Sage2-Vorlesung

```
x
```

```
x
```

```
parent(x)
```

```
Symbolic Ring
```

```
x^2+4
```

```
x^2 + 4
```

```
var('y')
```

```
y
```

```
parent(y)
```

```
Symbolic Ring
```

```
var('u v')
```

```
(u, v)
```

```
parent(u)
```

```
Symbolic Ring
```

```
f=(x+y)^3
f
```

```
(x + y)^3
```

```
g=expand(f)
g
```

```
x^3 + 3*x^2*y + 3*x*y^2 + y^3
```

```
f.expand()
```

```
x^3 + 3*x^2*y + 3*x*y^2 + y^3
```

```
g
```

```
x^3 + 3*x^2*y + 3*x*y^2 + y^3
```

```
factor(g)
```

```
(x + y)^3
```

```
factor(442)
```

```
2 * 13 * 17
```

```
show(diff(exp(-2*x),x))
```

$$-2\,e^{(-2\,x)}$$

Integral: $\int_0^{\pi} \sin(x)dx$

```
integrate(sin(x),x,0,pi)
```

```
    2
```

```
integral(sin(x),x,0,pi)
```

```
    2
```

```
integral(sin(x),(x,0,pi))
```

```
    2
```

```
parent(v)
```

```
    Symbolic Ring
```

```
reset('v')
```

```
parent(v)
```

```
    Traceback (click to the left of this block for traceback)
    ...
    NameError: name 'v' is not defined
```

```
f(x)=x^2+x
```

```
print f
show(f)
```

```
    x |--> x^2 + x
```

$$x \mapsto x^2 + x$$

```
parent(f)
```

```
    Callable function ring with argument x
```

```
F(n)=n*(n-1)
show(F)
```

$$n \mapsto (n-1)n$$

```
parent(n)
```

```
    Symbolic Ring
```

```
show(f)
```

$$x \mapsto x^2 + x$$

```
g(x)=x^4
```

```
show(f+g)
```

$$x \mapsto x^4 + x^2 + x$$

```
show(expand(g(f)))
```

$x^8 + 4x^7 + 6x^6 + 4x^5 + x^4$

```
print f(7)
print parent(f(7))
print factor(f(7))
print parent(56)
print factor(Integer(f(7)))
```

```
56
Symbolic Ring
56
Integer Ring
2^3 * 7
```

```
diff(f)
```

```
x |--> 2*x + 1
```

```
h(x,y,z)=sin(x*y+z)
diff(h)
```

```
(x, y, z) |--> (y*cos(x*y + z), x*cos(x*y + z), cos(x*y + z))
```

```
diff(h,y)
```

```
(x, y, z) |--> x*cos(x*y + z)
```

Integral $\int_1^\infty ae^{-x}dx$

```
var('a')
integral(a*exp(-x),x,1,oo)
```

```
a*e^(-1)
```

```
integral(exp(-a*x),x,1,oo)
```

```
Traceback (click to the left of this block for traceback)
...
Is a positive, negative or zero?
```

```
assume(a>0)
integral(exp(-a*x),x,1,oo)
```

```
e^(-a)/a
```

$\int_1^{\pi/3} \frac{\tan(x)}{x}dx$

```
h=integral(tan(x)/x,(x,1,pi/3))
show(h)
```

$$\int_1^{\frac{1}{3}\,\pi} \frac{\tan(x)}{x}\,dx$$

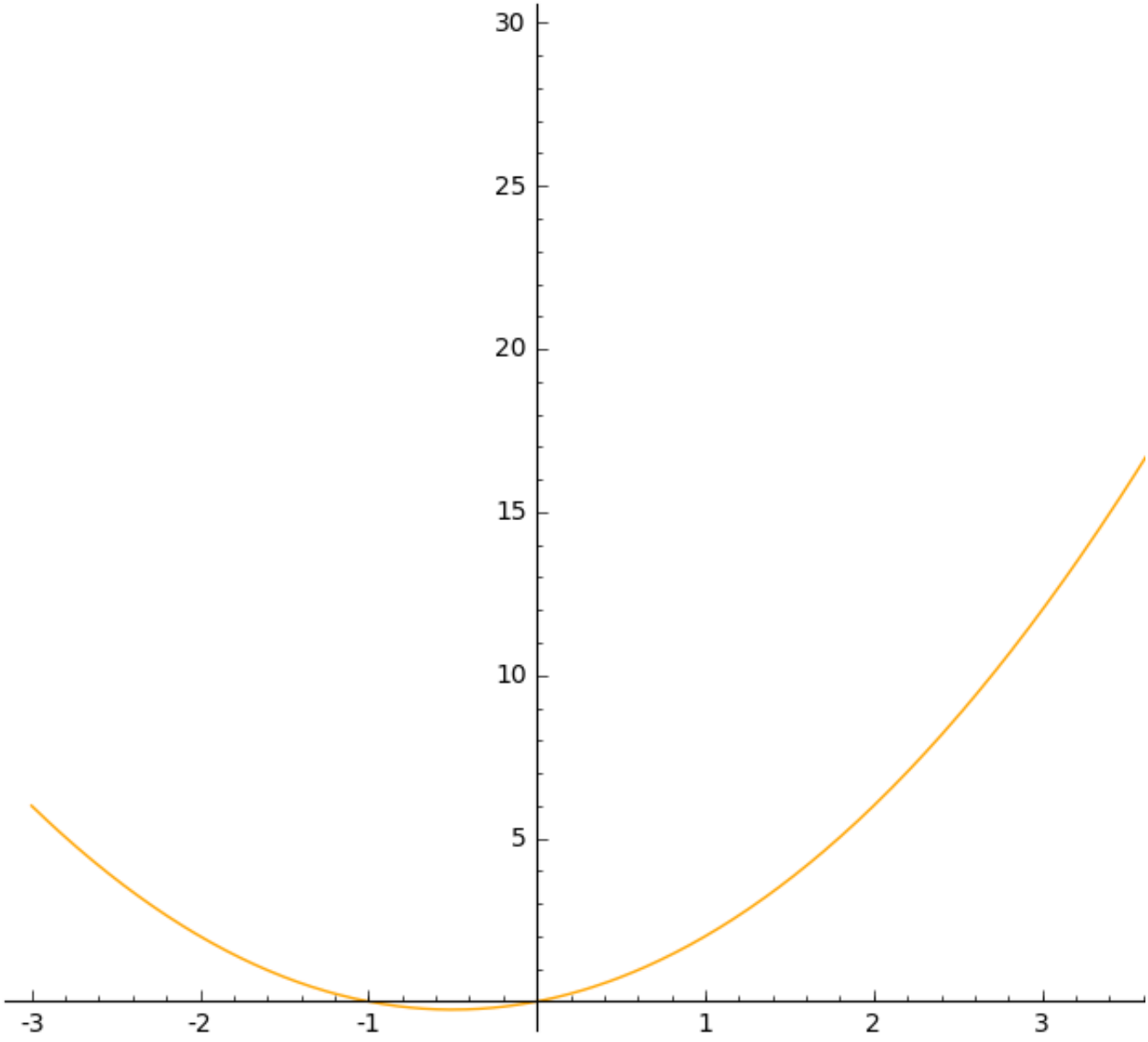
```
h.n()
```

```
0.07571599101702896
```

```
f
```

```
    x |--> x^2 + x
```

```
p=plot(f,x,-3,5,color="orange")
p
```



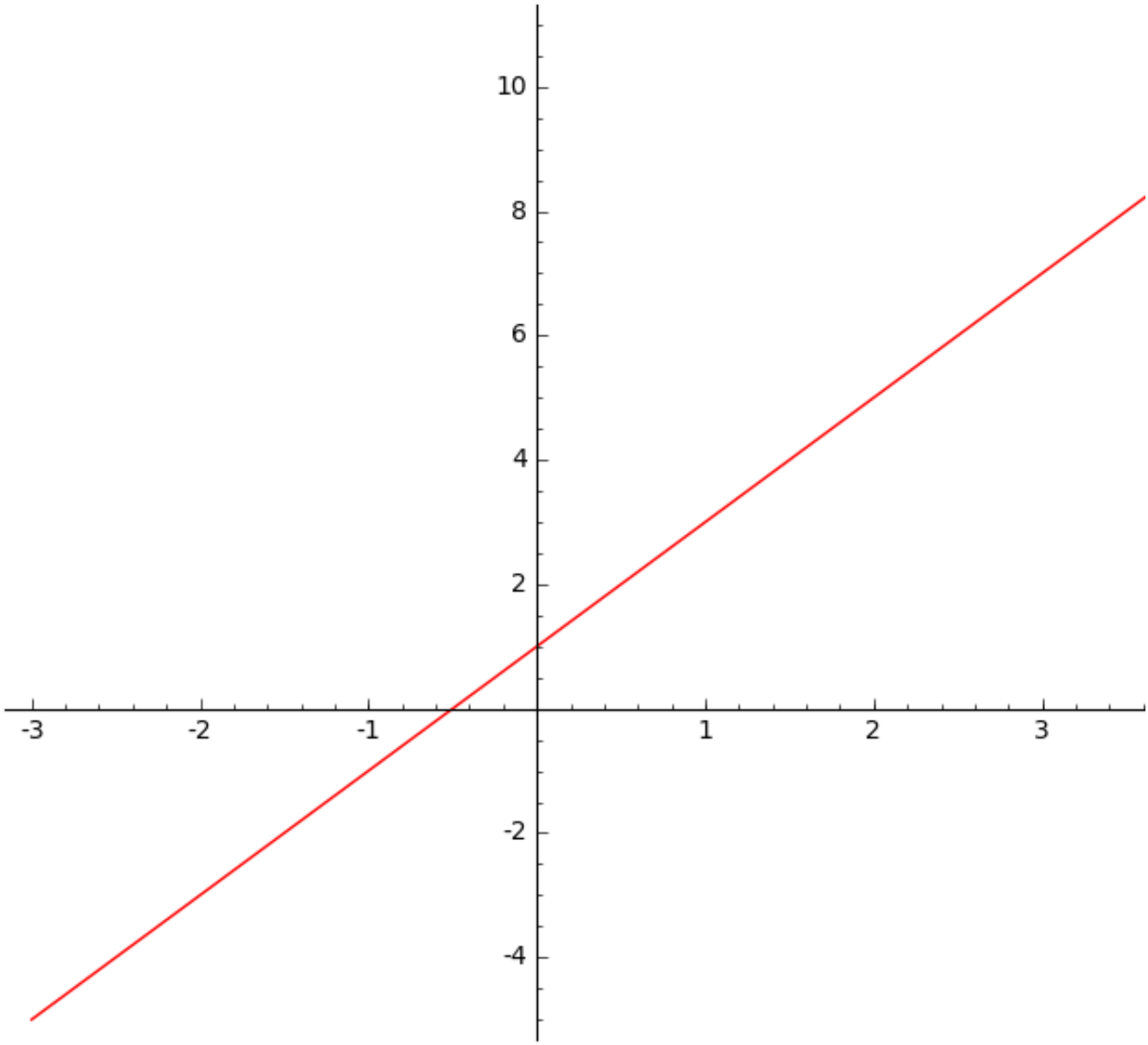

```
parent(p)
```

```
    <class 'sage.plot.graphics.Graphics'>
```

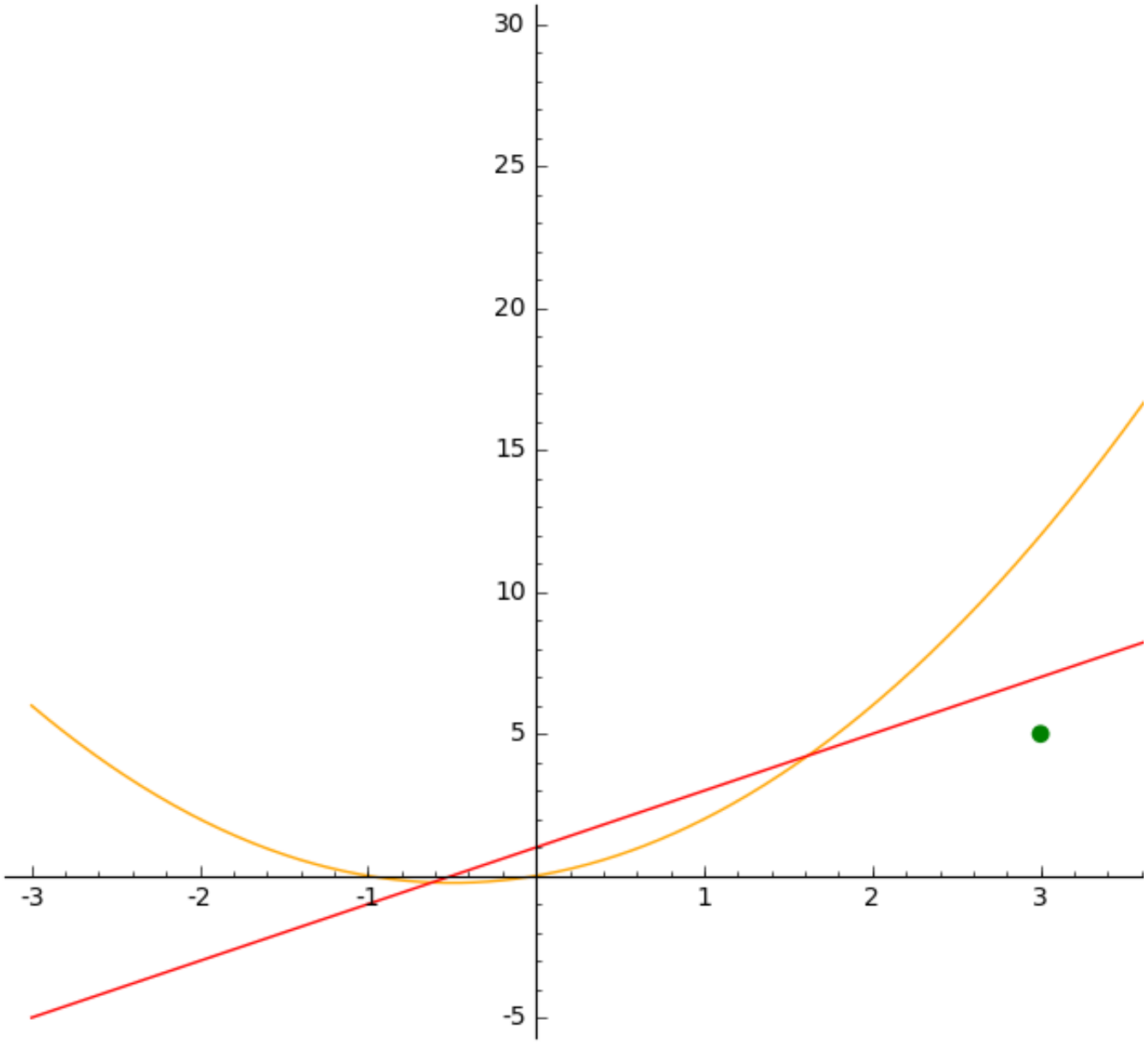
```
p.save("Funktionsplot.pdf")
```

```
    Funktionsplot.pdf
```

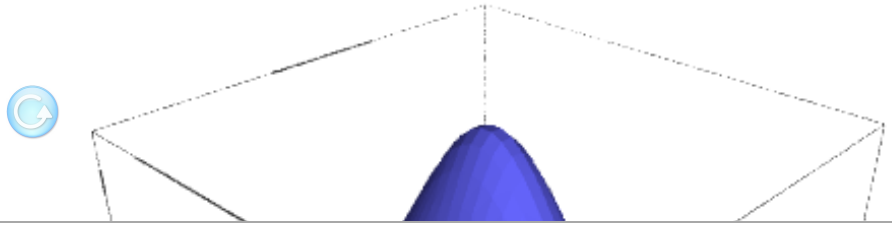
```
p_ableitung= plot(diff(f),x,-3,5,color="red")
p_ableitung
```



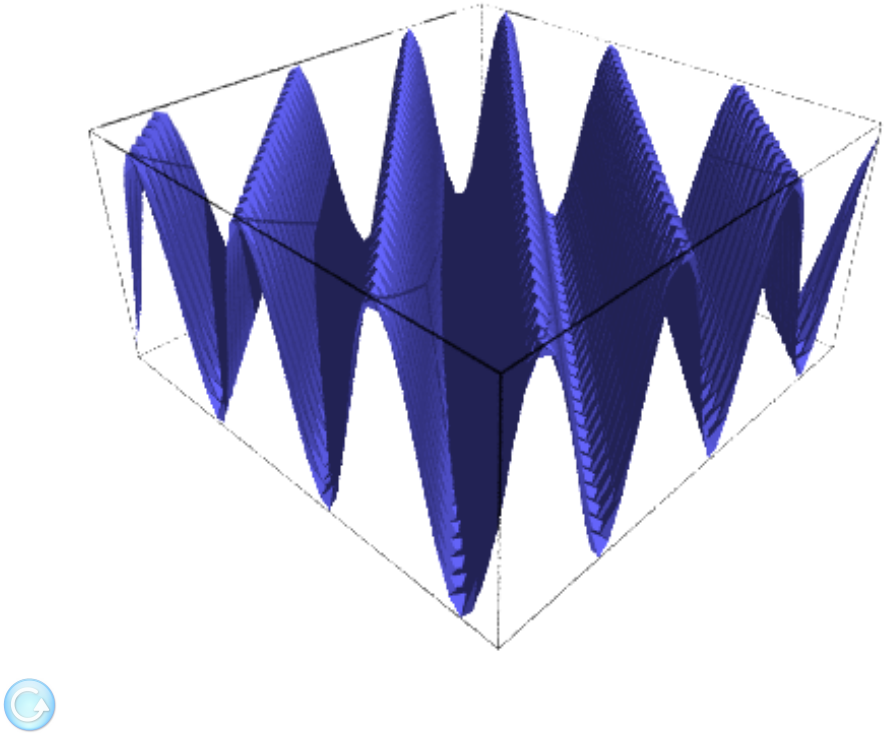

```
show(p+p_ableitung+point((3,5),color="green",size=50))
```



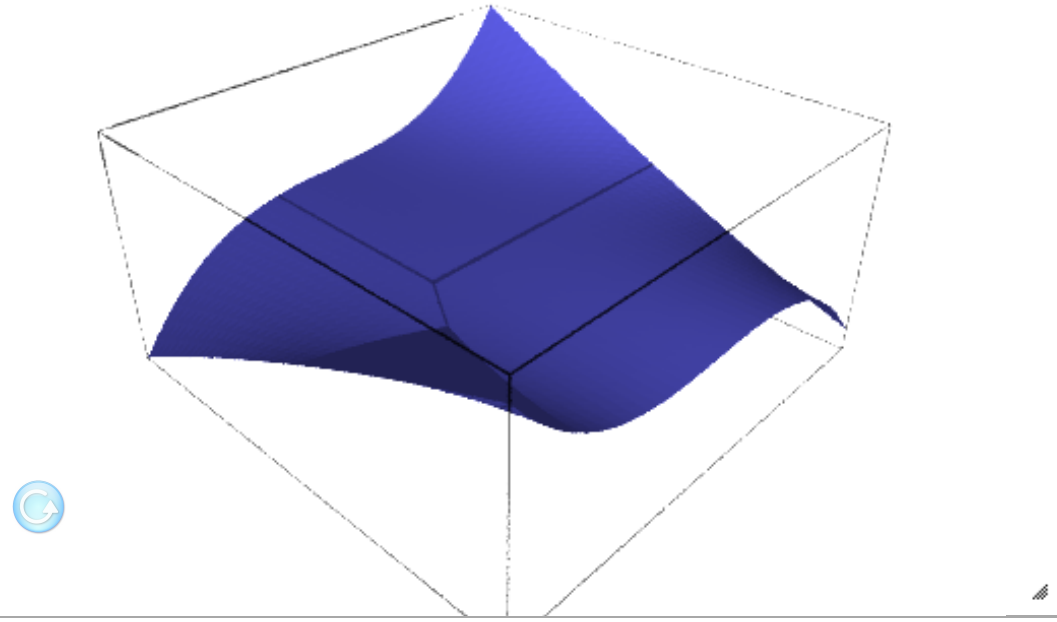

```
h(x,y)=exp(-x^2-y^2)
plot3d(h,(x,-2,2),(y,-3,3))
```



```
h1(x,y)=sin(x+y)
plot3d(h1,(x,-10,10),(y,-10,10))
```



```
h1(x,y)=x^2*y-x*y^3+2*x
plot3d(h1,(x,-10,10),(y,-10,10))
```



```
f(x)=1/x
limit(f,x=+oo)
limit(f,x=0,dir="minus")
```

```
    x |--> -Infinity
```

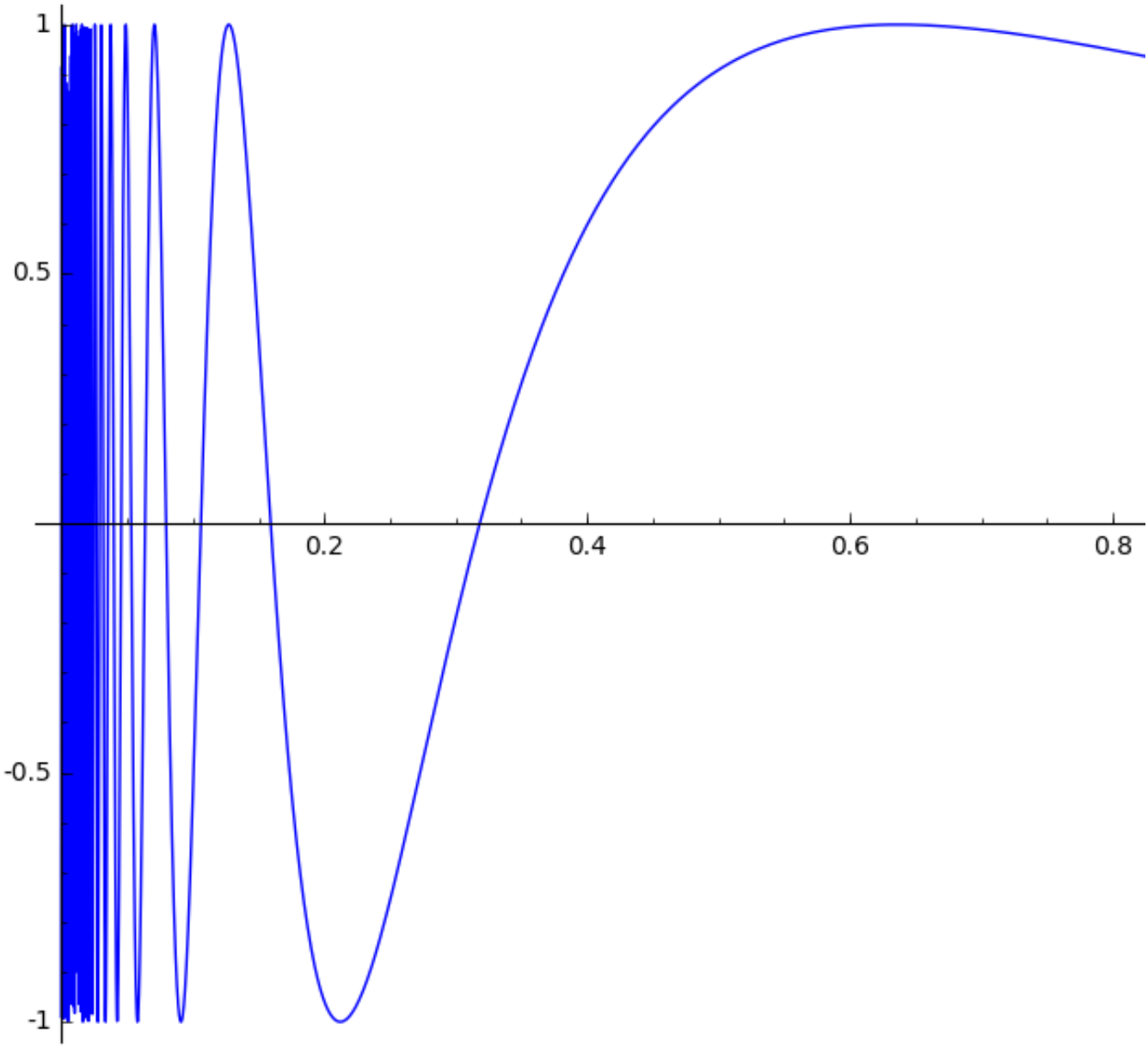
```
f1(x)=(x+3)/(x^2+5)
limit(f1,x=-oo)
```

```
    x |--> 0
```

```
f2(x)=sin(1/x)
limit(f2,x=0)
```

```
    x |--> ind
```

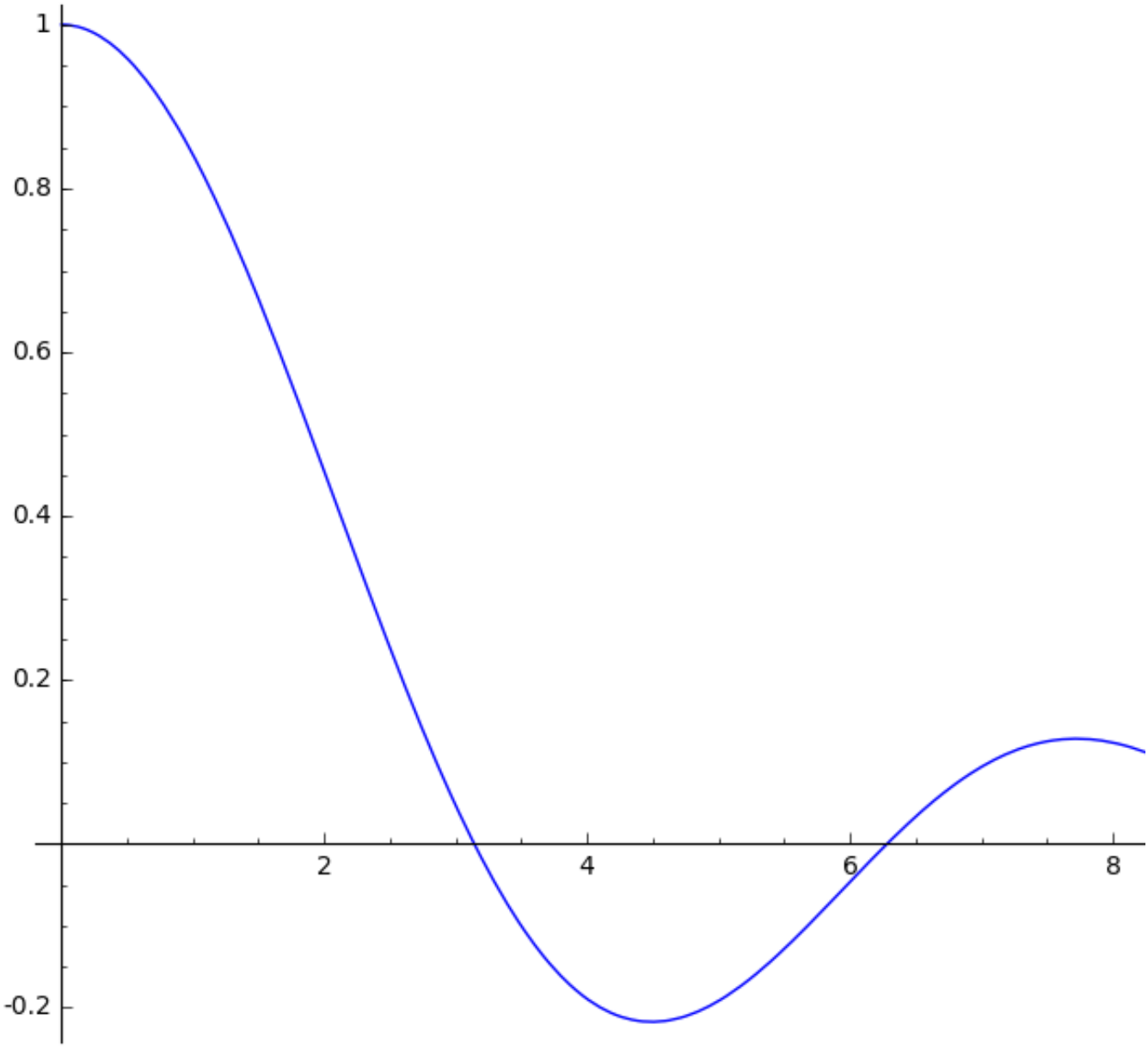
```
plot(f2,x,0,1)
```




```
f3(x)=sin(x)/x
limit(f3,x=0,dir="plus")
```

```
    x |--> 1
```

```
plot(f3,x,0,10)
```



Reihen: $\sum_{n\geq 1} a_n$

```
a(n)=1/n^2
sum(a(n),n,1,oo)
```

```
1/6*pi^2
```

```
f(x)=x^2-2*x-3
solutions = solve(f(x)==0,x)
print solutions
```

```
[
x == 3,
x == -1
]
```

```
solutions[0]
```

```
x == 3
```

```
f.subs(solutions[0])
```

```
    x |--> 0
```

```
f(solutions[0])
```

```
    (x == 3)^2 - 2*(x == 3) - 3
```

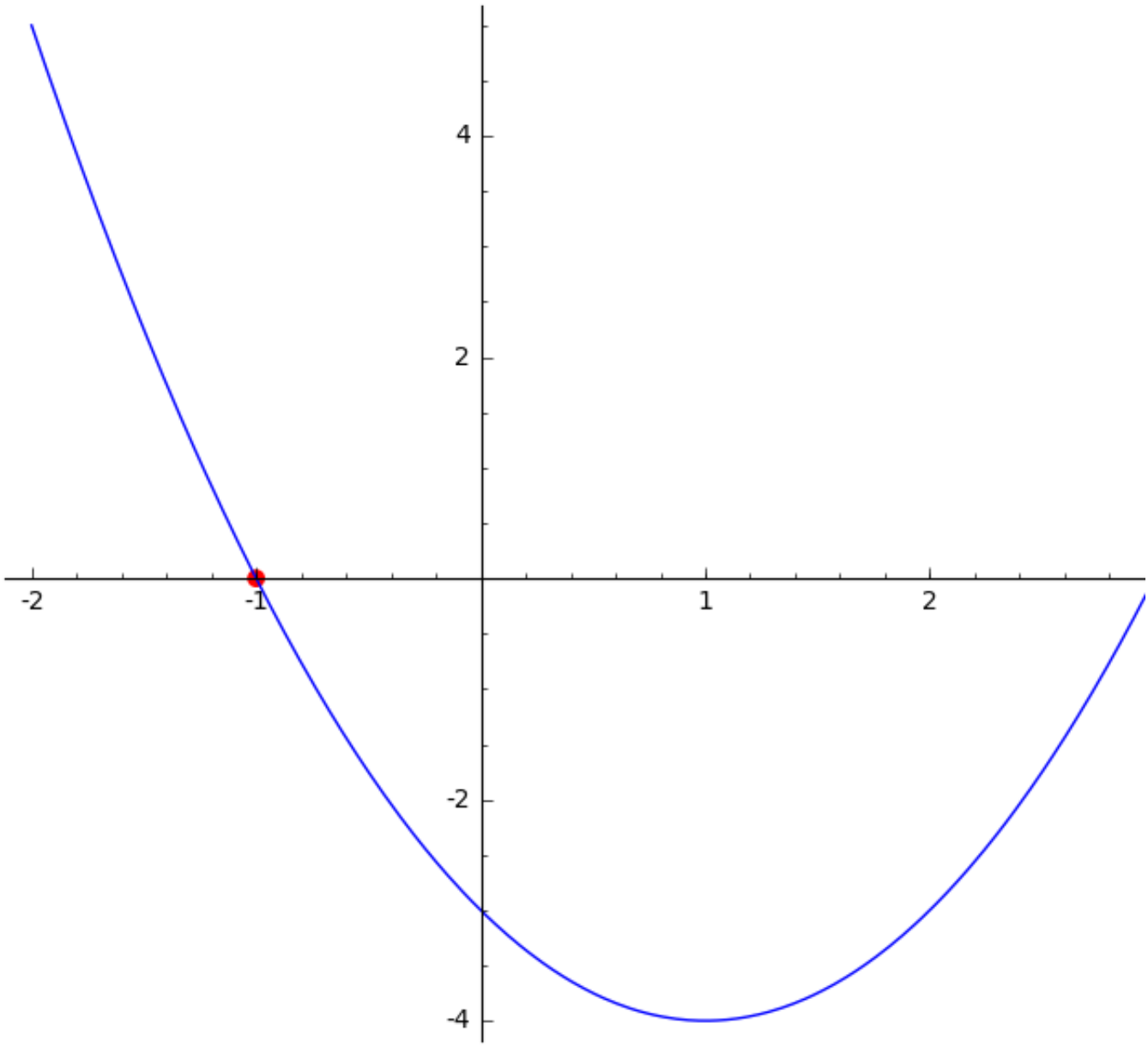
```
solutionlist = solve(f(x)==0,x,solution_dict=True)
print solutionlist
```

```
    [{x: 3}, {x: -1}]
```

```
print solutionlist[0]
print solutionlist[0][x]
```

```
    {x: 3}
    3
```

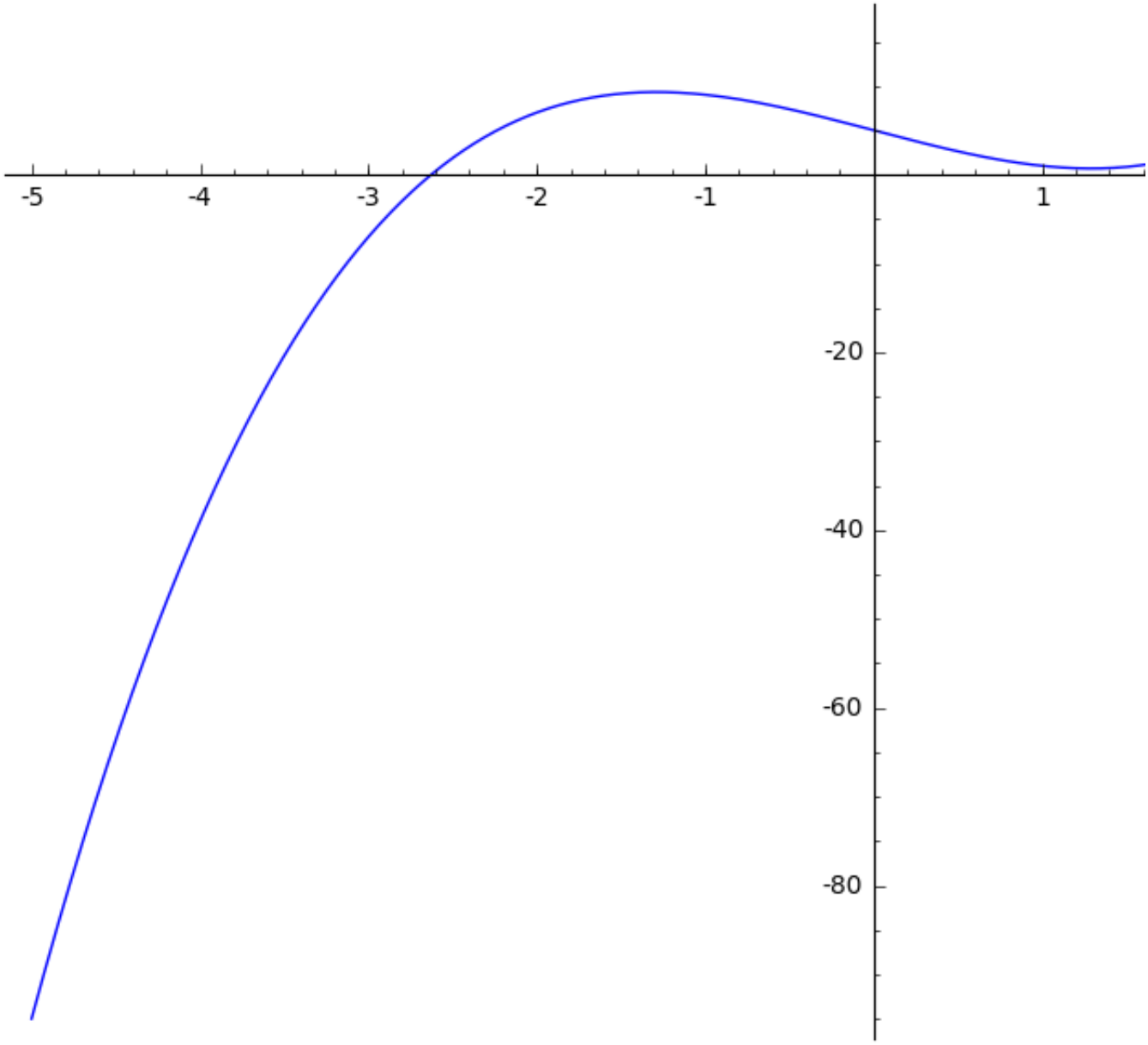
```
N1=point((solutionlist[0][x],0),color="red",size=50)
N2=point((solutionlist[1][x],0),color="red",size=50)
plot(f,x,-2,4)+N1+N2
```



```
find_root(f,-2,0)
```

```
-0.9999999999999986
```

```
f5(x)=x^3-5*x+5
plot(f5,x,-5,3)
```




```
solve(f5(x)==0,x)
```

```
[x == -1/2*(5/18*sqrt(7)*sqrt(3) - 5/2)^(1/3)*(I*sqrt(3) + 1) -
1/6*(-5*I*sqrt(3) + 5)/(5/18*sqrt(7)*sqrt(3) - 5/2)^(1/3), x ==
-1/2*(5/18*sqrt(7)*sqrt(3) - 5/2)^(1/3)*(-I*sqrt(3) + 1) -
1/6*(5*I*sqrt(3) + 5)/(5/18*sqrt(7)*sqrt(3) - 5/2)^(1/3), x ==
(5/18*sqrt(7)*sqrt(3) - 5/2)^(1/3) + 5/3/(5/18*sqrt(7)*sqrt(3) -
5/2)^(1/3)]
```

```
find_root(f5,-3,-2)
```

```
-2.627365084711833
```

```
Px=QQ[x]
```

```
parent(Px)
```

```
<class
'sage.rings.polynomial.polynomial_ring.PolynomialRing_field_with_c
egory'>
```

```
var('z')
QQ[z]
```

```
Univariate Polynomial Ring in z over Rational Field
```

```
z^3+z
```

```
z^3 + z
```

```
parent(z)
```

```
Symbolic Ring
```

```
x1=x
```

```
x=Px(x)
```

```
parent(x)
```

```
Univariate Polynomial Ring in x over Rational Field
```

```
parent(x1)
```

```
Symbolic Ring
```

```
P2.<u,v>=QQ[]
```

```
P2
```

```
Multivariate Polynomial Ring in u, v over Rational Field
```

```
parent(u^2)
```

```
Multivariate Polynomial Ring in u, v over Rational Field
```

```
parent(x^2)
```

```
Univariate Polynomial Ring in x over Rational Field
```

```
u^2+x^2
```

```
Traceback (click to the left of this block for traceback)
...
TypeError: unsupported operand parent(s) for +: 'Multivariate
Polynomial Ring in u, v over Rational Field' and 'Univariate
Polynomial Ring in x over Rational Field'
```

```
p=x^2-9
```

```
p.roots()
```

```
[(3, 1), (-3, 1)]
```

```
p1=x^2-3
```

```
p1.roots(ring=RR)
```

```
[(-1.73205080756888, 1), (1.73205080756888, 1)]
```

```
pe=SR(p1)
```

```
parent(pe)
```

```
Symbolic Ring
```

```
var('x')
solve(pe==0,x)
```

```
[x == -sqrt(3), x == sqrt(3)]
```

```
g(x,y)=x*y+3
h(x,y)=x-4*y
solve((g(x,y)==0,h(x,y)==0),(x,y))
```

```
[[x == -2*I*sqrt(3), y == -1/2*I*sqrt(3)], [x == 2*I*sqrt(3), y ==
1/2*I*sqrt(3)]]
```

```

```