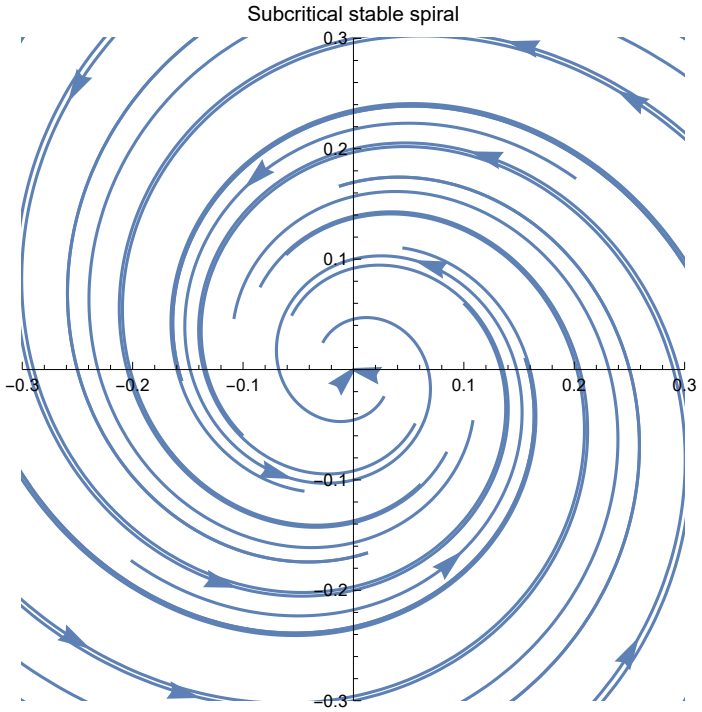
d)

In[16]:=
```
Clear["Global`*"]
xmin = -0.3;
xmax = 0.3;
ymin = -0.3;
ymax = 0.3;
solution[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] - 4 y[t] - x[t]^3, y'[t] == 4 x[t] + μ * y[t] + 2 y[t]^3,
     x[0] == x0, y[0] == y0} /. μ → -1, {x, y}, {t, -1, 1}];
IC0 = Table[{0, y}, {y, ymin, ymax, 0.1}]
IC1 = Table[{xmin, y}, {y, ymin, ymax, 0.2}];
IC2 = Table[{xmax, y}, {y, ymin, ymax, 0.2}];
IC3 = Table[{x, ymin}, {x, xmin, xmax, 0.2}];
IC4 = Table[{x, ymax}, {x, xmin, xmax, 0.2}];
ICs = Join[IC0, IC1, IC2, IC3, IC4];
plot =
  Table[ParametricPlot[
     Evaluate[{x[t], y[t]} /. solution[ICs[[i, 1]], ICs[[i, 2]]]], {t, -1, 1}, PlotRange →
      {{xmin, xmax}, {ymin, ymax}}, PlotLabel → "Subcritical stable spiral"] /.
    Line[x_] :> {Arrowheads[{0, 0.0375, 0.0375, 0}], Arrow[x]}, {i, Length[ICs]}];
Show[{plot}]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[22]=
$$\left\{\{0, -0.3\}, \{0, -0.2\}, \{0, -0.1\}, \left\{0, 5.55112 \times 10^{-17}\right\}, \{0, 0.1\}, \{0, 0.2\}, \{0, 0.3\}\right\}$$

Out[29]=

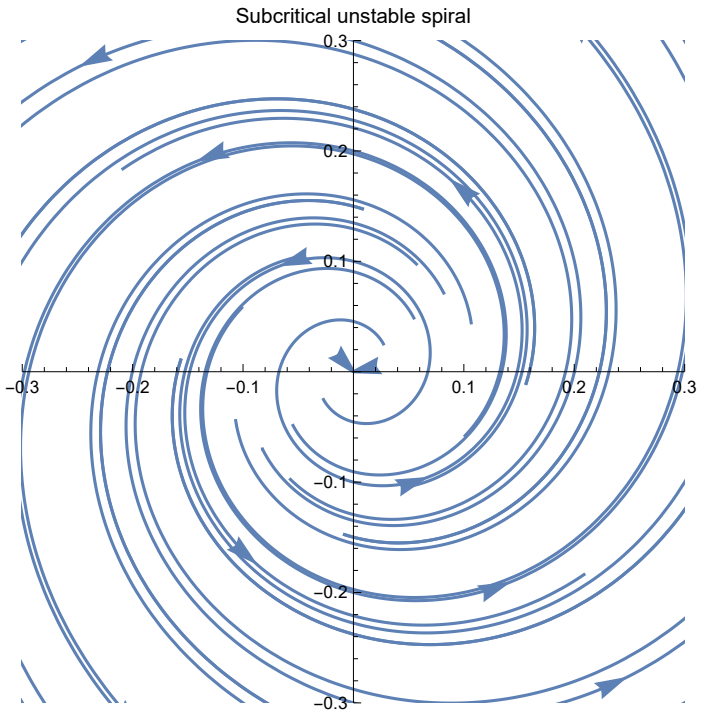


In[1]:=
```
Clear["Global`*"]
Clear["Global`*"]
xmin = -0.3;
xmax = 0.3;
ymin = -0.3;
ymax = 0.3;
solution[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] - 4 y[t] - x[t]^3, y'[t] == 4 x[t] + μ * y[t] + 2 y[t]^3,
     x[0] == x0, y[0] == y0} /. μ → 1, {x, y}, {t, -1, 1}];
IC0 = Table[{0, y}, {y, ymin, ymax, 0.1}]
IC1 = Table[{xmin, y}, {y, ymin, ymax, 0.2}];
IC2 = Table[{xmax, y}, {y, ymin, ymax, 0.2}];
IC3 = Table[{x, ymin}, {x, xmin, xmax, 0.2}];
IC4 = Table[{x, ymax}, {x, xmin, xmax, 0.2}];
ICs = Join[IC0, IC1, IC2, IC3, IC4];
plot =
  Table[ParametricPlot[
     Evaluate[{x[t], y[t]} /. solution[ICs[[i, 1]], ICs[[i, 2]]]], {t, -1, 1}, PlotRange →
      {{xmin, xmax}, {ymin, ymax}}, PlotLabel → "Subcritical unstable spiral"] /.
    Line[x_] :> {Arrowheads[{0, 0.0375, 0.0375, 0}], Arrow[x]}, {i, Length[ICs]}];
Show[{plot}]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[8]=
$$\left\{\{0, -0.3\}, \{0, -0.2\}, \{0, -0.1\}, \left\{0, 5.55112 \times 10^{-17}\right\}, \{0, 0.1\}, \{0, 0.2\}, \{0, 0.3\}\right\}$$

Out[15]=



In[ ]:=
```
Clear["Global`*"]
xmin = -0.3;
xmax = 0.3;
ymin = -0.3;
ymax = 0.3;
solution[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] + y[t] - x[t]^2, y'[t] == -x[t] + μ * y[t] + 2 x[t]^2,
     x[0] == x0, y[0] == y0} /. μ → -1, {x, y}, {t, -2, 2}];
IC0 = Table[{0, y}, {y, ymin, ymax, 0.1}]
IC1 = Table[{xmin, y}, {y, ymin, ymax, 0.05}];
IC2 = Table[{xmax, y}, {y, ymin, ymax, 0.05}];
IC3 = Table[{x, ymin}, {x, xmin, xmax, 0.05}];
IC4 = Table[{x, ymax}, {x, xmin, xmax, 0.05}];
ICs = Join[IC0, IC1, IC2, IC3, IC4];
plot =
  Table[ParametricPlot[
     Evaluate[{x[t], y[t]} /. solution[ICs[[i, 1]], ICs[[i, 2]]]], {t, -2, 2}, PlotRange →
      {{xmin, xmax}, {ymin, ymax}}, PlotLabel → "Supercritical stable spiral"] /.
    Line[x_] :↦ {Arrowheads[{0, 0.0375, 0.0375, 0}], Arrow[x]}, {i, Length[ICs]}];
Show[{plot}]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[ ]= $\left\{\{0, -0.3\}, \{0, -0.2\}, \{0, -0.1\}, \left\{0, 5.55112 \times 10^{-17}\right\}, \{0, 0.1\}, \{0, 0.2\}, \{0, 0.3\}\right\}$

NDSolve: At t == −1.57494, step size is effectively zero; singularity or stiff system suspected.

InterpolatingFunction: Input value {−1.99992} lies outside the range of data in the interpolating function. Extrapolation will be used.

InterpolatingFunction: Input value {−1.99992} lies outside the range of data in the interpolating function. Extrapolation will be used.

NDSolve: At t == −1.80563, step size is effectively zero; singularity or stiff system suspected.

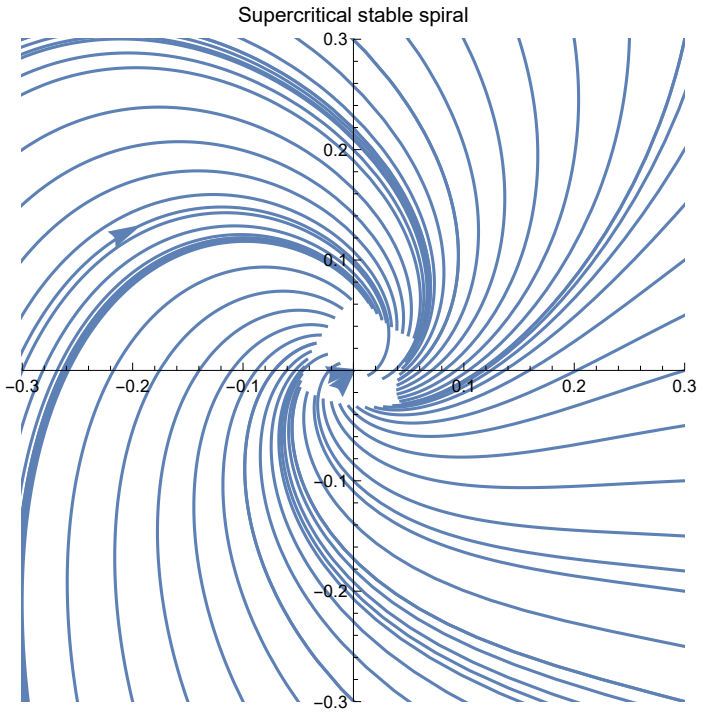
InterpolatingFunction: Input value {−1.99992} lies outside the range of data in the interpolating function. Extrapolation will be used.

General: Further output of InterpolatingFunction::dmval will be suppressed during this calculation.

NDSolve: At t == −1.75185, step size is effectively zero; singularity or stiff system suspected.

General: Further output of NDSolve::ndsz will be suppressed during this calculation.

Out[ ]=



In[•]:=
```
Clear["Global`*"]
xmin = -0.3;
xmax = 0.3;
ymin = -0.3;
ymax = 0.3;
solution[x0_, y0_] =
  NDSolve[{x'[t] == μ * x[t] + y[t] - x[t]^2, y'[t] == -x[t] + μ * y[t] + 2 x[t]^2,
    x[0] == x0, y[0] == y0} /. μ → 1, {x, y}, {t, -2, 2}];
IC0 = Table[{0, y}, {y, ymin, ymax, 0.1}]
IC1 = Table[{xmin, y}, {y, ymin, ymax, 0.1}];
IC2 = Table[{xmax, y}, {y, ymin, ymax, 0.1}];
IC3 = Table[{x, ymin}, {x, xmin, xmax, 0.1}];
IC4 = Table[{x, ymax}, {x, xmin, xmax, 0.1}];
ICs = Join[IC0, IC1, IC2, IC3, IC4];
plot =
  Table[ParametricPlot[
    Evaluate[{x[t], y[t]} /. solution[ICs[[i, 1]], ICs[[i, 2]]]], {t, -2, 2}, PlotRange →
     {{xmin, xmax}, {ymin, ymax}}, PlotLabel → "Supercritical unstable spiral"] /.
   Line[x_] :> {Arrowheads[{0, 0.0375, 0.0375, 0}], Arrow[x]}, {i, Length[ICs]}];
Show[{plot}]
```

NDSolve: Initial condition x0 is not a number or a rectangular array of numbers.

Out[•]= $\{\{0, -0.3\}, \{0, -0.2\}, \{0, -0.1\}, \{0, 5.55112 \times 10^{-17}\}, \{0, 0.1\}, \{0, 0.2\}, \{0, 0.3\}\}$

Out[•]=