```
using Plots, Symbolics, Nemo,  StaticArrays, IntervalRootFinding, IntervalArithmetic, IntervalArithmetic.Symbols
```

$[A, B, x, f]$

```
@variables A,B,x,f
```

[981//1000, 133//500, -823//1000, 119//5000]

```
a,b,c,d = [ 981//1000, 133//500, -823//1000, 238//10000]
```

[-221//10000000, -49//625000, 267//5000000, 67//20000]

```
α,β,γ,δ = [ -221//10000000, -784//10000000, 534//10000000, 335//100000]
```

[0.981, 0.266, -0.823, 0.0238, -2.21e-5, -7.84e-5, 5.34e-5, 0.00335]

```
a_,b_,c_,d_,α_,β_,γ_,δ_ = Float64.([a,b,c,d,α,β,γ,δ])
```

x0 =

$$\frac{5000}{4881} f \left(\frac{-823}{1000} - \frac{67}{20000} f \right)$$

```
x0 = f*(c-δ*f)//(1-d)
```

vfield0 =

$$\frac{981}{1000} f + \frac{1330}{4881} f \left(\frac{-823}{1000} - \frac{67}{20000} f \right) - \frac{221}{10000000} f^3 - \frac{1960}{23824161} f^3 \left(\frac{-823}{1000} - \frac{67}{20000} f \right)^2 +$$

```
vfield0 = a*f + b*x0 +α*f^3 + β*f*x0^2 + γ*x0^3
```

sol_v0 =

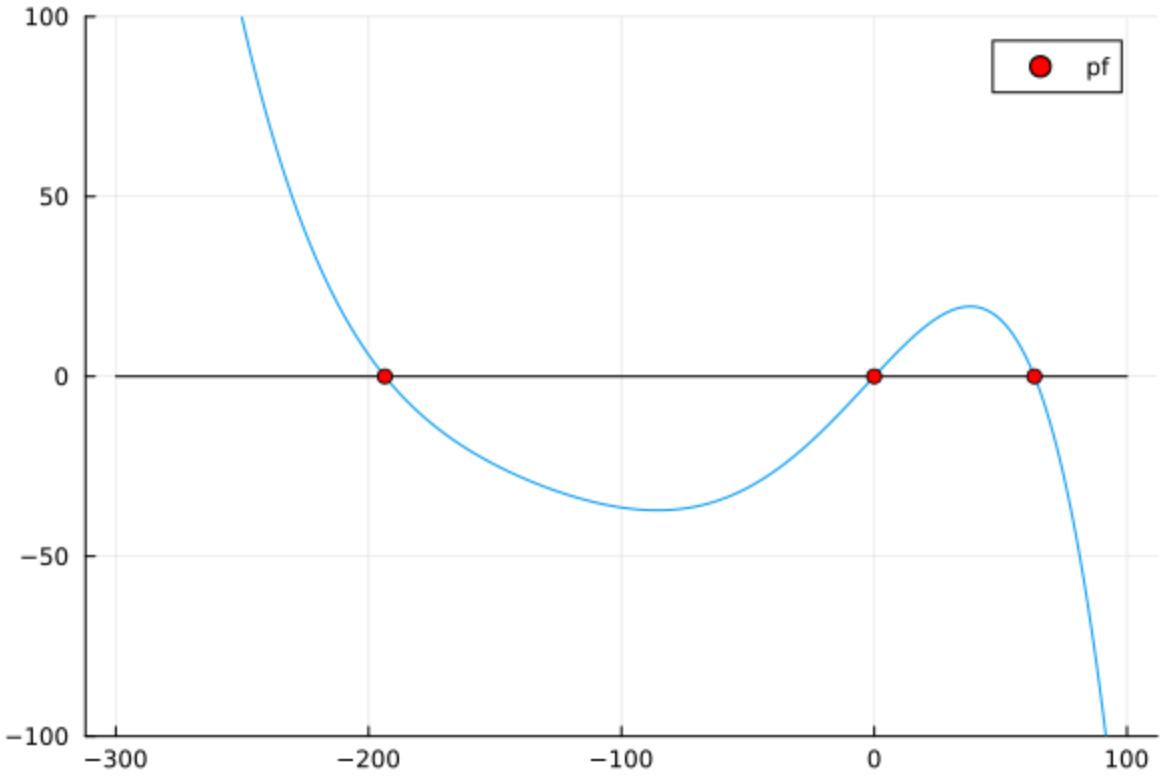
$$[\mathbf{roots}_{\mathbf{of}} \left(-9386518675736640000 + 11322511929120000 f + 1362206123546784 f^2 + 10473582999440 f^3 + 311 \right.$$

```
sol_v0 = symbolic_solve(vfield0,f)
```

Calculo numerico

```
[34.6071, 7.00081e-12, -67.2178]
```

```
begin
    x0_(x) = x*(c_-δ_*x)/(1-d_)
    vfield(x) = a_*x + b_*x0_(x) +α_*x^3 + β_*x*x0_(x)^2 + γ_*x0_(x)^3
    X = -200..100
    rts = IntervalRootFinding.roots(vfield, X)
    er = [mid.(r.region) for r in rts]
    xr = x0_.(er)
end
```




```
begin
    farr = -300:0.1:100
    pol = [Symbolics.symbolic_to_float(substitute(vfield0,Dict([f => f0]))) for f0 in
    farr]
    plot(farr,pol,yrange=(-100,100),label="")
    plot!(farr,farr*0,c=:black,label="")
    scatter!(er,er*0,c=:red,label="pf")
end
```

las raices son

-193.5750191371423 , 34.607074202163815 , 193.5750191371423 *A/B

0.0, 0.0, 0.0

63.37942013500981 , -67.21783269298389 , -63.37942013500981 *A/B

cuando B = 0 solo quieda la raiz en el origen ya que de la ultima ecuacion solo e=0 es solucion