

Gyroscope Nutation

- Gyro with intrinsic precession frequency $\omega_p = Mgl/L$ and nutation frequency $\omega_n = L/Ip$ in the equatorial plane. Variables are the horizontal and vertical angular velocities: ω_h & ω_v .

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(Local) In[118]:=
  Clear["Global`*"];

(Local) In[119]:=
  eqn = {wh[t] - wv'[t]/wn == wp, wh'[t]/wn + wv[t] == 0};

(Local) In[120]:=
  init = {wh[0] == wh0, wv[0] == wv0};

(Local) In[121]:=
  dsol = DSolve[Join[eqn, init], {wh[t], wv[t]}, t] // Simplify;

(Local) In[122]:=
  wsol[t_] = {wh[t], wv[t]} /. dsol

(Local) Out[122]=
  {{wp + (wh0 - wp) Cos[t wn] - wv0 Sin[t wn], wv0 Cos[t wn] + (wh0 - wp) Sin[t wn]}}
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(Local) In[123]:=
  coord[t_] = Integrate[wsol[ti], {ti, 0, t}]

(Local) Out[123]=
  {{t wp -  $\frac{wv0}{wn} + \frac{wv0 \cos[t wn]}{wn} - \frac{(wh0 - wp) \sin[t wn]}{wn}$ ,
   $\frac{wh0 - wp}{wn} - \frac{(wh0 - wp) \cos[t wn]}{wn} + \frac{wv0 \sin[t wn]}{wn}$ }}
```

- Set $\omega_{h0} \rightarrow 0$, $\omega_{v0} \rightarrow 0$ for nutation as when gyro is initially at rest, and then try $\omega_{h0} \rightarrow \omega_p$ for precession without nutation. Plots two nutation cycles.

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(Local) In[124]:=
  val = {wn == 4 Pi, wp == Pi, wh0 == 0, wv0 == 0};

(Local) In[125]:=
  curve = ParametricPlot[Evaluate[coord[t] /. val], {t, 0, 1}, GridLines == Automatic,
    Frame == True, PlotStyle == {RGBColor[1, 0, 0]}, PlotRange == {{-.5, 3.5}, {-0.8, 0.2}}];

(Local) In[126]:=
  Clear[coordplot];
  coordplot[t_] := ListPlot[coord[t] /. val, GridLines == Automatic,
    Frame == True, PlotStyle == {PointSize[0.03], RGBColor[0, 0, 1]},
    PlotRange == {{-.5, 3.5}, {-0.8, 0.2}}];

(Local) In[128]:=
  plotarray = Table[coordplot[tp], {tp, 0, 1, 0.05}];
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(Local) In[129]:=
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Show[curve, plotarray];
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