

```
restart;with(plots):
```

```
Warning, the name changecoords has been redefined
```

```
> s1 := (x, y) -> sqrt((x+r1)^2+y^2);
```

```
s2 := (x, y) -> sqrt((x-r2)^2+y^2);
```

```
veff := (x, y) -> -left( frac(x^2+y^2, 2) + frac(r2, s1(x, y)) + frac(r1, s2(x, y)) right);
```

```
fx := -left( frac(d, dx) veff(x, y) right) + 2 vy;
```

```
fy := -left( frac(d, dy) veff(x, y) right) - 2 vx
```

```
> subf := {x=x(t), y=y(t), vx=vx(t), vy=vy(t)}:
```

```
> eqs := d/dt x(t) = vx(t), d/dt y(t) = vy(t), d/dt vx(t) = subs(subf, fx), d/dt vy(t) = subs(subf, fy)
```

```
> LagrPnts := proc(a)
```

```
local l1, l2, l3, l4:
```

```
global x1, x2, x3, x4, y4, r1, r2:
```

```
r2:=1/(1+a):r1:=1-r2:
```

```
l1:=(r2/(x+r1)^2+r1/(x-r2)^2)-x:x1:=fsolve(l1, x=r2..2):
```

```
l2:=(r2/(x+r1)^2-r1/(x-r2)^2)-x:x2:=fsolve(l2, x=0..r2):
```

```
l3:=(r2/(x+r1)^2+r1/(x-r2)^2)+x:x3:=fsolve(l3, x=-2..-r1):
```

```
x4:=(r2-r1)/2:y4:=evalf(sqrt(3)/2):
```

```
end:
```

```
> LagrPnts(0.18):print(r1, r2, x1, x2, x3, x4, y4);
```

```
.1525423729, .8474576271, 1.270561734, .5154434537, -1.063347180, .3474576272,
```

```
.8660254040
```

```
> veff(x, y);
```

$$-\frac{1}{2}x^2 - \frac{1}{2}y^2 - \frac{.8474576271}{\sqrt{(x+.1525423729)^2+y^2}} - \frac{.1525423729}{\sqrt{(x-.8474576271)^2+y^2}}$$

```
> pl:=plot3d([ [x1, 0, veff(x1, 0)], [x2, 0, veff(x2, 0)], [x3, 0, veff(x3, 0)], [x4, y4, veff(x4, y4)], [x4, -y4, veff(x4, -y4)] ], x=-1.5..1.5, y=-1.4..1.4, style=point, symbol=cross, color=black, symbolsize=30):
```

```
> Vmin:=-4:nc:=20:
```

```
cons := [ seq(k/nc*Vmin, k=0..nc-1) ]:
```

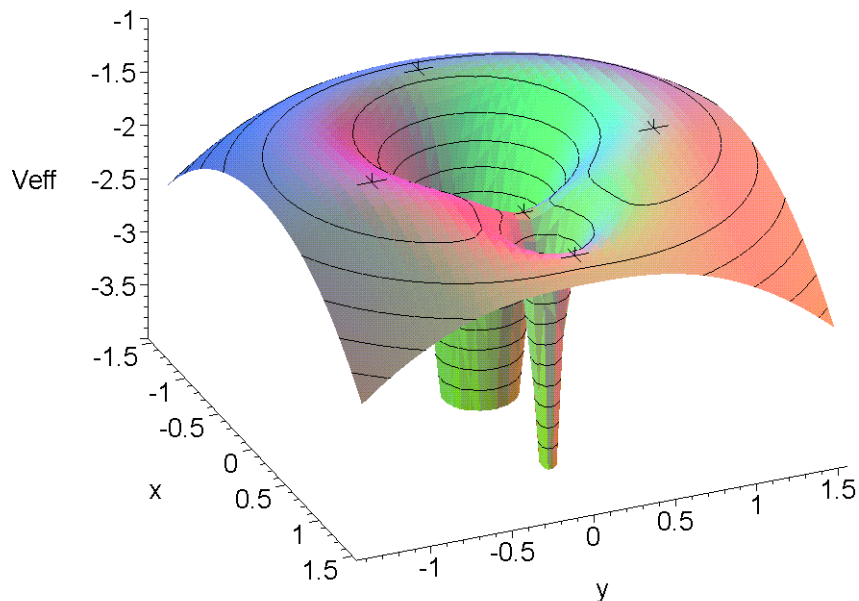
```
pv:=plot3d([x, y, veff(x, y)],
```

```
x=-1.5..1.5,
```

```
y=-1.4..1.5, grid=[40, 40], contours=cons, view=Vmin..-1,
```

```
labels=[`x`, `y`, `Veff`], lightmodel=light1, axes=FRAMED, style=PATC  
HCONTOUR, orientation=[-23, 53]):
```

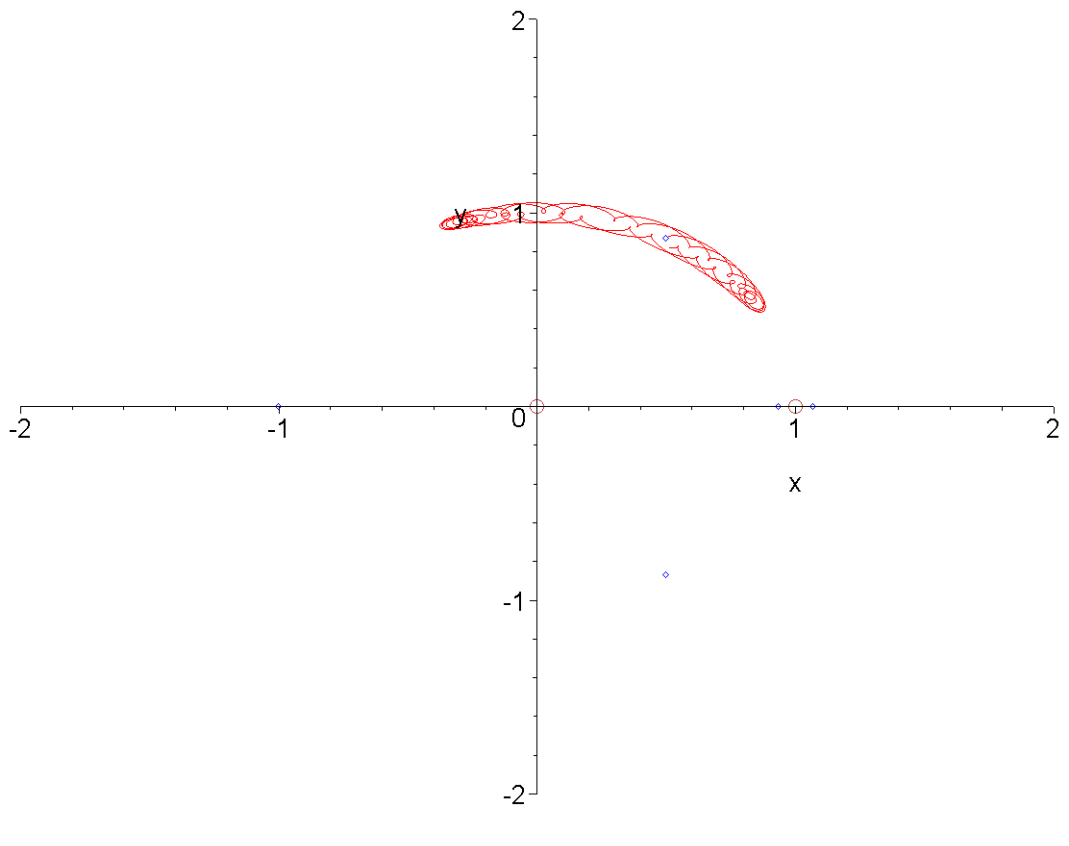
```
> display({pl, pv});
```



```

> a := .953875e-3:LagrPnts(a):print(r1,r2,x1,x2,x3,x4,y4);
LPnts:=[[x1,0]], [[x2,0]], [[x3,0]], [[x4,y4]], [[x4,-y4]]:
ppl:=plot([LPnts],style=point,symbol=diamond,symbolsize=15,colour=blue):
bodies:=[-r1,0],[r2,0]:
ppb:=plot([bodies],style=point,
symbol=[circle,circle],symbolsize=[30,10],colour=brown):
.0009529660,.9990470340,1.068808764,.9323871917,-1.000397069,.4990470340,
.8660254040
> funs:={x(t),y(t),vx(t),vy(t)};
      funs:={x(t),y(t),vx(t),vy(t)}
> ini0:=x(0)=x4*1.01,y(0)=y4*1.01,vx(0)=0.01,vy(0)=0.01:
ran:=0..200:
dsol0:=dsolve([eqs,ini0],numeric,funs,range=ran):
pl:=odeplot(dsol0,[x(t),y(t)],ran,labels=[x,y],
view=[-2..2,-2..2]):
> display({pl,ppl,ppb});

```



[>