John Clouse IMD HW5

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Initialize

```
clearvars -except hw_pub function_list

rSOI=[546507.344255845;
    527978.380486028;
    531109.066836708];

vSOI=[4.9220589268733;
    5.36316523097915;
    5.22166308425181];

mu = 398600.4415;
```

Problem 1: Compute the effects of perturbations on the velocity to the B Plane

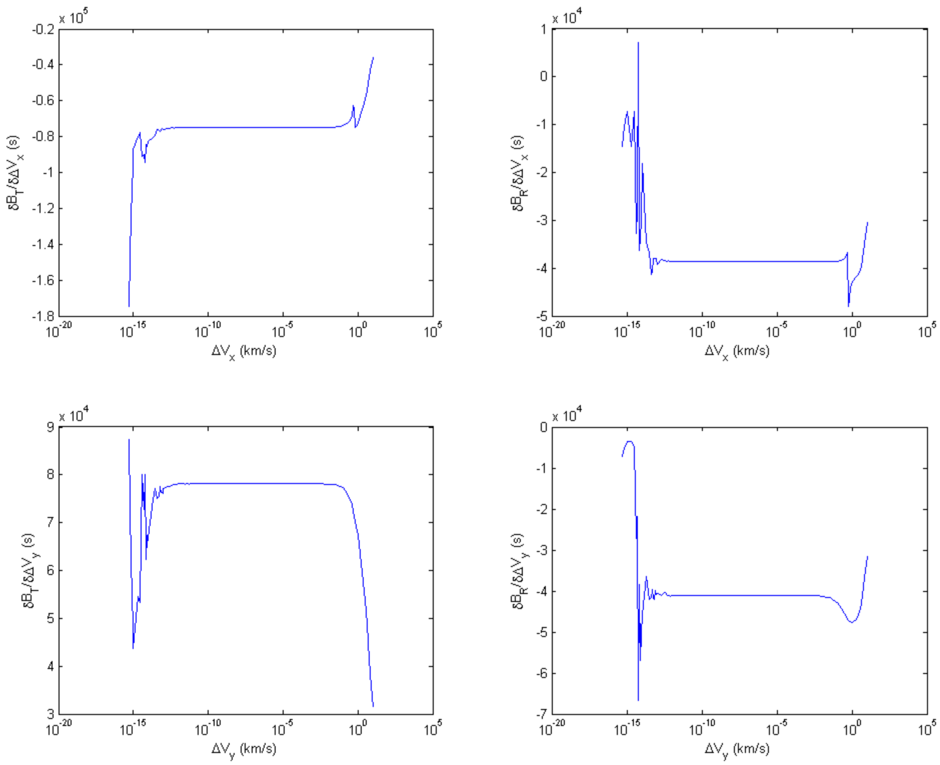
```
% The B-Plane as-is
[ b, B_hat, B_plane ] = Bplane_rv( rSOI, vSOI, mu );

BT = dot(b*B_hat, B_plane(:,2));
BR = dot(b*B_hat, B_plane(:,3));

% Set up the velocities and storage
dv_range = 10:-1:1;
blah = 1e-1;
% blah = 1e-4;
% dv_range = 9*blah;
while min(dv_range) > 5e-16
    dv_range = [dv_range (9:-1:1)*blah];
    blah = blah*1e-1;
end

dv_range = dv_range(dv_range > 5e-16);

dBT_dvx = zeros(1,length(dv_range));
```

```
dBT_dvy = zeros(1,length(dv_range));
dBR_dvx = zeros(1,length(dv_range));
dBR_dvy = zeros(1,length(dv_range));

% Iterate on the velocity perturbations
for ii = 1:length(dv_range)
    % X first
    [ b_x, B_hat_x, B_plane_x ] = ...
        Bplane_rv( rSOI, vSOI + [dv_range(ii);0;0], mu );

    BT_x = dot(b_x*B_hat_x, B_plane_x(:,2));
    BR_x = dot(b_x*B_hat_x, B_plane_x(:,3));

    dBT_dvx(ii) = (BT_x - BT)/dv_range(ii);
    dBR_dvx(ii) = (BR_x - BR)/dv_range(ii);

    % Y
    [ b_y, B_hat_y, B_plane_y ] = ...
        Bplane_rv( rSOI, vSOI + [0;dv_range(ii);0], mu );

    BT_y = dot(b_y*B_hat_y, B_plane_y(:,2));
    BR_y = dot(b_y*B_hat_y, B_plane_y(:,3));

    dBT_dvy(ii) = (BT_y - BT)/dv_range(ii);
    dBR_dvy(ii) = (BR_y - BR)/dv_range(ii);
end
```

Problem 1 conclusion

Numerical errors are pretty significant toward smaller perturbations, due to the very small dV being in the denominator. The nonlinearities are noticable both in very small and very large perturbations. I would say the linear cutoff point is in the tens of meters per second. My later computations will use 1 m/s as the velocity at which to calculate the partials.

```
figure('Position', hw_pub.figPosn)
subplot(2,2,1)
% loglog(dv_range,dBT_dvx)
semilogx(dv_range,dBT_dvx)
ylabel('\deltaB_T/\delta\DeltaV_x (s)')
xlabel('\DeltaV_x (km/s)')
subplot(2,2,2)
semilogx(dv_range,dBR_dvx)
ylabel('\deltaB_R/\delta\DeltaV_x (s)')
xlabel('\DeltaV_x (km/s)')
subplot(2,2,3)
semilogx(dv_range,dBT_dvy)
ylabel('\deltaB_T/\delta\DeltaV_y (s)')
xlabel('\DeltaV_y (km/s)')
subplot(2,2,4)
semilogx(dv_range,dBR_dvy)
ylabel('\deltaB_R/\delta\DeltaV_y (s)')
xlabel('\DeltaV_y (km/s)')
```



Problem 2: Find the dV needed to hit the desired target

```
BT_target = 13135.7982982557; %km
BR_target = 5022.26511510685; %km
vel = vSOI;

% Numerically calculate at dV = 1 m/s
calc_vel = 1e-3; %km/s

tol = 1e-10;

BT_curr = BT;
BR_curr = BR;
d_BT = BT_target - BT_curr;
d_BR = BR_target - BR_curr;

% Keep iterating until we hit the tolerance
while abs(d_BT) > tol && abs(d_BR) > tol
    dB = [d_BT; d_BR];
    % X first
    [ b_x, B_hat_x, B_plane_x ] = ...
        Bplane_rv( rSOI, vel + [calc_vel;0;0], mu );
```

```
    BT_x = dot(b_x*B_hat_x, B_plane_x(:,2));
    BR_x = dot(b_x*B_hat_x, B_plane_x(:,3));

    dBT_dvx = (BT_x - BT_curr)/calc_vel;
    dBR_dvx = (BR_x - BR_curr)/calc_vel;

    % Y
    [ b_y, B_hat_y, B_plane_y ] = ...
        Bplane_rv( rSOI, vel + [0;calc_vel;0], mu );

    BT_y = dot(b_y*B_hat_y, B_plane_y(:,2));
    BR_y = dot(b_y*B_hat_y, B_plane_y(:,3));

    dBT_dvy = (BT_y - BT_curr)/calc_vel;
    dBR_dvy = (BR_y - BR_curr)/calc_vel;

    dV = [dBT_dvx dBT_dvy; dBR_dvx dBR_dvy]\dB;

    vel = vel+[dV;0];

    % Calculate resultant b-plane target
    [ b, B_hat, B_plane ] = ...
        Bplane_rv( rSOI, vel, mu );
    BT_curr = dot(b*B_hat, B_plane(:,2));
    BR_curr = dot(b*B_hat, B_plane(:,3));
    d_BT = BT_target - BT_curr;
    d_BR = BR_target - BR_curr;
end
```

Problem 2 conclusion

```
fprintf('New velocity vector:\n');
disp(vel)
fprintf('\b\b km/s\n')
fprintf('\n')
fprintf('dV:\n')
disp(vel-vSOI)
fprintf('\b\b km/s\n')
```

```
New velocity vector:
   5.286077698289384
   5.298100544621716
   5.221663084251810 km/s

dV:
   0.364018771416085
  -0.065064686357434
                   0 km/s
```

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