Name: PHY401 (Fall 2006), 09/04/06

# Homework Assignment #2

(*Due Date*: Wednesday, September 13, 12:40 pm, in class)

2.1 *Baseball Trajectory (cf. Exercise 2.13 in the textbook)* *(7 pts.)*
Construct a FORTRAN program to calculate the 2-D trajectory of a baseball (mass 0.3 $kg$, radius 5 $cm$) including a drag force (but without spinning) on sea level with (constant) drag coefficient $C$=0.5 and initial speed $v_0$=125 $mph$.

(a) Calculate and plot the trajectories and ranges (using a linear interpolation) in still air for various launch angles $\Theta_0$ in steps of 1° and determine the launch angle that gives the maximum range.

(b) Repeat part (a) using $\Theta_0$=40° only for a head wind of 20 $mph$, and for a tail wind of 20 $mph$.

(c) Implement a speed-dependent drag coefficient,

$$C(v) = 0.1 + \frac{0.4}{1 + \exp[(v - v_d)/\Delta]} \tag{1}$$

with $v_d$=160 $mph$ and $\Delta$=10 $mph$, and calculate the trajectories for fixed launch angle, $\Theta_0$=40°, for $v_0$=160 and 210$mph$, and compare to results for constant $C$=0.5.

2.2 *Table Tennis Ball with Spin (cf. Exercise 2.24 in the textbook)* *(3 pts.)*
Modify your code of the previous problem (but save it under a new name!) to describe the trajectory of a horizontally launched (smooth) table tennis ball (radius 2.0 $cm$, mass 3 $g$, initial height=1.2 $m$) with initial speed $v_0$=4 $m/s$. Include both a drag force and a Magnus force, $\vec{F}_M = S_0\ \vec{\omega} \times \vec{v}$, with the axis of rotation out of the vertical plane of motion, $S_0/m$=0.04 (SI units) and $\omega = \pm 2\pi \cdot 10\ rad/s$. Calculate and plot the trajectories for all three cases (no spin, "topspin" and "slice").