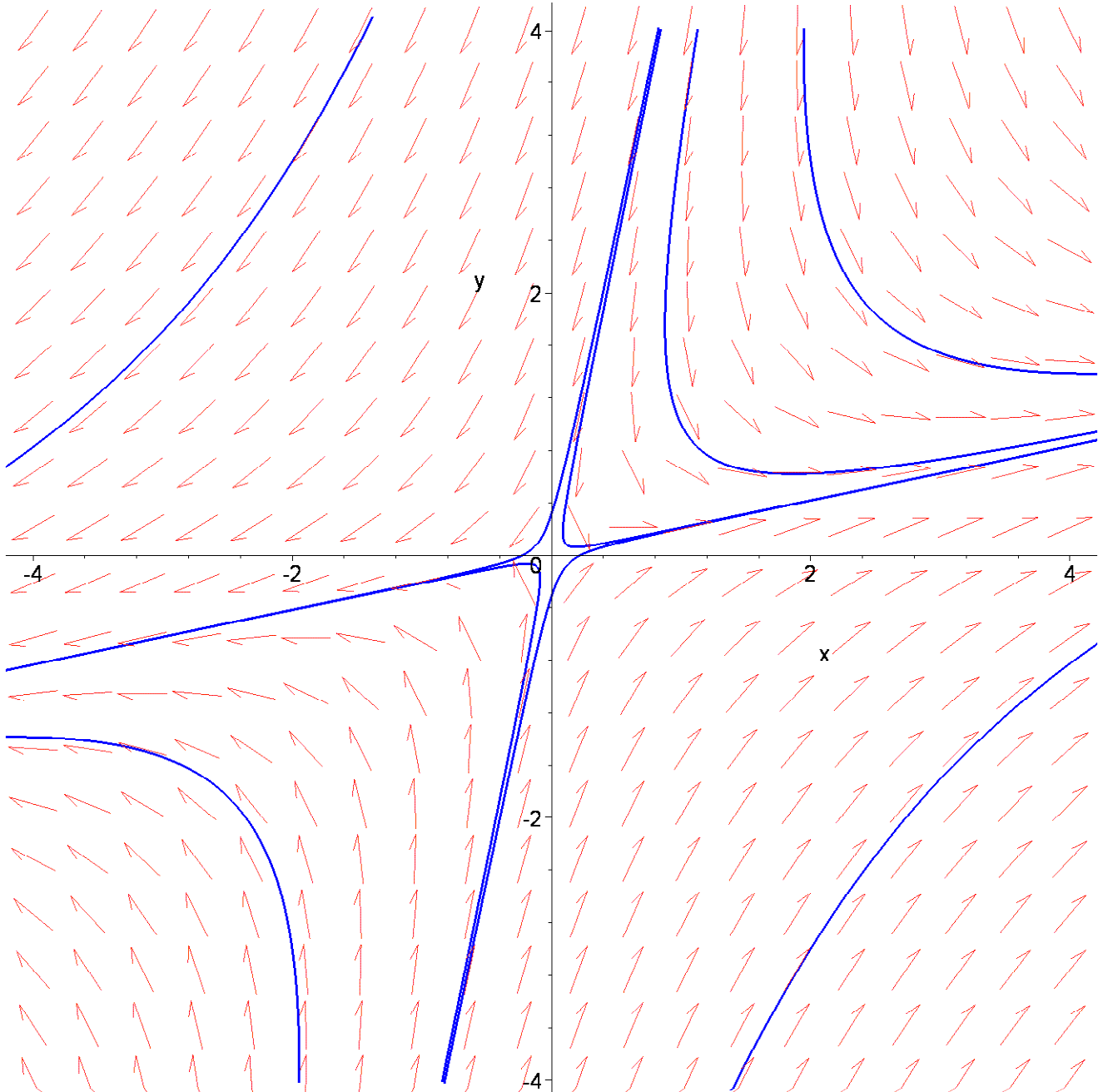


```

> with(DEtools) :
> phaseportrait([D(x)(t)=2*x(t)-y(t),D(y)(t) =
x(t)-3*y(t)], [x(t), y(t)], t=-10..10, [[x(0)=2, y(0)=-3], [x(0)=2, y(0)=
3], [x(0)=-2, y(0)=3], [x(0)=-2, y(0)=-3], [x(0)=1, y(0)=1], [x(0)=.1, y(0)
)=.1], [x(0)=.1, y(0)=-.1], [x(0)=-.1, y(0)=-.1], [x(0)=-.1, y(0)=.1]], x
=-4..4, y=-4..4, stepsize=0.01, linecolor=blue);

```

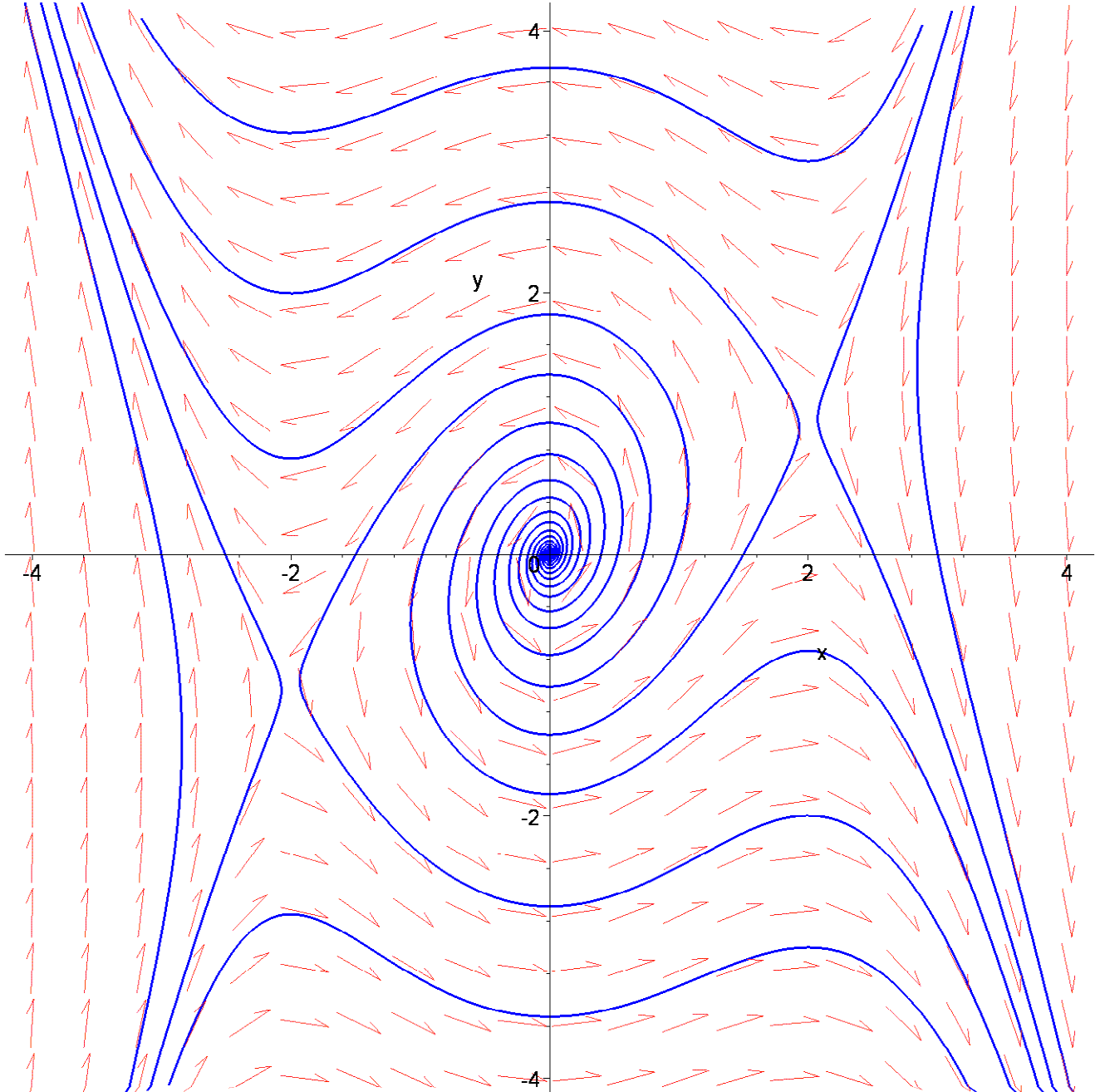


Phase portrait for  $x' = 2x - y$ ,  $y' = x - 3y$ . The critical point  $(0,0)$  is a saddle, which is always unstable.

```

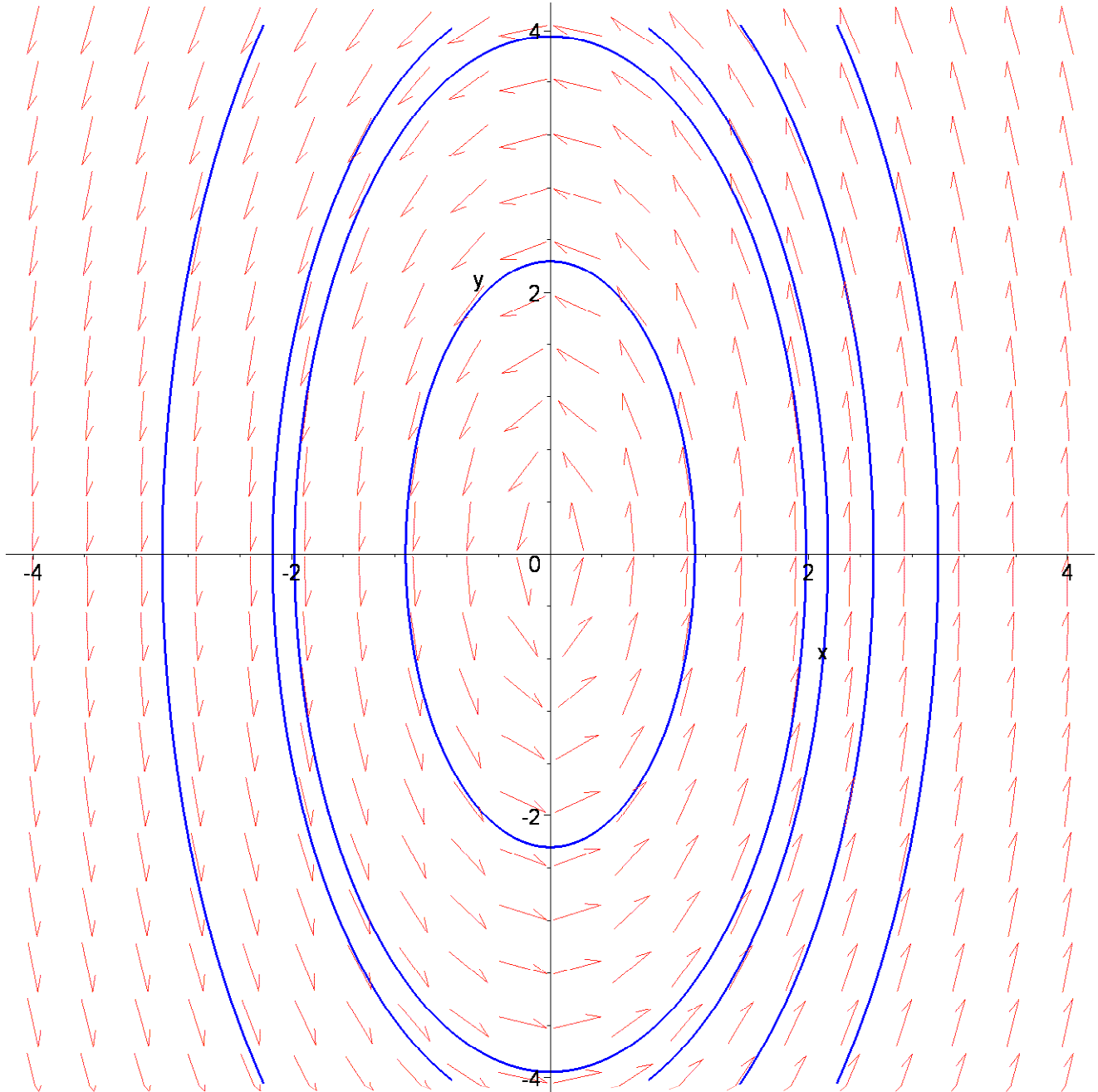
> phaseportrait ([D(x)(t)=x(t)-2*y(t), D(y)(t) =
4*x(t)-x(t)^3], [x(t), y(t)], t=-10..10, [[x(0)=2, y(0)=-3], [x(0)=2, y(0)
)=3], [x(0)=1, y(0)=1], [x(0)=-1, y(0)=-1], [x(0)=3, y(0)=0], [x(0)=-3, y(
0)=0], [x(0)=2.1, y(0)=0.9], [x(0)=1.9, y(0)=1.1], [x(0)=-2.1, y(0)=-0.9
], [x(0)=-1.9, y(0)=-1.1]], x=-4..4, y=-4..4, stepsize=0.01, linecolor=blue);

```



Phase portrait for  $x' = x - 2y$ ,  $y' = 4x - x^3$ . The critical points  $(2,1)$  and  $(-2,-1)$  are saddles and thus unstable. The critical point  $(0,0)$  is an (unstable) spiral source.

```
> phaseportrait([D(x)(t)=-y(t),D(y)(t)=
4*x(t)], [x(t),y(t)],t=-10..10,[[x(0)=2,y(0)=-3],[x(0)=2,y(0)=3],[x
(0)=1,y(0)=1],[x(0)=-1,y(0)=-1],[x(0)=3,y(0)=0],[x(0)=-3,y(0)=0],[
x(0)=2.1,y(0)=0.9],[x(0)=1.9,y(0)=1.1],[x(0)=-2.1,y(0)=-0.9],[x(0)
=-1.9,y(0)=-1.1]],x=-4..4,y=-4..4,stepsize=0.01,linecolor=blue);
```

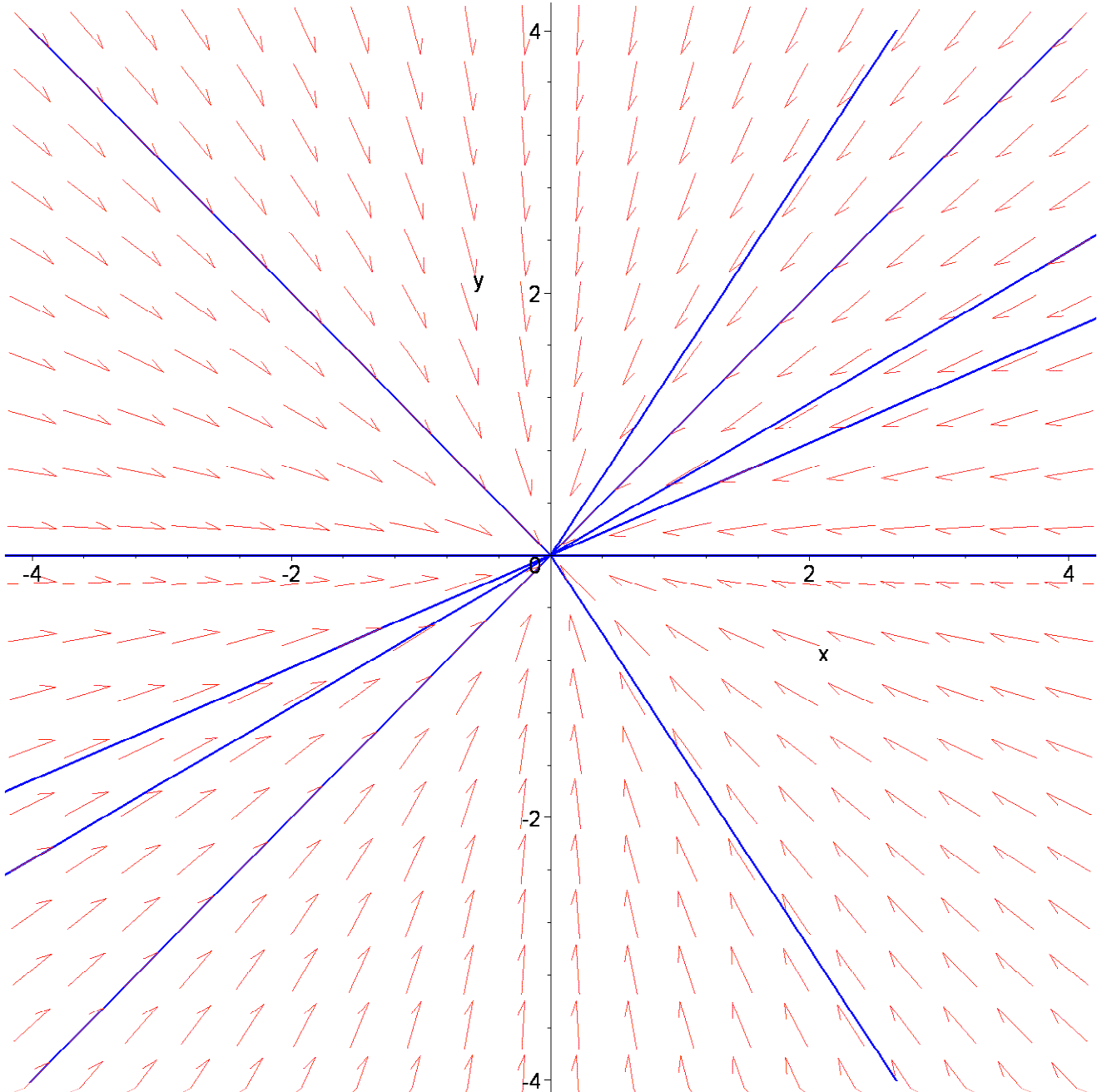


Phase portrait for  $x' = -y$ ,  $y' = 4x$ . The critical point  $(0,0)$  is a center and so stable but not asymptotically stable.

```

> phaseportrait ([D(x)(t)=-x(t),D(y)(t) =
-y(t)], [x(t), y(t)], t=-10..10, [[x(0)=2,y(0)=-3], [x(0)=2,y(0)=3], [x(
0)=1,y(0)=1], [x(0)=-1,y(0)=-1], [x(0)=3,y(0)=0], [x(0)=-3,y(0)=0], [x
(0)=2.1,y(0)=0.9], [x(0)=1.9,y(0)=1.1], [x(0)=-2.1,y(0)=-0.9], [x(0)=
-1.9,y(0)=-1.1], [x(0)=-1,y(0)=1]], x=-4..4,y=-4..4, stepsize=0.01, li
necolor=blue);

```

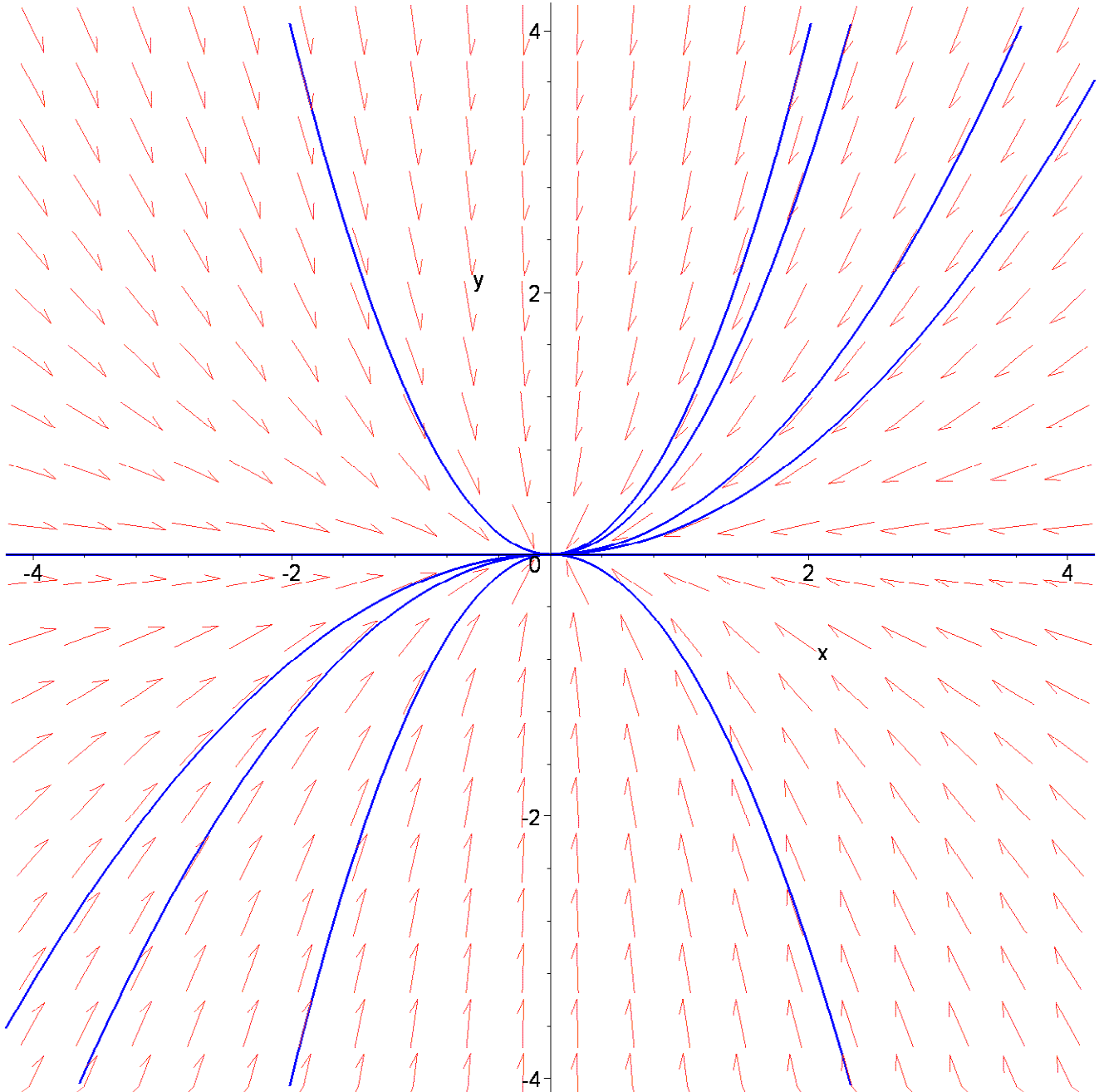


Phase portrait for  $x' = -x$ ,  $y' = -y$ . The critical point  $(0,0)$  is a proper nodal sink and so asymptotically stable as all nearby points approach  $(0,0)$  along their trajectories.

```

> phaseportrait([D(x)(t)=-x(t),D(y)(t) =
-2*y(t)], [x(t), y(t)], t=-10..10, [[x(0)=2, y(0)=-3], [x(0)=2, y(0)=3], [
x(0)=1, y(0)=1], [x(0)=-1, y(0)=-1], [x(0)=3, y(0)=0], [x(0)=-3, y(0)=0],
[x(0)=2.1, y(0)=0.9], [x(0)=1.9, y(0)=1.1], [x(0)=-2.1, y(0)=-0.9], [x(0)
)=-1.9, y(0)=-1.1], [x(0)=-1, y(0)=1]], x=-4..4, y=-4..4, stepsize=0.01,
linecolor=blue);

```

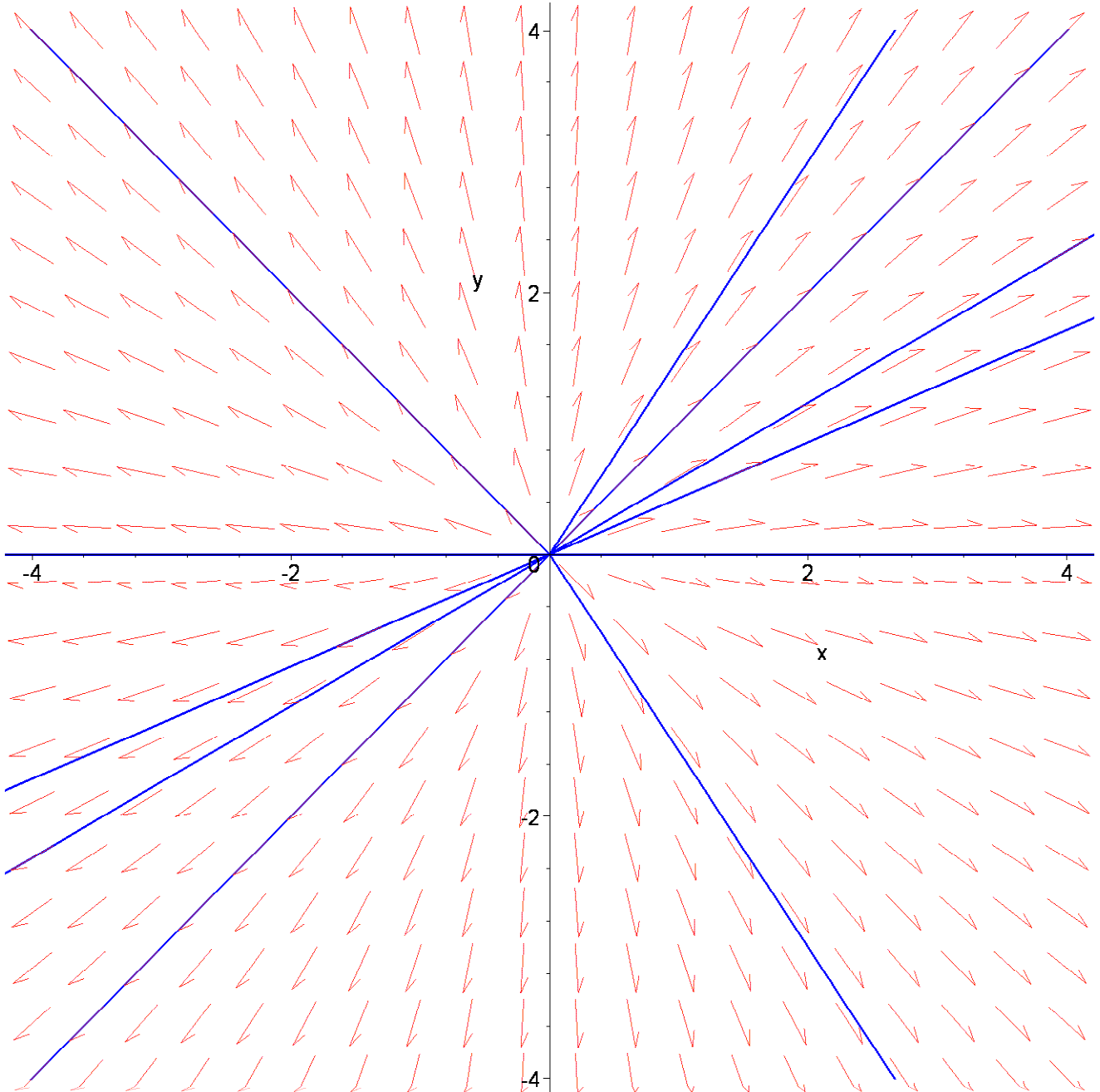


Phase portrait for  $x' = -x$ ,  $y' = -2y$ . The critical point  $(0,0)$  is an improper nodal sink and so asymptotically stable. This node is improper because the trajectories approach  $(0,0)$  along a common tangent line.

```

> phaseportrait ([D(x)(t)=x(t),D(y)(t) =
y(t)], [x(t),y(t)], t=-10..10, [[x(0)=2,y(0)=-3],[x(0)=2,y(0)=3],[x(0)
)=1,y(0)=1],[x(0)=-1,y(0)=-1],[x(0)=3,y(0)=0],[x(0)=-3,y(0)=0],[x(
0)=2.1,y(0)=0.9],[x(0)=1.9,y(0)=1.1],[x(0)=-2.1,y(0)=-0.9],[x(0)=-
1.9,y(0)=-1.1],[x(0)=-1,y(0)=1]], x=-4..4,y=-4..4,stepsize=0.01,lin
ecolor=blue);

```



[ Phase portrait for  $x' = x, y' = y$ . The critical point  $(0,0)$  is a proper nodal source and so unstable.