
```
clc, clear
close all

[rcm, Icm] = aquaMassProps();

%rcm = rcm.*100

[A,Icm_prime] = eig(Icm);

rcm_prime = A.*rcm.';

% Random ICs

x0_deg = [-7, 2, 5].';
x0 = x0_deg*pi/180;
Tfinal = 120;

genPlots(Icm_prime, 'random')

x0_deg = [10, 0, 0].';
x0 = x0_deg*pi/180;
Tfinal = 120;

genPlots(Icm_prime, 'principal')

function genPlots(Icm_prime, name)

    load_system("eulerPropagate")
    open_system("eulerPropagate")

    sim("eulerPropagate")

    om = om_p;

    n = size(t,1);

    Tvec = zeros([n 1]);
    Lvec = zeros([n 3]);
    for i=1:n
        Lvec(i,:) = Icm_prime*om(i,:).';
        Tvec(i) = 0.5*dot(om(i,:).', Lvec(i,:).');
    end

    L = vecnorm(Lvec,2,2);

    T = Tvec(1);
    L = L(1);
```

```

% Integration
figure
hold on
plot(t, om(:,1))
plot(t, om(:,2))
plot(t, om(:,3))
hold off

% Energy and Momentum Ellipsoids
Ix = Icm_prime(1,1);
Iy = Icm_prime(2,2);
Iz = Icm_prime(3,3);
% Energy and Momentum Ellipsoids
a_energy = sqrt(2*T/Ix);
b_energy = sqrt(2*T/Iy);
c_energy = sqrt(2*T/Iz);
n = 100;

x = linspace(-a_energy, a_energy, n);
X = meshgrid(x);
Y = zeros(size(X));
Z = zeros(size(X));
yu = real( sqrt((1/Iy).*(2*T - Ix.*x.^2)) );
yl = -yu;
for i=1:length(x)
    xi = X(:,i).';
    yi = linspace(yl(i), yu(i), n);
    Y(:,i) = yi;
    zi = real(sqrt((1/Iz).*(2*T - Ix.*xi.^2 - Iy.*yi.^2)));
    Z(:,i) = zi;
end

figure
surface(X,Y,Z,'FaceColor','g','HandleVisibility','off')
surface(X,Y,-Z,'FaceColor','g','DisplayName','Energy Ellipsoid')
hold on

a_mom = L/Ix;
b_mom = L/Iy;
c_mom = L/Iz;

x = linspace(-a_mom, a_mom, n);
X = meshgrid(x);
Y = zeros(size(X));
Z = zeros(size(X));
yu = sqrt((1/Iy^2).*(L^2 - Ix^2.*x.^2));
yl = -yu;
for i=1:length(x)
    xi = X(:,i).';
    yi = linspace(yl(i), yu(i), n);
    Y(:,i) = yi;
    zi = real(sqrt((1/Iz^2).*(L^2 - Ix^2.*xi.^2 - Iy^2.*yi.^2)));
    Z(:,i) = zi;

```

end

```
surface(X,Y,Z,'FaceColor','b', 'HandleVisibility', 'off')
surface(X,Y,-Z,'FaceColor', 'b', 'DisplayName', 'Momentum Ellipsoid')

% Polhode plots
plot3(om(:,1), om(:,2), om(:,3), 'r', 'LineWidth', 5, 'DisplayName',
'Polhode')
axis equal
view([1 1 0.5])
ax = gca();
ax.FontSize = 14;
xlabel('x')
ylabel('y')
zlabel('z')
legend
exportgraphics(gcf, ['./Images/ellipsoid_polhode_', name, '.png'])

xmin = min(om(:,1));
xmax = max(om(:,1));
ymin = min(om(:,2));
ymax = max(om(:,2));
zmin = min(om(:,3));
zmax = max(om(:,3));

x = linspace(xmin, xmax, n);

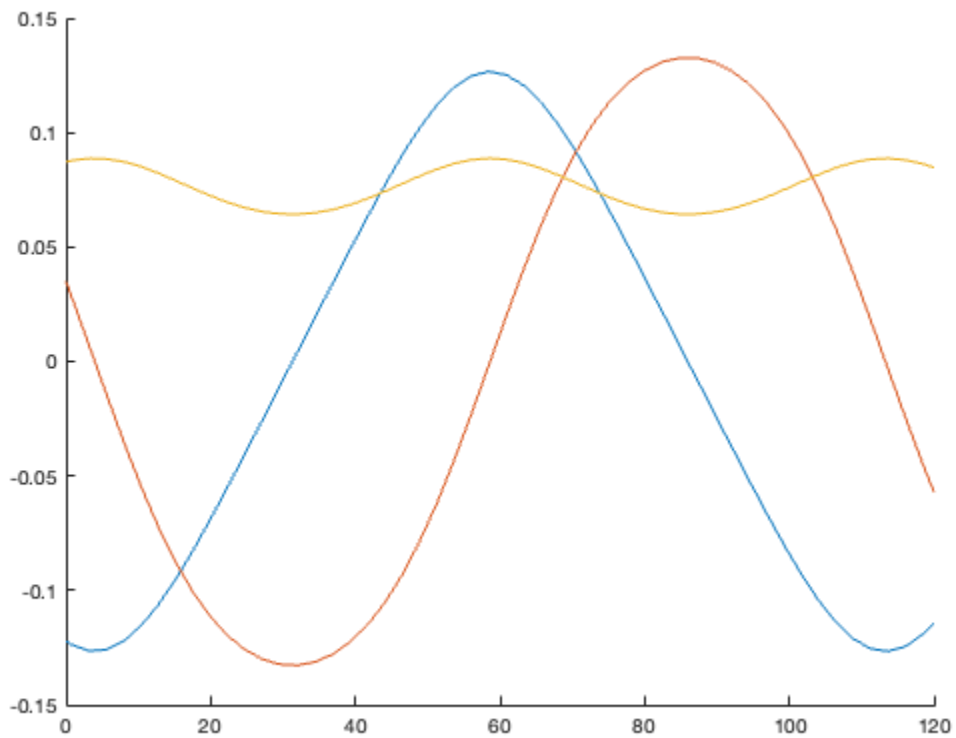
figure
subplot(3,1,1)
ax = gca();
ax.FontSize = 14;
ax.LineWidth = 2;
plot(om(:,1), om(:,2), 'DisplayName', 'Simulated', 'LineWidth', 2)
hold on
y = real( sqrt( (L^2 - 2*T*Iz - (Ix - Iz).*Ix.*x.^2)/((Iy - Iz)*Iy) ) );
plot(x,y, 'r--', 'HandleVisibility','off', 'LineWidth', 2)
plot(x,-y,'r--', 'DisplayName', 'Theoretical', 'LineWidth', 2)
xlabel('x')
ylabel('y')
legend
axis equal
subplot(3,1,2)
ax = gca();
ax.FontSize = 14;
ax.LineWidth = 2;
plot(om(:,1), om(:,3), 'LineWidth', 2)
hold on
xlabel('x')
ylabel('z')
z = real( sqrt( (L^2 - 2*T*Iy - (Ix - Iy).*Ix.*x.^2)/((Iz - Iy)*Iz) ) );
plot(x,z, 'r--', 'LineWidth', 2)
axis equal
```

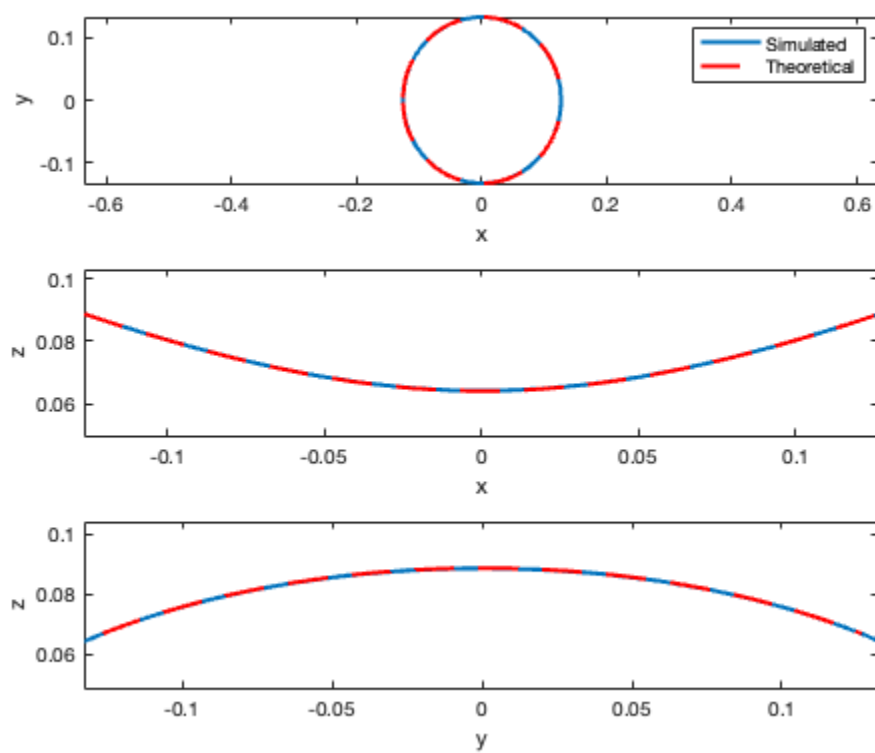
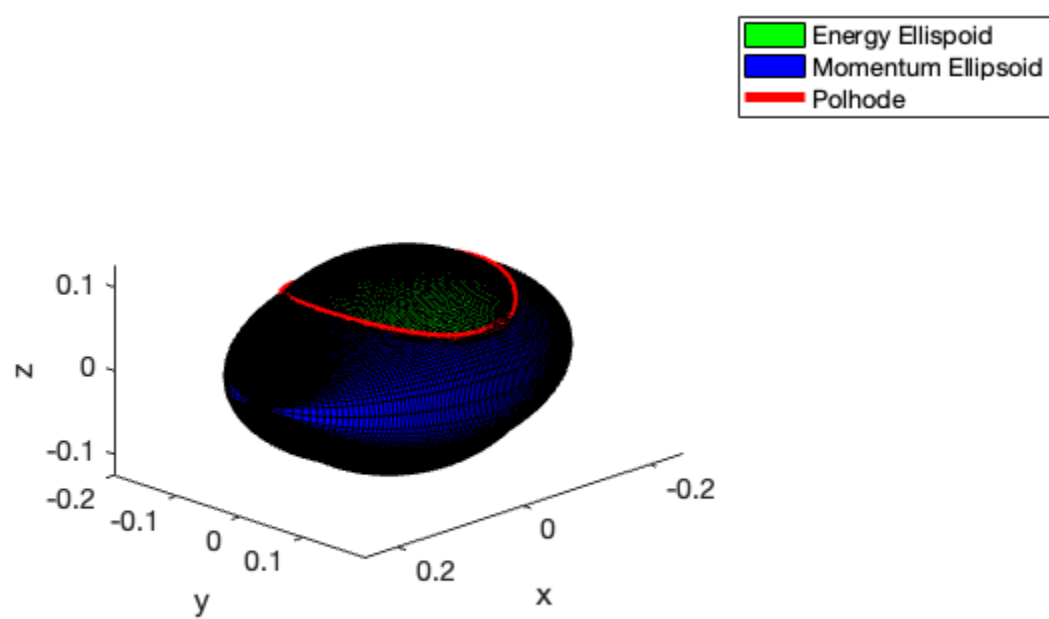
```

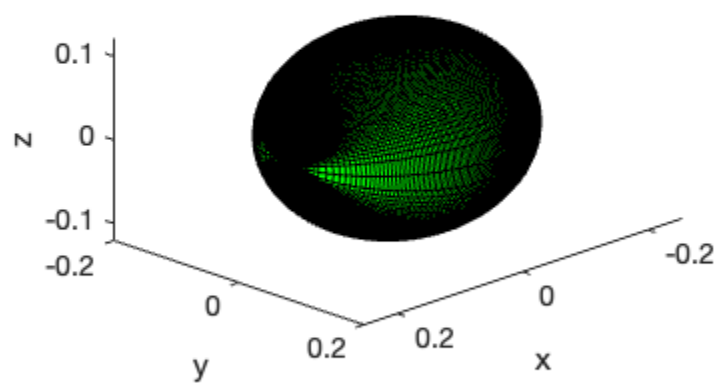
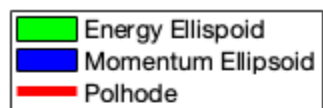
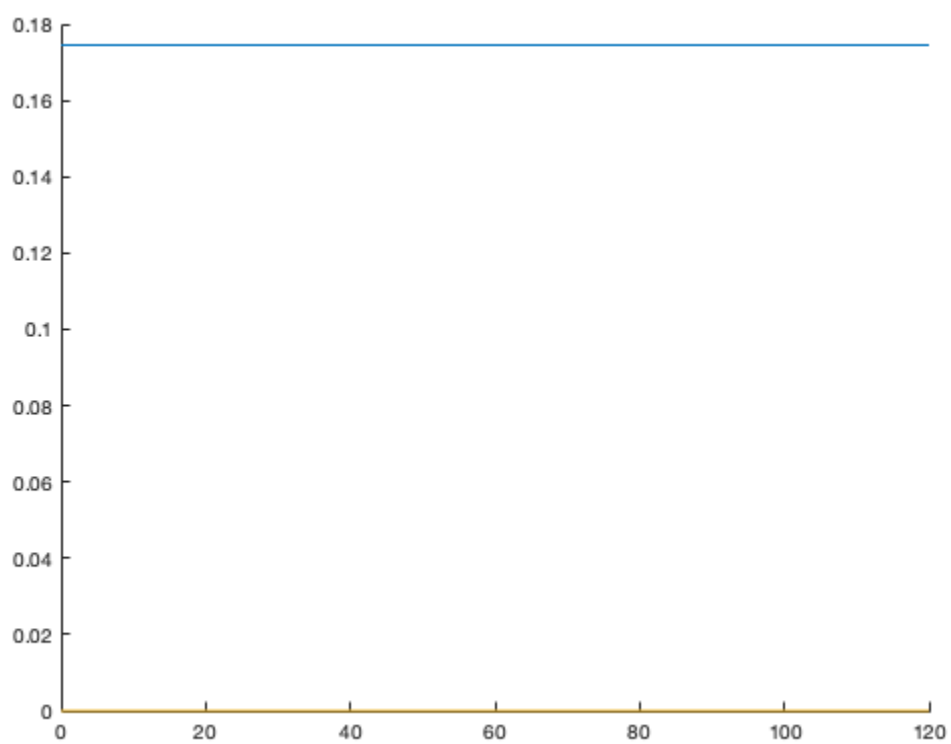
subplot(3,1,3)
ax = gca();
ax.FontSize = 14;
ax.LineWidth = 2;
plot(om(:,2), om(:,3), 'LineWidth', 2)
hold on
xlabel('y')
ylabel('z')
y = x;
z = real( sqrt( (L^2 - 2*T*Ix - (Iy - Ix).*Iy.*y.^2)/((Iz - Ix)*Iz) ) );
plot(y,z, 'r--', 'LineWidth', 2)
axis equal

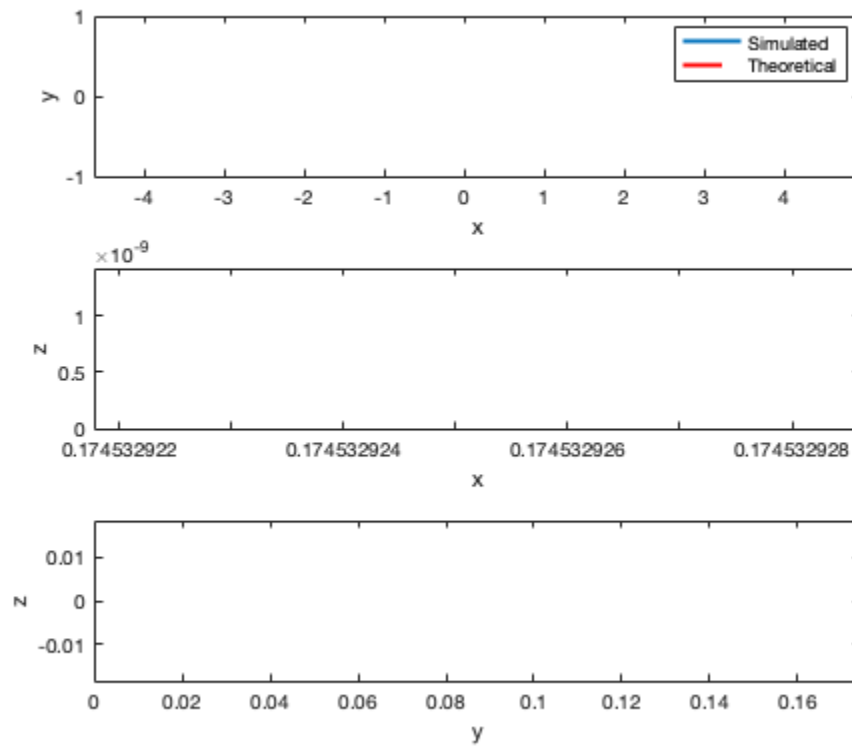
exportgraphics(gcf, ['./Images/planar_polhode_', name, '.png'])
end

```









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