

# Wind Turbines, Winglets, and Vorticity

Charles Tierney – MA 198 Math Seminar

# Overview of Fluids

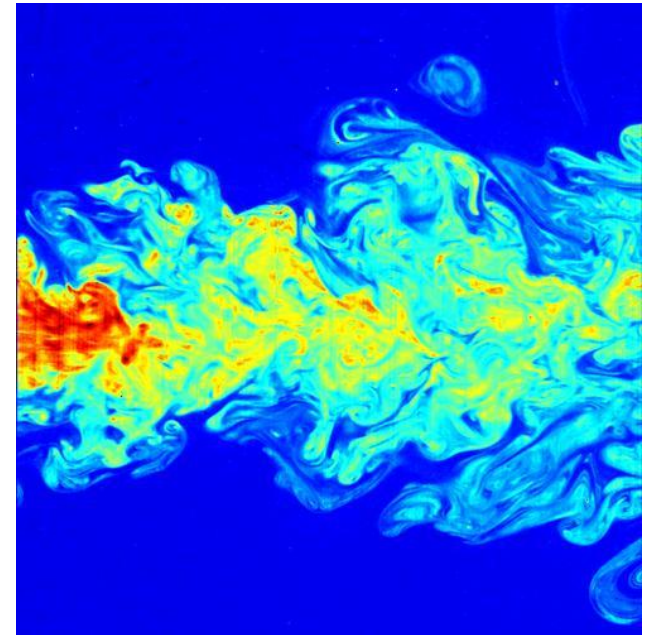
- Important Properties
  - Density
  - Viscosity
- Analysis Frameworks/Assumptions
  - Inviscid
  - Incompressible
  - Continuous
  - Steady Flow

# Forces

- Inertial Forces
- Pressure Forces
- Viscous Forces

# Reynolds Number and Turbulent Flow

- Reynolds number (Re)
- Turbulent Flow

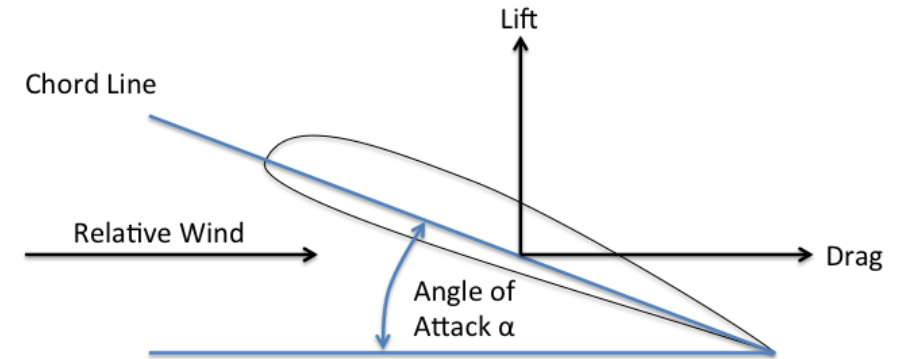


source:

[https://upload.wikimedia.org/wikipedia/commons/b/b9/False\\_color\\_image\\_of\\_the\\_far\\_field\\_of\\_a\\_submerged\\_turbulent\\_jet.jpg](https://upload.wikimedia.org/wikipedia/commons/b/b9/False_color_image_of_the_far_field_of_a_submerged_turbulent_jet.jpg)

# Aerodynamic Forces

- Lift and Drag
  - What they are
  - How they are calculated
- Profile Drag versus Induced Drag
  - What is profile drag?
  - What is induced drag?



Source:  
[http://code7700.com/images/airfoil\\_terminology\\_2.png](http://code7700.com/images/airfoil_terminology_2.png)

# Wing Tip Vortices

- Formation
- Downwash
- Change in effective angle of attack



Source:  
[https://howthingsfly.si.edu/sites/default/files/image-large/il\\_wingtipvortexedit\\_lg.jpg](https://howthingsfly.si.edu/sites/default/files/image-large/il_wingtipvortexedit_lg.jpg)

# Wind Turbines vs. Airplanes

- Flow over blades differs
- How each accounts for induced drag

# Visualization of Wing tip Vortices

- <http://i.imgur.com/qRq5fFY.webm>



# Winglets

- What winglets do
- How does it decrease the induced drag

# Vorticity

- What it is
- How it's Calculated
- Visualization

# What the Project Aims to Do

- Using OpenGL/Vpython
- Fixed camera angle on the tip of the blade
- Show vector field as it moves through space
- Allow for variable flow rates