

```

> des := {delta(t) = 0.01*t, delta(t0) = delta0, diff(phi(t), t) =
tan(delta(t))/l, diff(x(t), t) = V*cos(phi(t)), diff(y(t), t) =
V*sin(phi(t)), phi(t0) = phi0, x(t0) = x0, y(t0) = y0};
> desSol := dsolve(des, numeric, parameters = [V, l, t0, x0, y0,
phi0, delta0]);
> desSol(parameters = [109, 5, 0, 0, 0, 0, 0]);
> desSol(90);
> with(plots);
> odeplot(desSol, [[t, x(t)], [t, y(t)], [t, phi(t)]], 0 .. 300,
labels = ["t", "Trajectory"], legend = ["x(t) - Position in x",
"y(t) - Position in y", "phi(t) - Heading Angle"]);
> odeplot(desSol, [t, x(t), y(t)], 0 .. 300);
> odeplot(desSol, [x(t), y(t), phi(t)], 0 .. 150, labels = ["x -
Position", "y - Position", "phi - Heading Angle"]);

```

$$des := \left\{ \begin{aligned}
&\delta(t) = 0.01 t, \delta(t_0) = \delta_0, \frac{d}{dt} \phi(t) = \frac{\tan(\delta(t))}{l}, \frac{d}{dt} x(t) = V \cos(\phi(t)), \frac{d}{dt} y(t) \\
&= V \sin(\phi(t)), \phi(t_0) = \phi_0, x(t_0) = x_0, y(t_0) = y_0 \end{aligned} \right\}$$

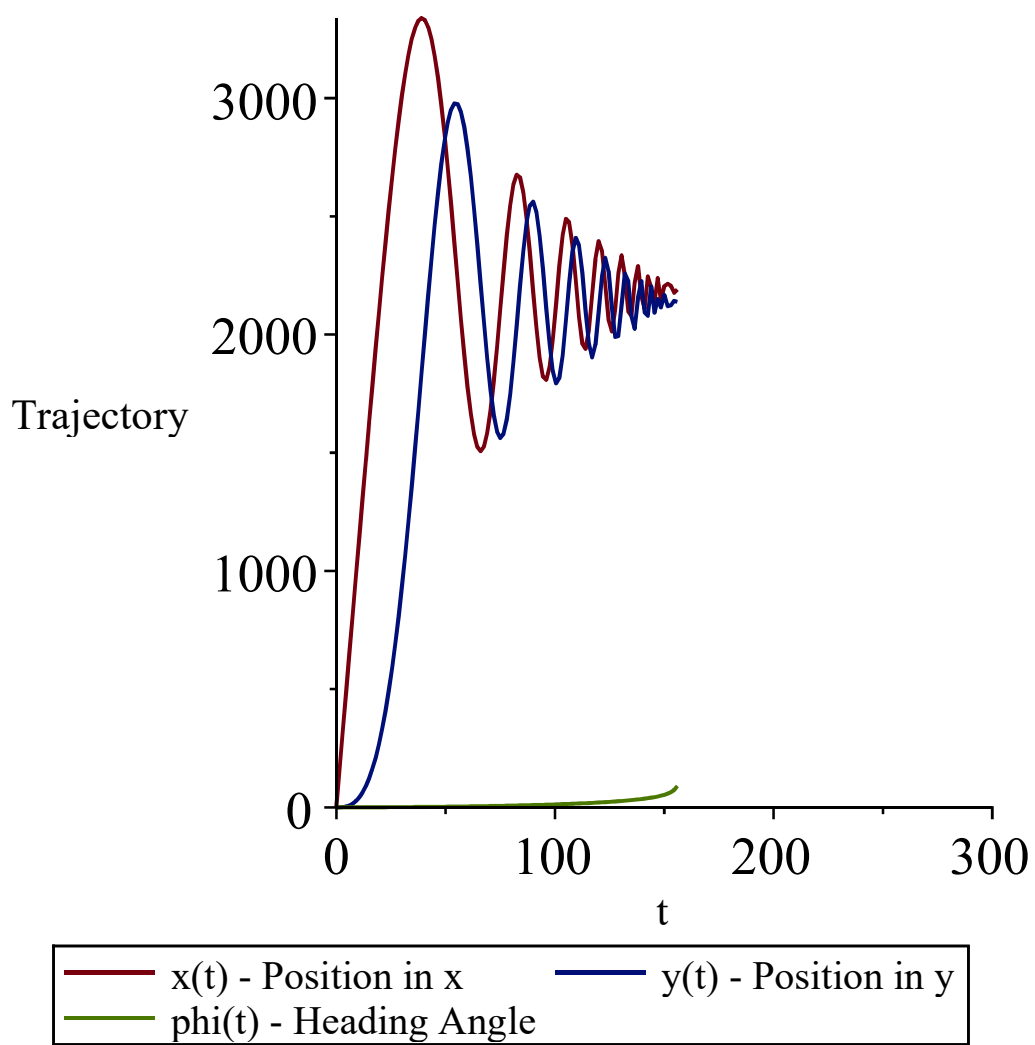
*desSol* := **proc**(*x\_rkf45\_dae*) ... **end proc**

[*V* = 109., *l* = 5., *t*<sub>0</sub> = 0., *x*<sub>0</sub> = 0., *y*<sub>0</sub> = 0.,  $\phi_0 = 0.$ ,  $\delta_0 = 0.$ ]

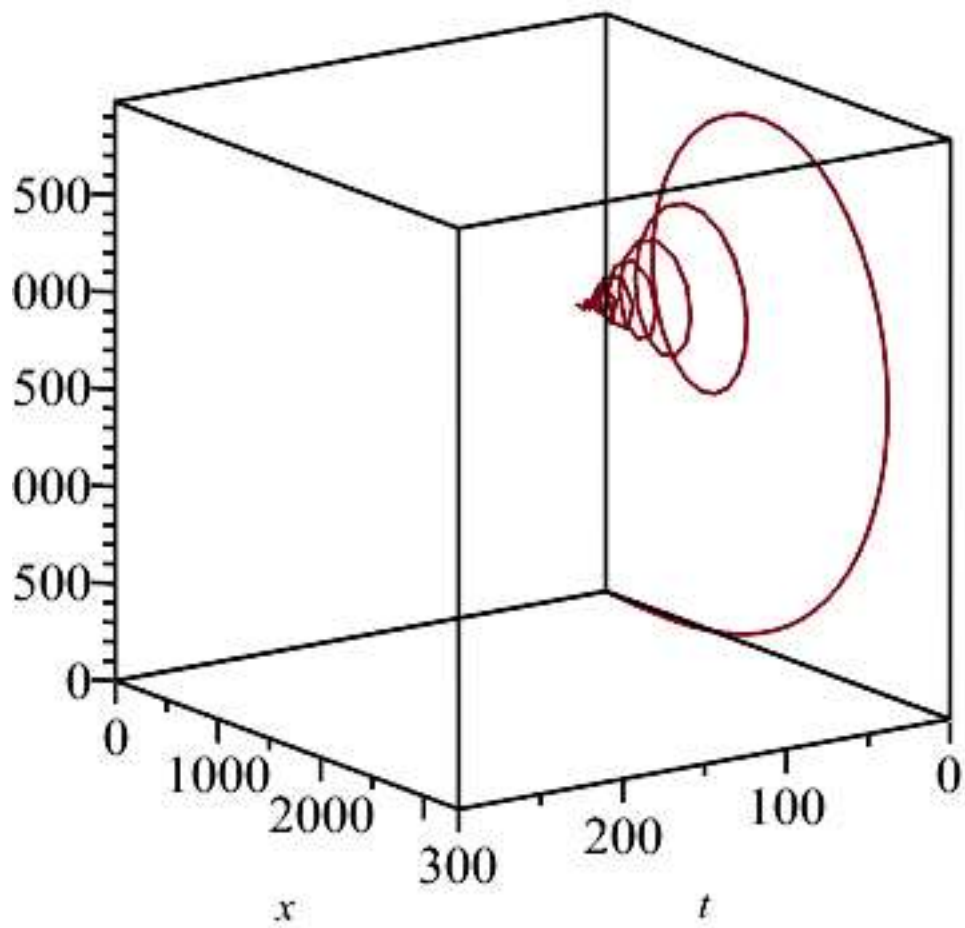
[*t* = 90.,  $\delta(t) = 0.9000000000000000$ ,  $\phi(t) = 9.50884887136091$ ,  $x(t) = 2184.94156683081$ ,  $y(t) = 2561.96008935270$ ]

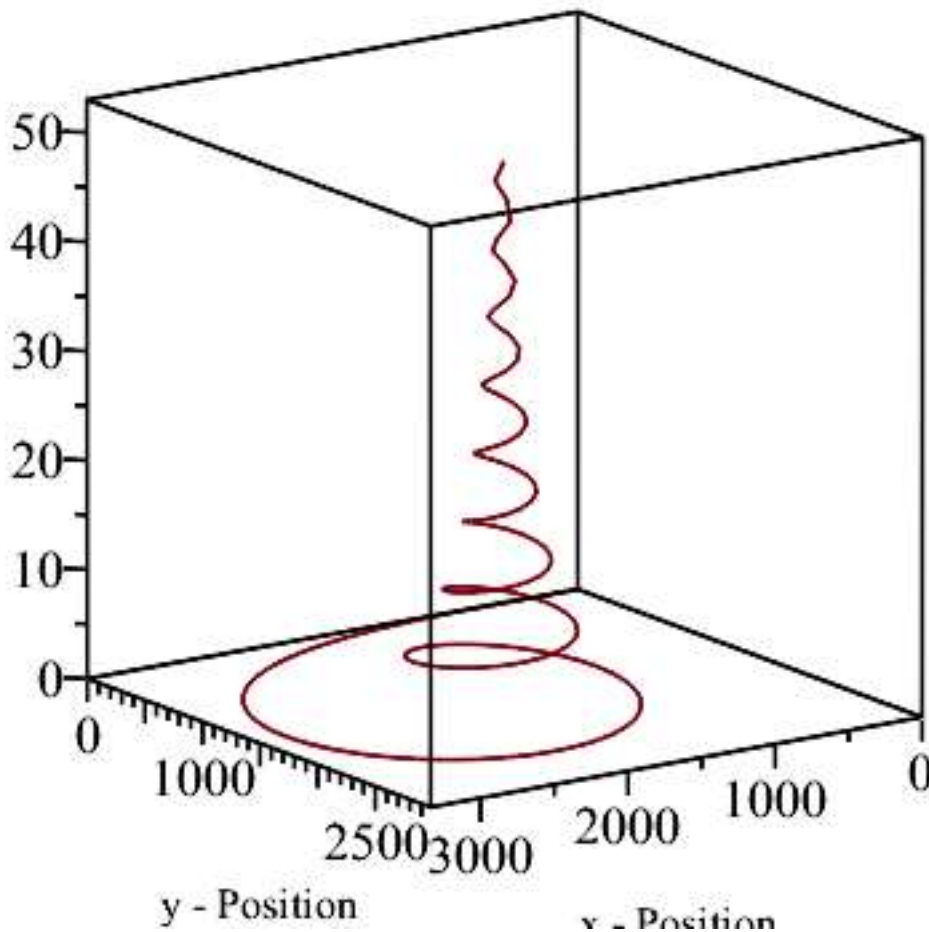
[*animate*, *animate3d*, *animatecurve*, *arrow*, *changecoords*, *complexplot*, *complexplot3d*, *conformal*, *conformal3d*, *contourplot*, *contourplot3d*, *coordplot*, *coordplot3d*, *densityplot*, *display*, *dualaxisplot*, *fieldplot*, *fieldplot3d*, *gradplot*, *gradplot3d*, *implicitplot*, *implicitplot3d*, *inequal*, *interactive*, *interactiveparams*, *intersectplot*, *listcontplot*, *listcontplot3d*, *listdensityplot*, *listplot*, *listplot3d*, *loglogplot*, *logplot*, *matrixplot*, *multiple*, *odeplot*, *pareto*, *plotcompare*, *pointplot*, *pointplot3d*, *polarplot*, *polygonplot*, *polygonplot3d*, *polyhedra\_supported*, *polyhedraplot*, *rootlocus*, *semilogplot*, *setcolors*, *setoptions*, *setoptions3d*, *shadebetween*, *spacecurve*, *sparsematrixplot*, *surfdata*, *textplot*, *textplot3d*, *tubeplot*]

Warning, cannot evaluate the solution further right of 157.07963, probably a singularity



[Warning, cannot evaluate the solution further right of 157.07963, probably a singularity](#)





```
> fsolve(des)
```

$$fsolve\left(\left\{\delta(t) = 0.01 t, \delta(t0) = \emptyset, \frac{d}{dt} \phi(t) = \frac{\tan(\delta(t))}{l}, \frac{d}{dt} x(t) = V \cos(\phi(t)), \frac{d}{dt} y(t) = V \sin(\phi(t)), \phi(t0) = \phi0, x(t0) = x0, y(t0) = y0\right\}, \{V, \emptyset, l, \phi0, t, t0, x0, y0\}\right) \quad (1)$$

```
> singularities(des, t)
```

$$singularities(des, t) \quad (2)$$

```
> singularities(desSol, [[t, x(t)], [t, y(t)], [t, phi(t)]] )
```

$$singularities(desSol, [[t, x(t)], [t, y(t)], [t, \phi(t)]] ) \quad (3)$$

```
> with
(DEtools,
singularities, hyperode, convertAlg, dpolyform)
with (DEtools, singularities, hyperode, convertAlg, dpolyform) \quad (4)
```

```
> singularities(des)
```

$$singularities(des) \quad (5)$$

```
> singularities(desSol)
```

$$\text{singularity}(\text{desSol}) \quad (6)$$

$$\begin{aligned} &> \text{singularity}(\text{des}, x(t), y(t)) \\ &\text{singularity}(\text{des}, x(t), y(t)) \end{aligned} \quad (7)$$

$$\begin{aligned} &> \text{des} \\ &\text{des} \end{aligned} \quad (8)$$

$$\begin{aligned} &> \text{singularity}(\{ \delta(t) = 0.01 * t, \delta(t0) = \delta0, \text{diff}(\phi(t), t) = \tan(\delta(t)) / l, \text{diff}(x(t), t) = V * \cos(\phi(t)), \text{diff}(y(t), t) = V * \sin(\phi(t)), \phi(t0) = \phi0, x(t0) = x0, y(t0) = y0 \}, \\ &t, x(t), y(t)) \\ &\text{singularity} \left( \left\{ \delta(t) = 0.01 t, \delta(t0) = \delta0, \frac{d}{dt} \phi(t) = \frac{\tan(\delta(t))}{l}, \frac{d}{dt} x(t) = V \cos(\phi(t)), \frac{d}{dt} \right. \right. \\ &\left. \left. y(t) = V \sin(\phi(t)), \phi(t0) = \phi0, x(t0) = x0, y(t0) = y0 \right\}, t, x(t), y(t) \right) \end{aligned} \quad (9)$$

$$\begin{aligned} &> \text{singularity}(\{ \delta(t) = 0.01 * t, \delta(t0) = \delta0, \text{diff}(\phi(t), t) = \tan(\delta(t)) / l, \text{diff}(x(t), t) = V * \cos(\phi(t)), \text{diff}(y(t), t) = V * \sin(\phi(t)), \phi(t0) = \phi0, x(t0) = x0, y(t0) = y0 \}, \\ &t, x(t), y(t), \phi(t)) \\ &\text{singularity} \left( \left\{ \delta(t) = 0.01 t, \delta(t0) = \delta0, \frac{d}{dt} \phi(t) = \frac{\tan(\delta(t))}{l}, \frac{d}{dt} x(t) = V \cos(\phi(t)), \frac{d}{dt} \right. \right. \\ &\left. \left. y(t) = V \sin(\phi(t)), \phi(t0) = \phi0, x(t0) = x0, y(t0) = y0 \right\}, t, x(t), y(t), \phi(t) \right) \end{aligned} \quad (10)$$

>