TURBULENCE ASSIGNMENT
Wednesday 06 June 2018

Using the JHU public turbulence database to explore basic aspects of turbulence:

1. Go to http://turbulence.pha.jhu.edu and familiarize yourself with the database.

2. Download **Matlab scripts with solutions**.
   Use your own token.

3. We will access the transitional boundary-layer database, so familiarize yourself with the simulation Readme-file on the webpage.
   To specify the boundary-layer database in the Matlab script, use: ***dataset = 'transition_bl'***

4. The domain size and number of grid points in the streamwise and spanwise directions are,
   Lx = 969.8465; Nx = 3320;
   Lz = 240;   Nz = 2048;
   For the wall-normal grid, use the file "**BL_ycoor.mat**".

5. Visualization: (Do not use spatial or temporal interpolation)
   a. Write a Matlab script that reads the velocity every 10th grid point in the x-z plane
      $100 < x < 600$
      $y = 1$
      $0 < z < 240$
      at time t=0 and plot contours of w(x,z).
      Repeat at various times, until you can identify a turbulent spot!
   b. Query the database and plot contours of the w-velocity in sub-sampled end and side views, in planes that bisect the spot.

6. Averages
   a. Write a Maltab script that reads the velocity gradient every 10th grid point in the x-z plane
      $100 < x < 600$
      $y = 0$
      $0 < z < 240$
      and plot contours of $C_f(x,z)$.
   b. Compute the spanwise average of $C_f(x,z)$ from part (b) and plot it versus x.
   c. Query the velocity every 20th point in x and z, and every 10th point in y only.
      $100 < x < 600$
      $0 < y < ymax$
      $0 < z < 240$
      and compute the boundary-layer 99%, displacement and momentum thicknesses, and plot them.

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7. Spot detection
   For the snapshot with a spot, use a threshold on the w-velocity to identify the boundary of a turbulent spot and calculate the area of the spot.

8. Streak detection
   From an end view in the early transitional region, compute the streamwise-velocity perturbations. Identify the local maxima in the spanwise plane, and extract the local perturbation velocity. Using these values, plot a probability density function of the streak amplitudes.

Note: Feel free to add analysis of any other feature of turbulence you may wish to explore. Remember, the database allows you access to a full 4-D space-time history of three velocity components and pressure, and allows you to calculate velocity gradients and pressure.