In[2725]:=
```
Remove[r, theta, x1, x2, mu, omega, sol, sol1, eq1, eq2, T, r0]
sol = Solve[{mu * r == r^3}, {r}]

r0 = r /. sol[[3]]

thetaP = omega + nu * r0^2;
T = 2 * Pi / (thetaP)

x1 = r * Cos[theta];
x2 = r * Sin[theta];
Remove[thetaP, rP, omega, nu, mu]

eq1 = rP * Cos[theta] - r * Sin[theta] * thetaP ==
   1 / 10 * x1 - x2^3 - x1 * x2^2 - x1^2 * x2 - x2 - x1^3;
eq2 = rP * Sin[theta] + r * Cos[theta] * thetaP ==
   x1 + 1 / 10 * x2 + x1 * x2^2 + x1^3 - x2^3 - x1^2 * x2;
sol1 = Solve[{eq1, eq2}, {rP, thetaP}];

rP = rP /. sol1[[1]]
thetaP = thetaP /. sol1[[1]]

{mu, omega, nu} = {1 / 10, 1, 1}
```

Out[2726]= $\left\{\{r \to 0\}, \left\{r \to -\sqrt{mu}\right\}, \left\{r \to \sqrt{mu}\right\}\right\}$

Out[2727]= $\sqrt{mu}$

Out[2729]= $\dfrac{2\,\pi}{mu + omega}$

Out[2736]= $\dfrac{1}{10}\left(r - 10\,r^3\,\text{Cos}[\text{theta}]^2 - 10\,r^3\,\text{Sin}[\text{theta}]^2\right)$

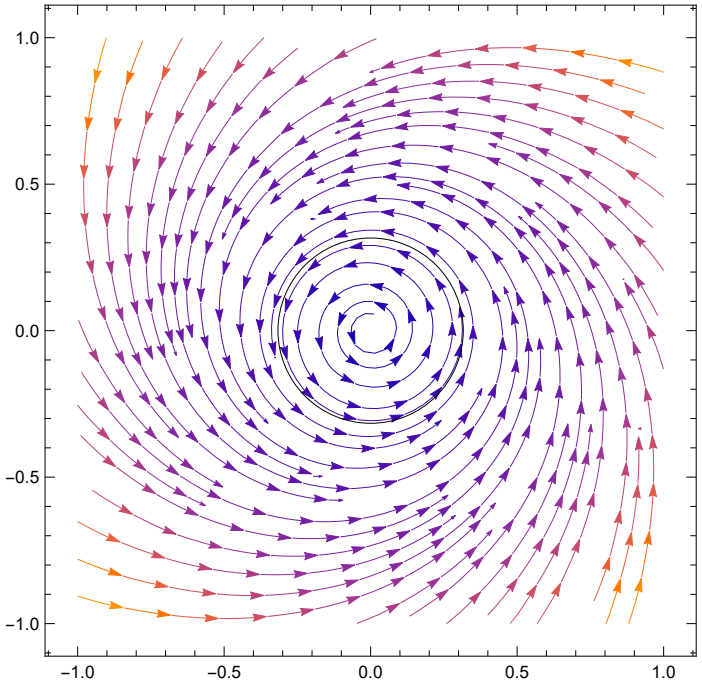
Out[2737]= $1 + r^2\,\text{Cos}[\text{theta}]^2 + r^2\,\text{Sin}[\text{theta}]^2$

Out[2738]= $\left\{\dfrac{1}{10}, 1, 1\right\}$

In[2680]:=
```
Remove[r, theta, x1, x2, mu, omega, t]
x1'[t] = 1 / 10 * x1[t] - x2 [t]^3 - x1[t] * x2[t]^2 - x1[t]^2 * x2[t] - x2[t] - x1[t]^3;
x2'[t] = x1[t] + 1 / 10 * x2[t] + x1[t] * x2[t]^2 + x1[t]^3 - x2[t]^3 - x1[t]^2 * x2[t];

Show[
 StreamPlot[{1 / 10 * x1[t] - x2 [t]^3 - x1[t] * x2[t]^2 - x1[t]^2 * x2[t] - x2[t] - x1[t]^3,
   x1[t] + 1 / 10 * x2[t] + x1[t] * x2[t]^2 + x1[t]^3 - x2[t]^3 - x1[t]^2 * x2[t]},
  {x1[t], -1, 1}, {x2[t], -1, 1}],
 Graphics[Circle[{0, 0}, Sqrt[1 / 10]]]
]
```

Out[2683]=



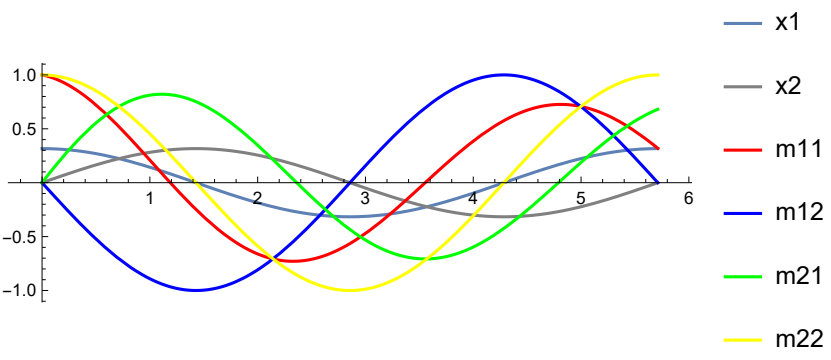
In[2684]:=
```
Remove[x1, x2, m11, m21, m22, m12]
T = 2 * Pi / 1.1;
s = NDSolve[
    {x1'[t] == x1[t] / 10 - x2[t]^3 - x1[t] * x2[t]^2 - x1[t]^2 * x2[t] - x2[t] - x1[t]^3,
                x2'[t] == x1[t] + x2[t] / 10 + x1[t] * x2[t]^2 +
       x1[t]^3 - x2[t]^3 - x1[t]^2 * x2[t],
                m11'[t] == m11[t] * (1 / 10 - x2[t]^2 - 2 * x1[t] * x2[t] - 3 * x1[t]^2) +
                      m21[t] * (-3 x2[t]^2 - 2 * x1[t] * x2[t] - x1[t]^2 - 1),
                m12'[t] == m12[t] * (1 / 10 - x2[t]^2 - 2 * x1[t] * x2[t] - 3 * x1[t]^2) +
                      m22[t] * (-3 x2[t]^2 - 2 * x1[t] * x2[t] - x1[t]^2 - 1),
                m21'[t] == m11[t] * (1 + x2[t]^2 + 3 * x1[t]^2 - 2 x1[t] * x2[t]) +
                     m21[t] * (1 / 10 + 2 * x1[t] * x2[t] - 3 x2[t]^2 - x1[t]^2),
                m22'[t] == m12[t] * (1 + x2[t]^2 + 3 * x1[t]^2 - 2 x1[t] * x2[t]) +
                     m22[t] * (1 / 10 + 2 * x1[t] * x2[t] - 3 x2[t]^2 - x1[t]^2),
                x1[0] == Sqrt[0.1], x2[0] == 0, m11[0] == 1, m12[0] == 0,
     m21[0] == 0, m22[0] == 1}, {x1, x2, m11, m12, m21, m22}, {t, 0, T}];
{x1[T] /. s, x2[T] /. s, m11[T] /. s, m12[T] /. s, m21[T] /. s, m22[T] /. s}

Show[ParametricPlot[Evaluate[{t, x1[t]} /. s], {t, 0, T}, PlotLegends → {x1}],
 ParametricPlot[Evaluate[{t, x2[t]} /. s],
  {t, 0, T}, PlotStyle → Gray, PlotLegends → {x2}],
 ParametricPlot[Evaluate[{t, m11[t]} /. s], {t, 0, T},
  PlotStyle → Red, PlotLegends → {m11}],
 ParametricPlot[Evaluate[{t, m12[t]} /. s], {t, 0, T},
  PlotStyle → Blue, PlotLegends → {m12}],
 ParametricPlot[Evaluate[{t, m21[t]} /. s], {t, 0, T},
  PlotStyle → Green, PlotLegends → {m21}],
 ParametricPlot[Evaluate[{t, m22[t]} /. s], {t, 0, T},
  PlotStyle → Yellow, PlotLegends → {m22}],
 PlotRange → All
]

M = {{m11[T] /. s[[1]], m12[T] /. s[[1]]}, {m21[T] /. s[[1]], m22[T] /. s[[1]]}}
lambda = Eigenvalues[M]
Log[lambda[[1]]] / T
Log[lambda[[2]]] / T
```

Out[2687]= $\{\{0.316228\}, \{-6.71405 \times 10^{-9}\}, \{0.319053\}, \{2.12317 \times 10^{-8}\}, \{0.680947\}, \{1.\}\}$

Out[2688]=



Out[2689]= $\{\{0.319053, 2.12317 \times 10^{-8}\}, \{0.680947, 1.\}\}$

Out[2690]= {1., 0.319053}

Out[2691]= 5.78753×10^{-9}

Out[2692]= −0.2