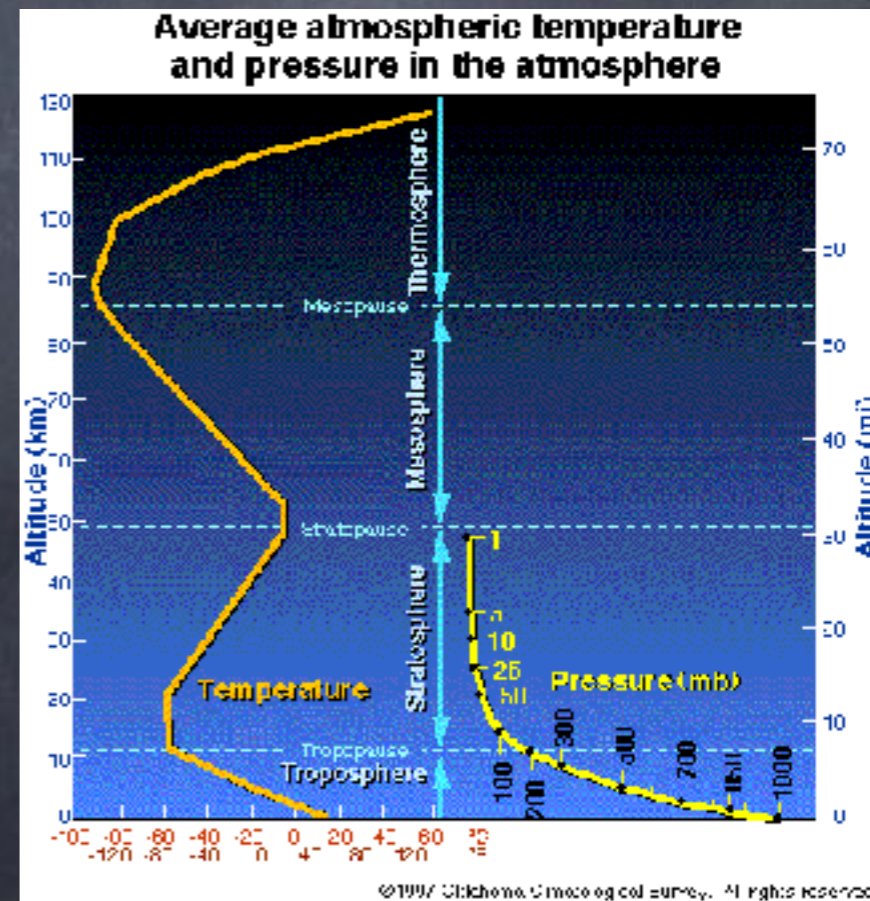


<http://help.autodesk.com/cloudhelp/2016/ENU/NINCAD-SelfTraining/images/GUID-C8909EE2-CDAC-4D55-8A47-CAA2543C36F0.png>

<https://www.maximintegrated.com/jp/images/appnotes/5319/5319Fig01.gif>



<http://funnel.sfsu.edu/courses/metr104/S12/images/PressureProfile.jpg>



<http://okfirst.mesonet.org/train/meteorology/graphics/VertTP.gif>

# Laminar to turbulent flows

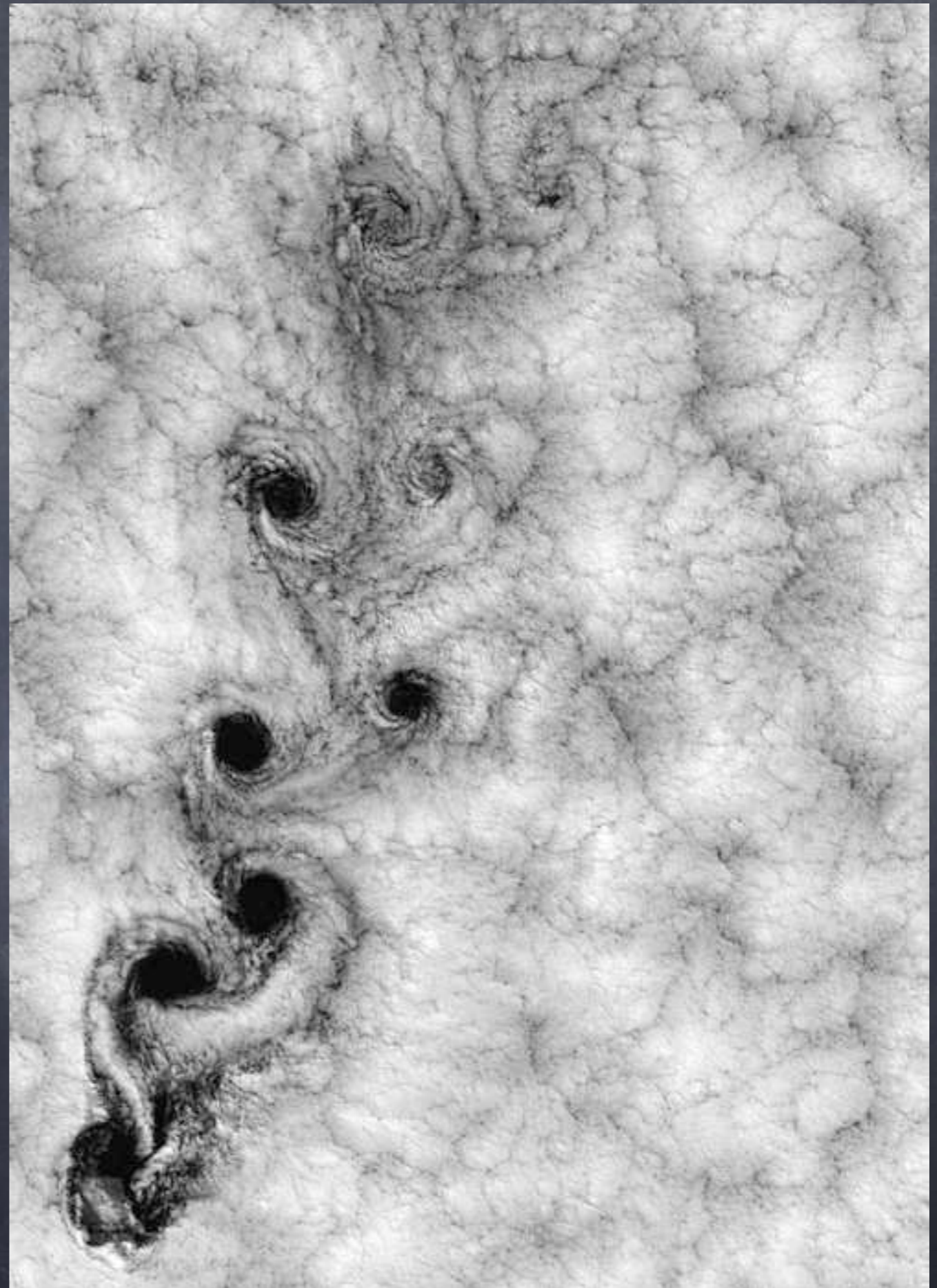
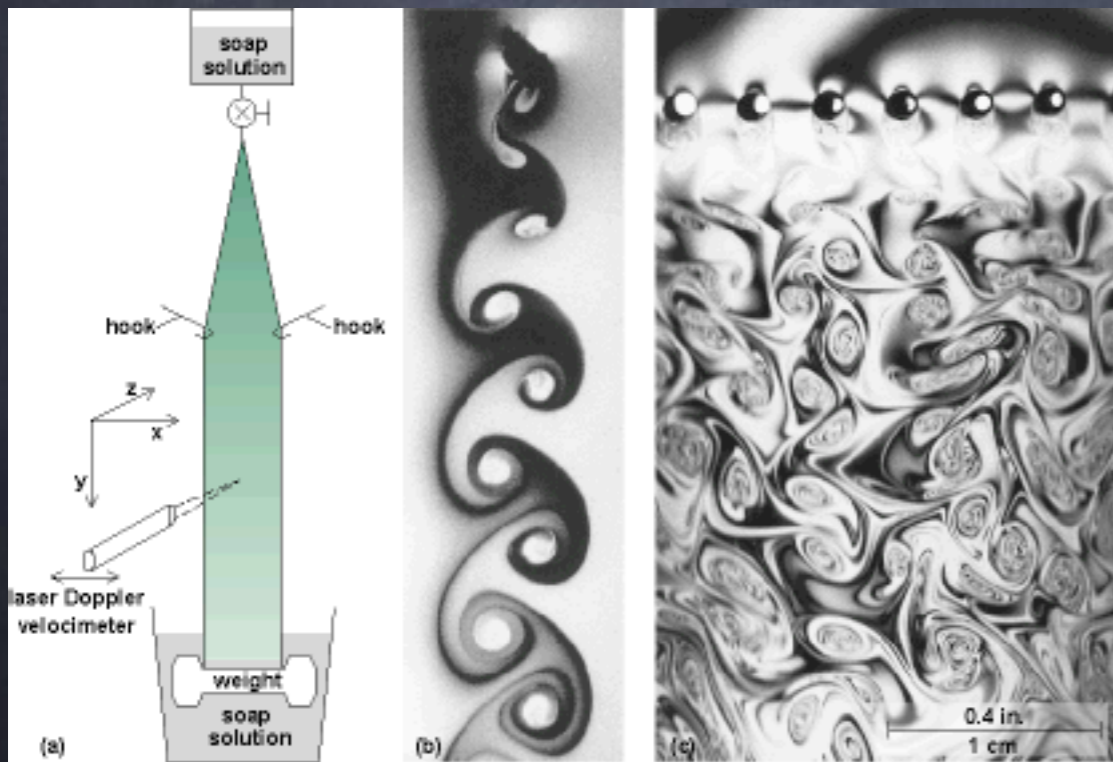


[http://f\\*&kyeahfluidynamics.tumblr.com/search/turbulence/page/1](http://f*&kyeahfluidynamics.tumblr.com/search/turbulence/page/1)

- The entire class in one picture

# Instabilities

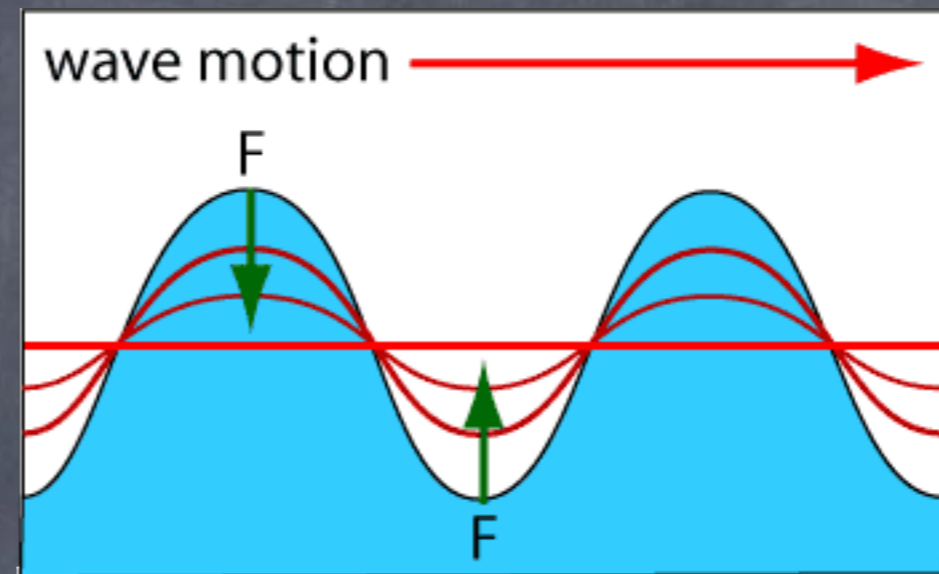
- Van Karman vortex streets



# Waves



<https://thumbs.dreamstime.com/b/rippling-water-surface-flowing-water-surface-water-waves-background-wallpaper-63396495.jpg>



[http://www.scienceisart.com/B\\_Waves/WaveForce.gif](http://www.scienceisart.com/B_Waves/WaveForce.gif)



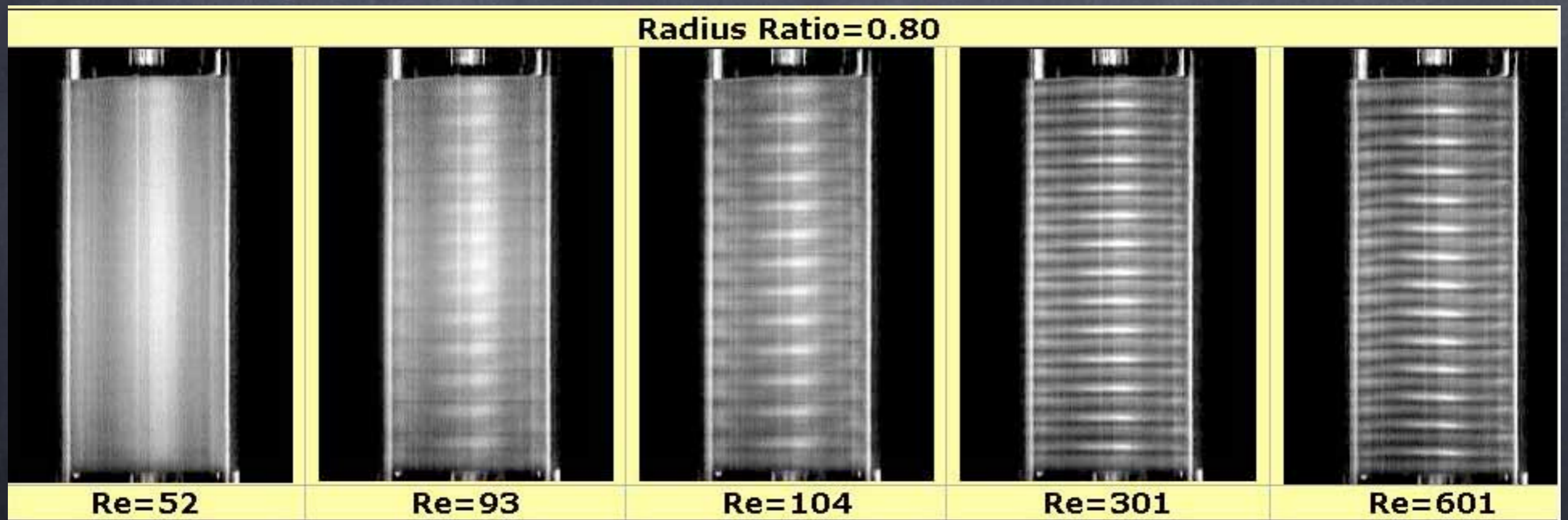
<https://johnvagabondscience.files.wordpress.com/2008/10/splash-water-waves-4554.jpg>



<http://thenextweb.com/google/files/2010/08/waves-patterns-in-space-and-time.jpg>

# Waves and flows

- Couette flow

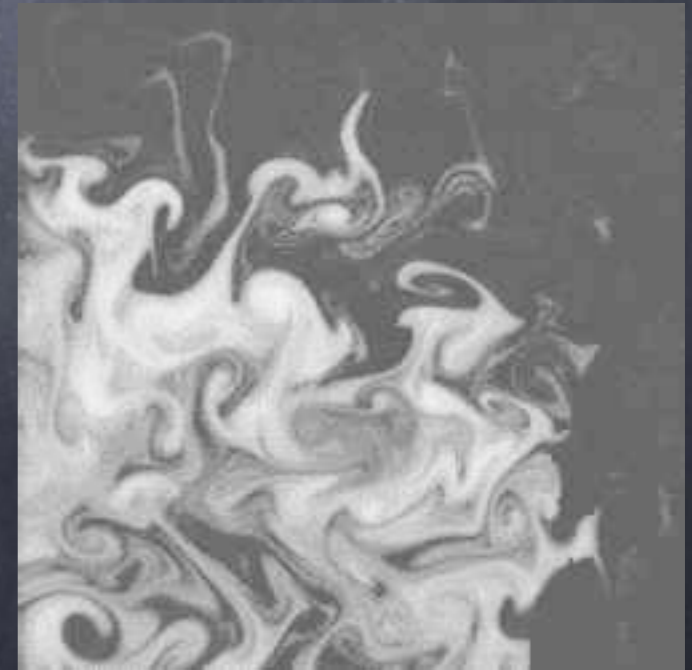


[http://serve.me.nus.edu.sg/limtt/TCF\\_0.8.JPG](http://serve.me.nus.edu.sg/limtt/TCF_0.8.JPG)

# Turbulence



<http://knol.google.com/k/the-secret-of-turbulence#>

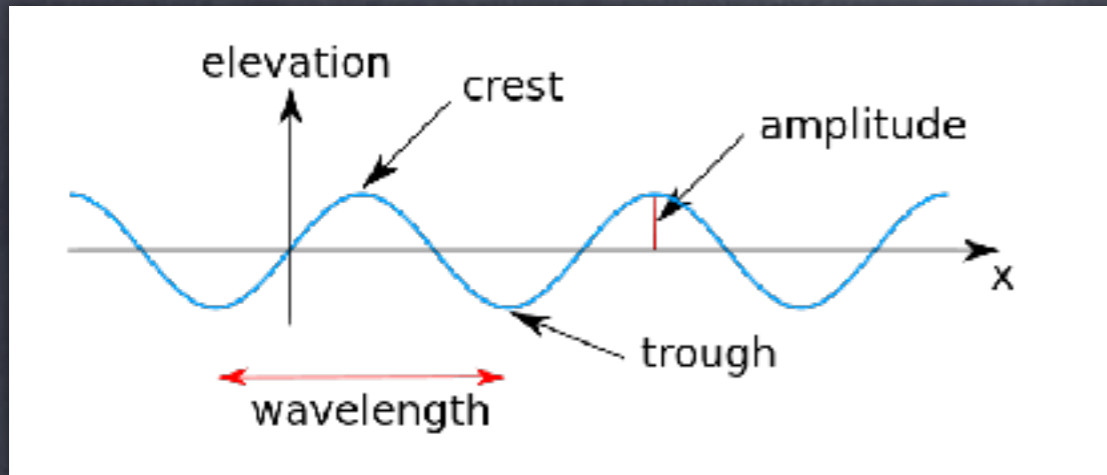


<http://arstechnica.com/science/news/2008/11/is-turbulence-a-chaotic-repeller-or-attractor.ars>

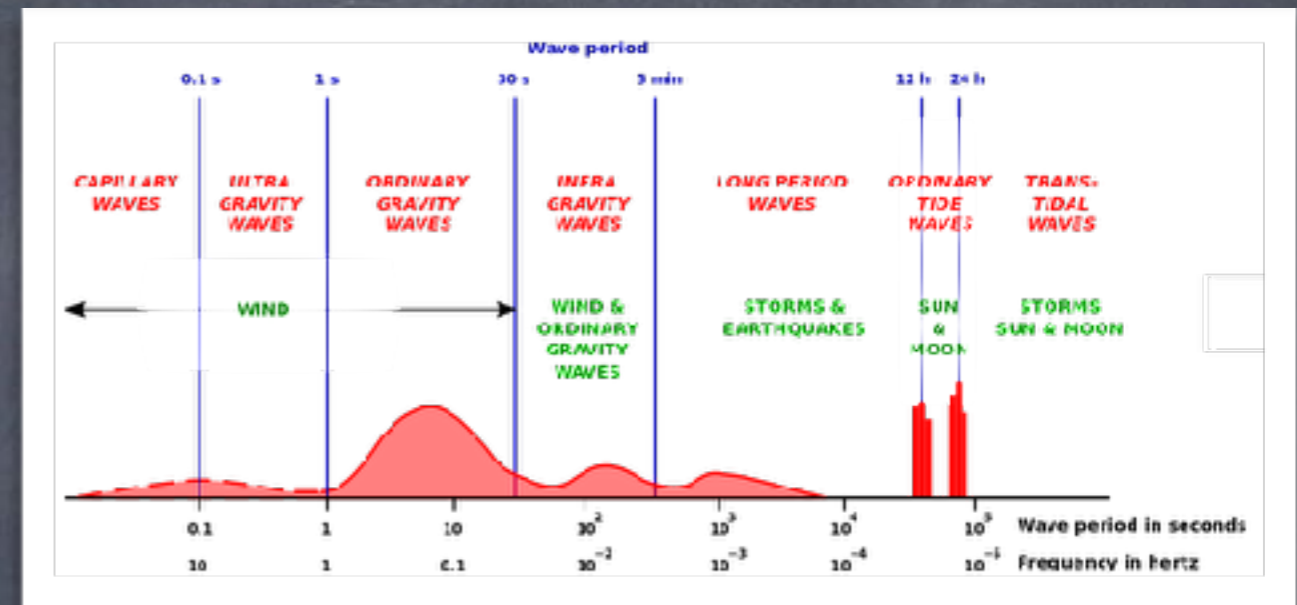
<http://matter.cc.brandeis.edu/research/turbulence.gif>



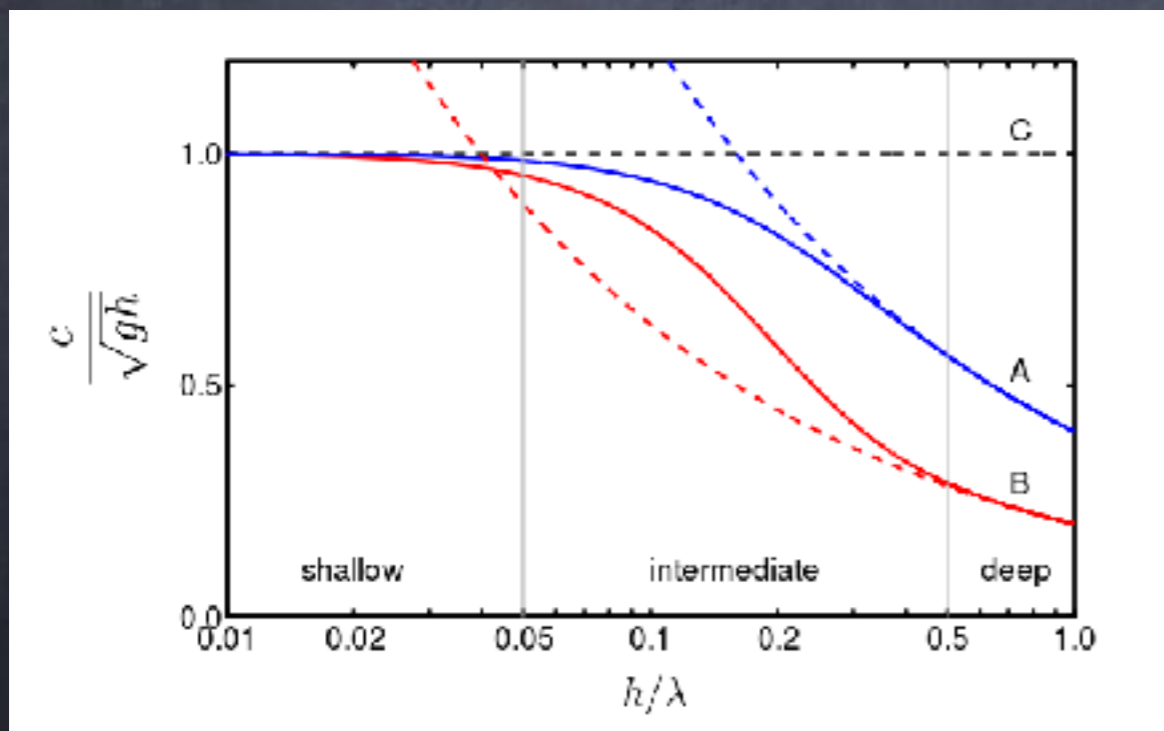
# Surface Waves



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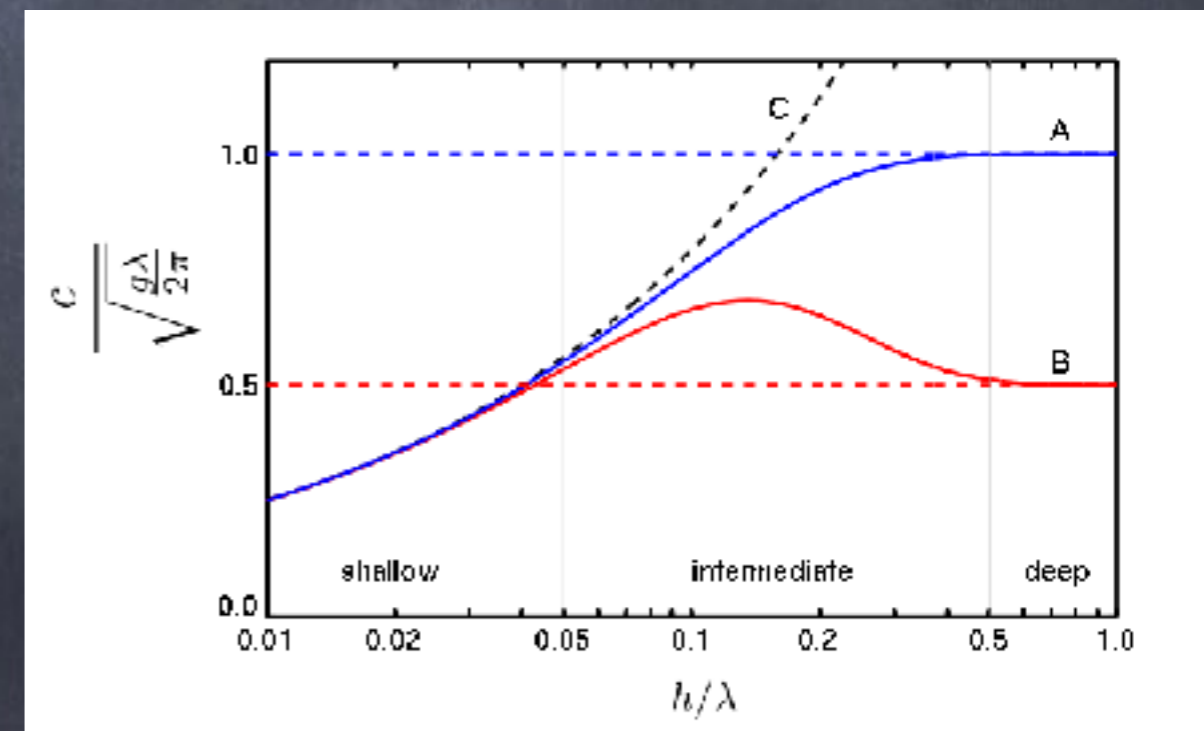


By Walter H. Munk - <http://journals.tdl.org/ICCE/article/view/904>, CC BY 3.0, <https://commons.wikimedia.org/w/index.php?curid=18102158>



By Kraaiennest - Own work, GFDL, <https://commons.wikimedia.org/w/index.php?curid=3872149>

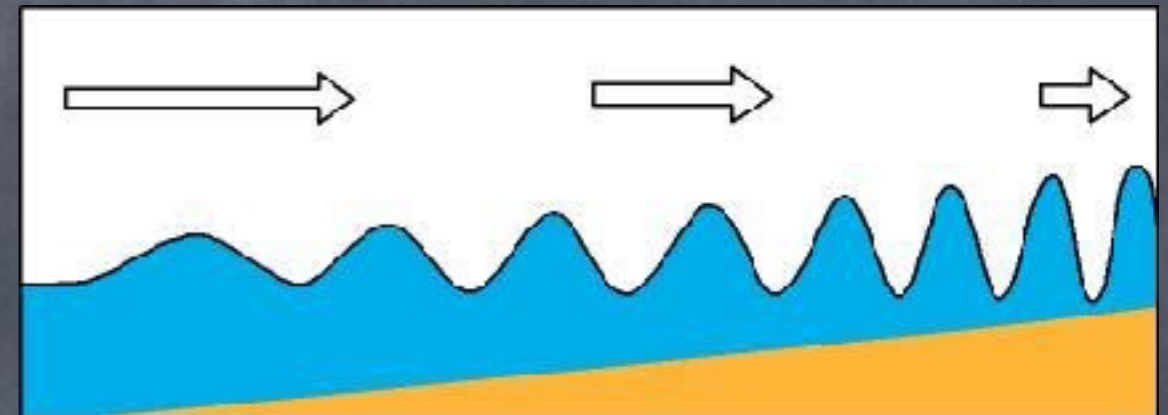
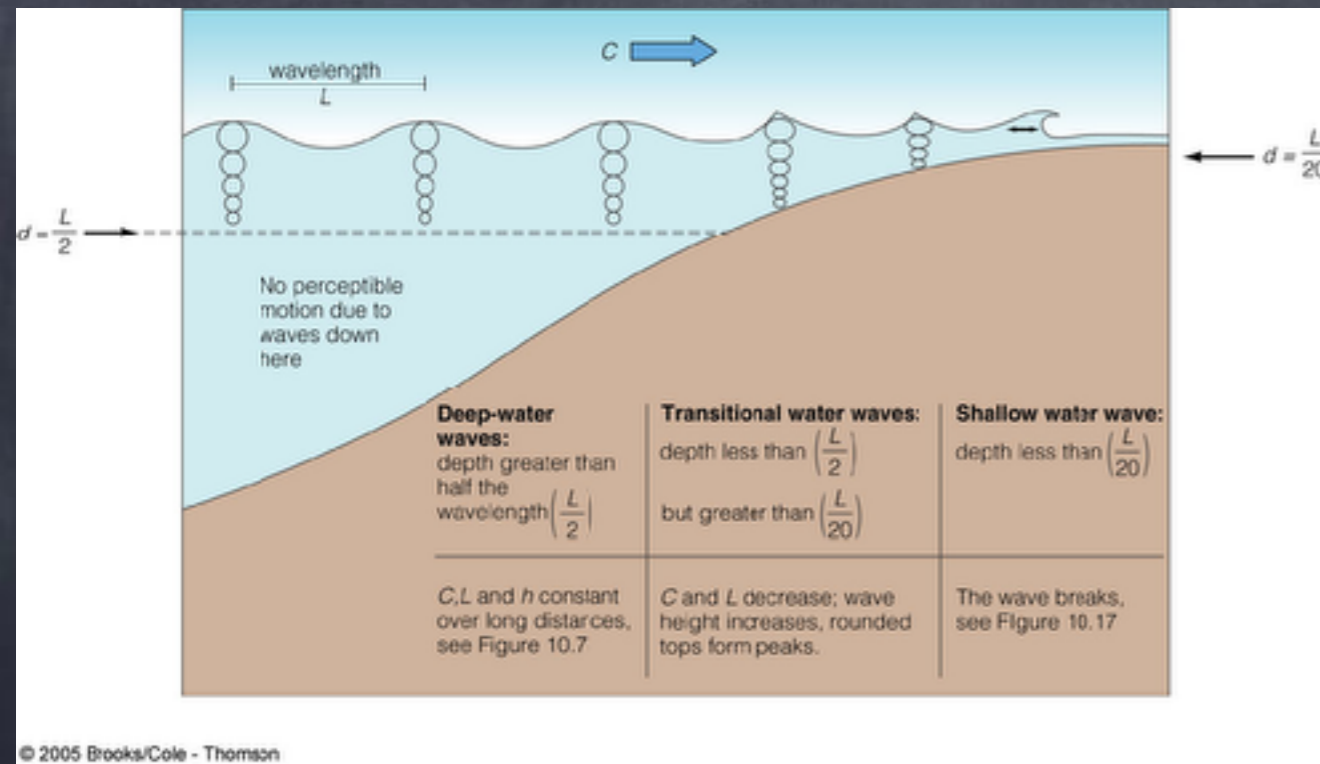
Dispersion of gravity waves on a fluid surface. Phase and group velocity divided by  $\sqrt{gh}$  as a function of  $h/\lambda$ . A: phase velocity, B: group velocity, C: phase and group velocity  $\sqrt{gh}$  valid in shallow water. Drawn lines: based on dispersion relation valid in arbitrary depth. Dashed lines: based on dispersion relation valid in deep water.



By Kraaiennest - Own work, GFDL, <https://commons.wikimedia.org/w/index.php?curid=3872149>

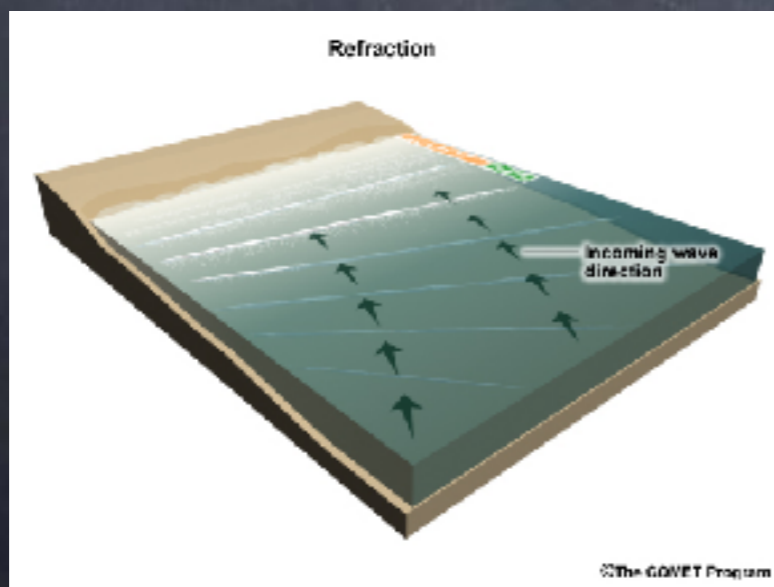
Dispersion of gravity waves on a fluid surface. Phase and group velocity divided by deep-water phase velocity  $\sqrt{g\lambda / (2\pi)}$  as a function of relative depth  $h/\lambda$ . Blue lines (A): phase velocity; Red lines (B): group velocity; Black dashed line (C): phase and group velocity  $\sqrt{gh}$  valid in shallow water. Drawn lines: dispersion relation valid in arbitrary depth. Dashed lines (blue and red): deep water limits.

# Beaching



<http://images.magicseaweed.com/news/441.jpg>

<https://i.stack.imgur.com/LUKMQ.jpg>

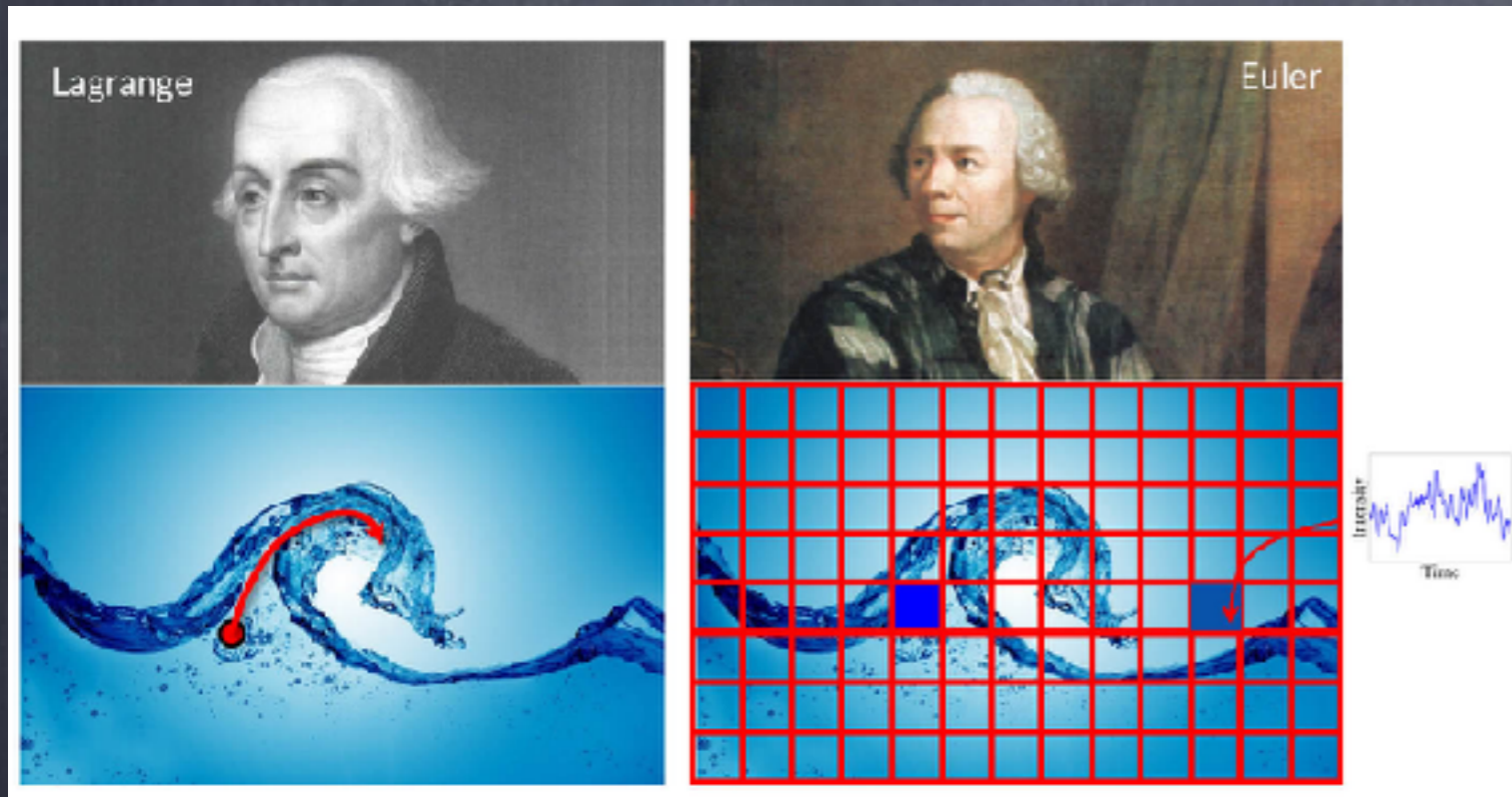


[http://stream1.cmatc.cn/pub/comet/CoastalWeather/sww/comet/marine/SWW/media/graphics/refraction\\_straightbeach.jpg](http://stream1.cmatc.cn/pub/comet/CoastalWeather/sww/comet/marine/SWW/media/graphics/refraction_straightbeach.jpg)

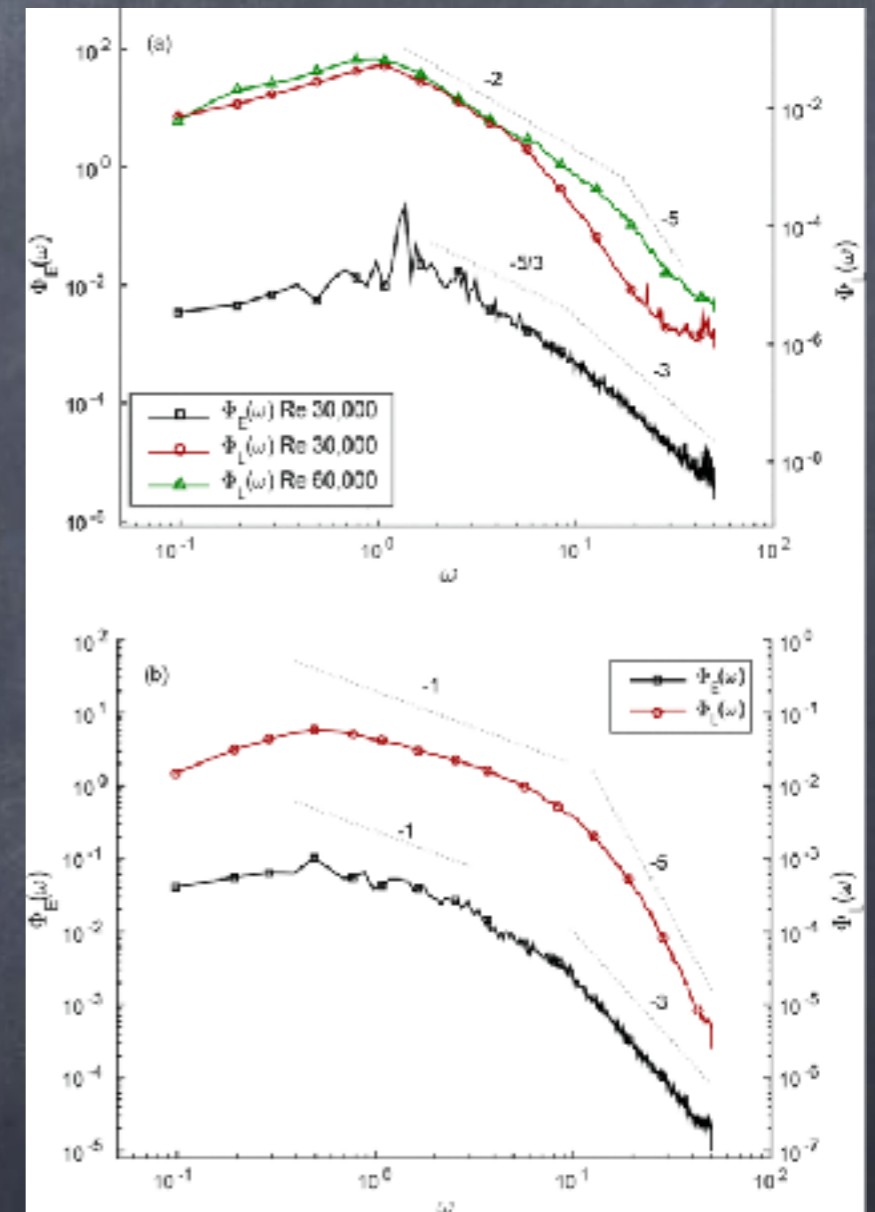


<https://i.ytimg.com/vi/bt08ZMj37rw/hqdefault.jpg>

# Lagrangian vs Eulerian



<http://hoskere2.web.engr.illinois.edu/cs445/finalProject/eulr.jpg>



<https://www.researchgate.net/publication/301515835/figure/fig6/AS:362285500518400@1463387002110/Lagrangian-frequency-spectrum-PHLo-and-Eulerian-frequency-spectrum-PHEo-of-the-tra.png>