Computational fluid dynamics of small insects

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Project Background and Goals

Scientists have been studying flight intensively for the past century, however there has been a focus on larger flyers such as birds and large flies. The realm of tiny insect flight remains relatively unstudied.

Background information:
• Reynolds number is the represented by the equation:

\[
Re = \frac{VL}{m} = \frac{\text{inertial}}{\text{viscous}}
\]

• The smaller the Reynolds number the smaller in the insect
• Tiny insects fly like they are swimming in the air.
• Fruit flies fly at about Re=120 and thrips fly at Re=10.

The purpose of my project is to see if tiny insects with Reynolds numbers from 1-100 could generate vertical force from drag rather than aerodynamic lift.
Project Results

• We were able to use a computational method to simulate the wing beats and to calculate the drag and lift produced by a wing beat.
• Wing motions tested included the following:

  ![Simple up-down wing motion](image)

  ![Wing motion including angle of stroke plane](image)

• Our results showed that as Re increases, the vertical force produced by drag also increases.
  • We concluded that tiny insects do not use drag to produce vertical flight
• We also found that the angle of the stroke plane does not affect vertical flight for low Reynolds numbers.