notebook

October 12, 2022

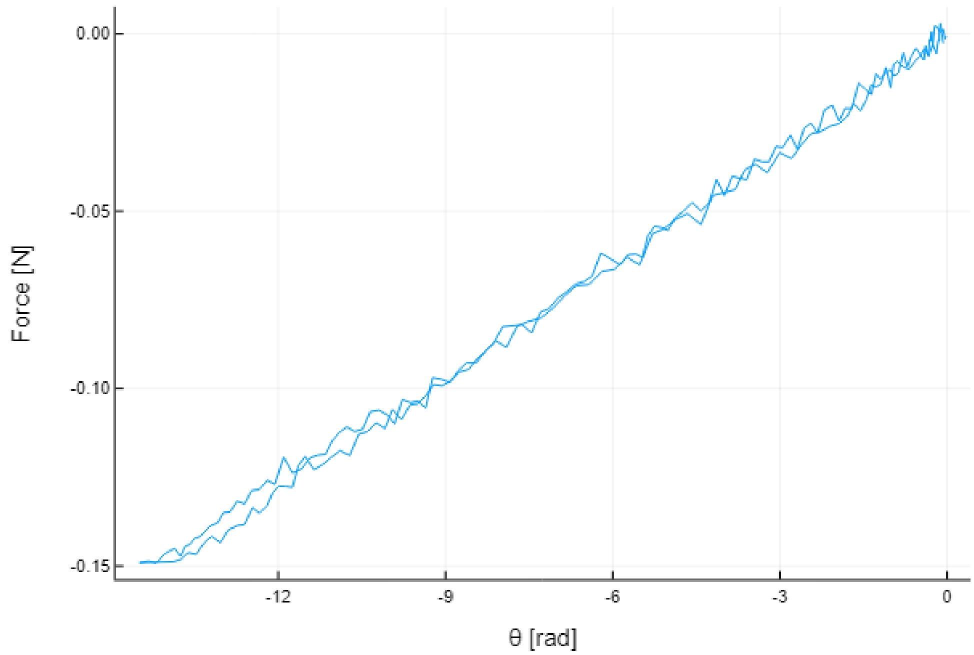
<h1> TOP Verkleg Æfing </h1>
<h3> Snúningspendúll (Torsional Pendulum) </h3>
<i> Authors </i>

[ ]:
```
using DataFrames, Statistics, CSV
using Measurements, Unitful
using Plots, PlotThemes
using EasyFit, Peaks, Symbolics
using Latexify, LaTeXStrings
plotlyjs();
val(x) = Measurements.value(ustrip(upreferred(x)));
err(x) = Measurements.uncertainty(ustrip(upreferred(x)));
```

0.1 Gögn

0.1.1 Gögn 1, mæling á kraft og

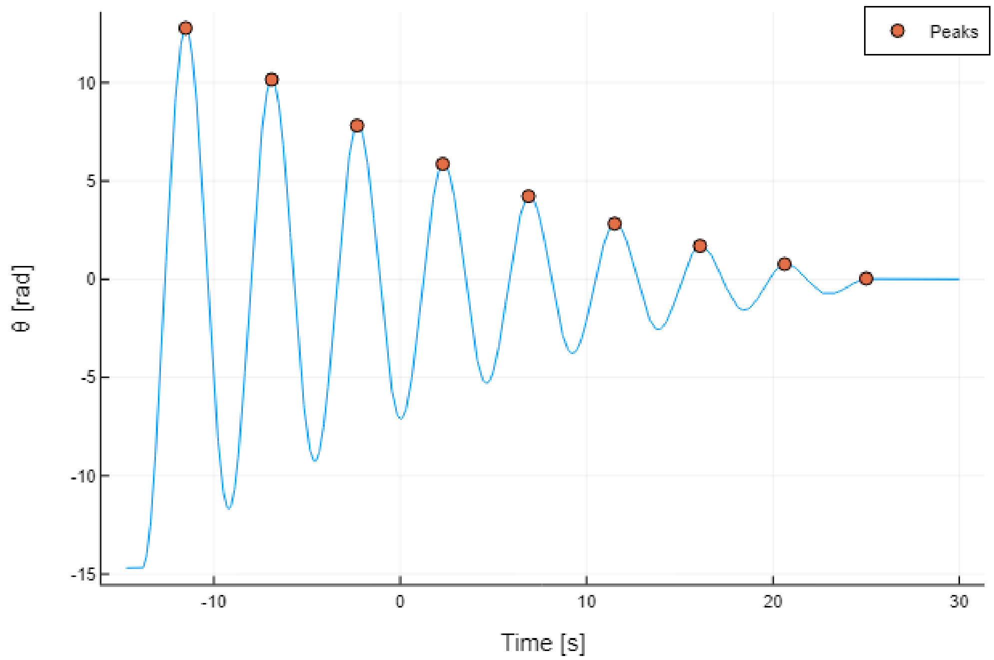
[ ]:
```
data = CSV.read("data.csv", DataFrame)

data = data[data[!,1] .> -0.15,:]

plot(data[!,2],data[!,1],
        xlabel = "  [rad]",
        ylabel = "Force [N]",
        labels =:none)
```



0.1.2 Gögn 2, Mæling á yfir tíma með málmskífu

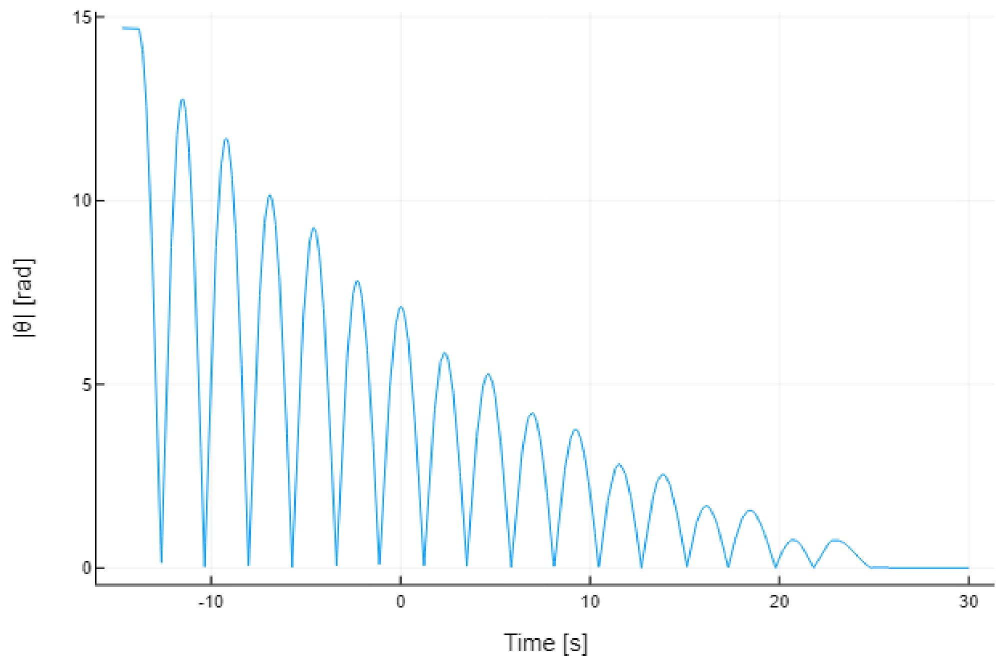
Með hápunktum og y-ás hliðraður

[ ]:
```julia
data2 = CSV.read("data2.csv", DataFrame)

data2 = data2 .- data2[end,2]

plot(data2[!,1], data2[!,2],
        xlabel = "Time [s]",
        ylabel = "  [rad]",
        labels = :none)

peaks = findmaxima(data2[!,2])
peaks = peaks[1][peaks[2] .> -10]

scatter!(data2[peaks,1],data2[peaks,2],
                labels = "Peaks")
```



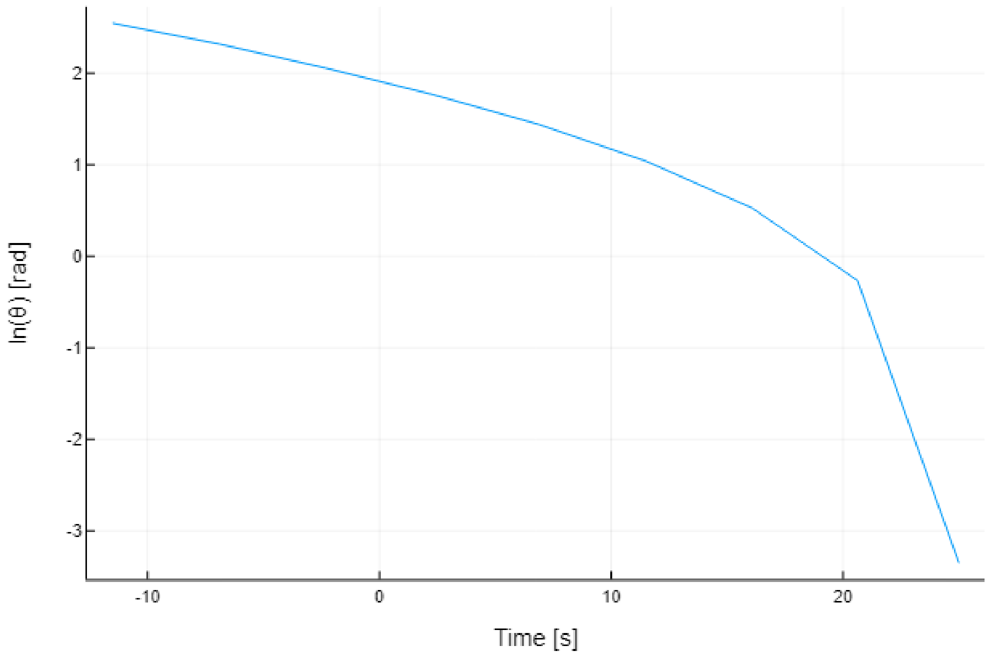
Gögn 2 nema abs

[ ]:
```
plot(data2[!,1], abs.(data2[!,2]),
xlabel = "Time [s]",
ylab = "| | [rad]",
labels = :none)
```



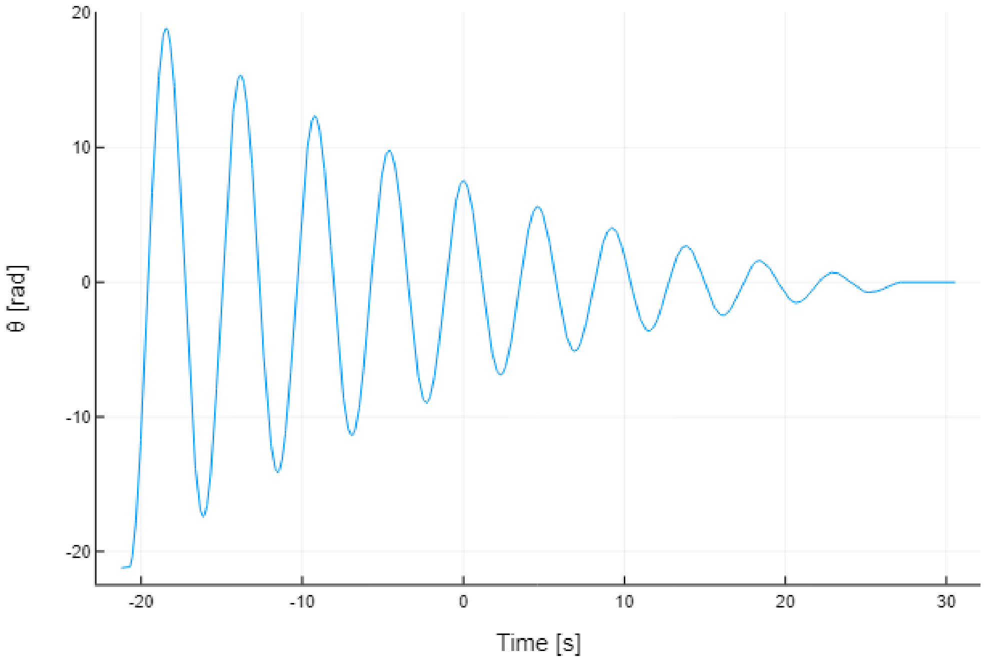
Gögn 2 hápunktar nema $\log_e$ skali á y-ás

[ ]:
```
plot(data2[peaks,1], log.(data2[peaks,2]),
xlabel = "Time [s]",
ylabel = "ln( ) [rad]",
labels = :none)
```



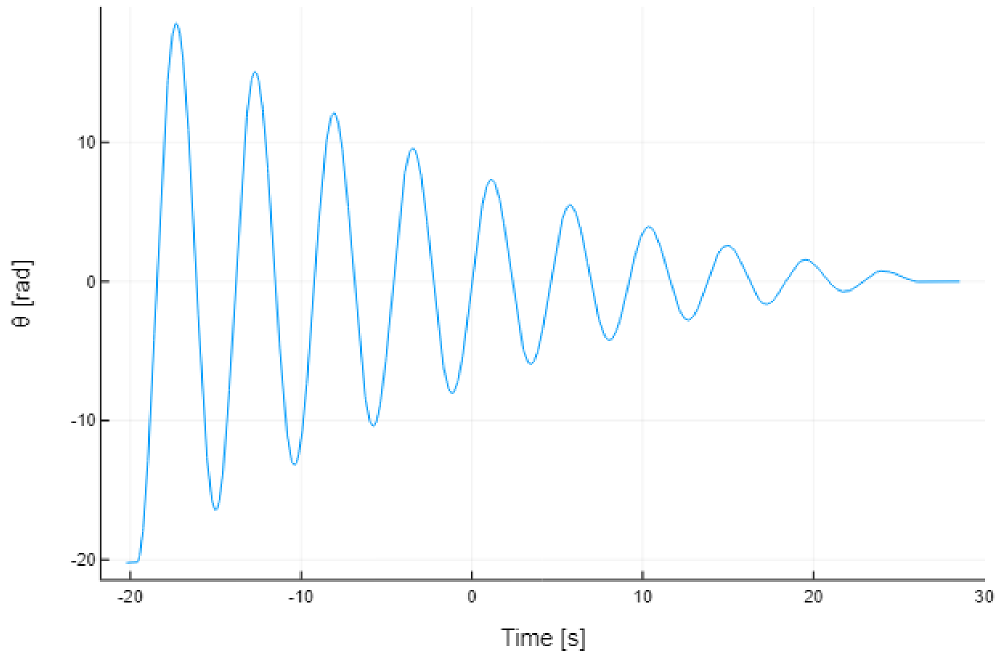
0.1.3 Gögn 3, Mæling á yfir tíma nema með segul á topp súlunar

[ ]:
```
data3 = CSV.read("data3.csv", DataFrame)
data3 = data3 .- data3[end,2]

plot(data3[!,1], data3[!,2],
xlabel = "Time [s]",
ylabel = "  [rad]",
labels = :none)
```



0.1.4 Gögn 4, Mæling á yfir tíma nema með segul á hlið topp súlunar

[ ]:
```
data4 = CSV.read("data4.csv", DataFrame)
data4 = data4 .- data4[end,2]

plot(data4[!,1], data4[!,2],
xlabel = "Time [s]",
ylabel = "  [rad]",
labels = :none)
```



0.2 Útreykningar

0.2.1 Góða gamla fallið

[ ]:
```
"""
Fall til að fynna jöfnu óvissu fyrir gefna jöfnu
"""
function findErrorFromSym(symExpr; errorPrefix = "Err")
        vars = Symbolics.get_variables(symExpr)
        varErrs = []

        for i in vars
                push!(varErrs, Symbolics.variable(string(errorPrefix,i)))
        end

        Dvars = [expand_derivatives(Differential(i)(symExpr)) for i in vars]

        symErr = sqrt(sum((Dvars[i]*varErrs[i])^2 for i in eachindex(vars)))

        return symErr
end
```

findErrorFromSym

0.2.2 Mælingar

[ ]:
```
k  = fitlinear(data[!,2],data[!,1]).a*1u"N*m"
```

0.010578748137015833 m N

[ ]:
```
rskvfull = (5.16±0.01)u"cm"
rskvinn = (0.27±0.01)u"cm"
r  = rskvfull-rskvinn
```

4.89 ± 0.014 cm

[ ]:
```
r = (9.5±.1)u"cm"
Δr = 0.1
m = (122±1)u"g"
Δm = 1
```

1

0.2.3 Jöfnur og útreikningar

[ ]:
```
k = fitlinear(data2[peaks,1],log.(data2[peaks,2]))
```

```
------------------- Linear Fit -------------

Equation: y = ax + b

With: a = -0.12751728725755984
      b = 1.7714598833776345

Pearson correlation coefficient, R = 0.8749555892893659
Average square residue = 0.6957180337976472

Predicted Y: ypred = [3.239948963435694, 2.650819096305767…
residues = [0.6924588273459258, 0.3326559733484027…

--------------------------------------------
```

Óvissa k

[ ]:
```
latexify(:(Δk=sqrt(n/(n*sum(x.^2)-sum(x.^2)))),env = :eq)
```

$$\Delta k = \sqrt{\frac{n}{n \cdot \sum x^2 - \sum x^2}} \tag{1}$$

[ ]:
```
x = data2[peaks,1]
n = length(x)
Δk = sqrt(n/(n*sum(x.^2)-sum(x.^2)))
```

0.025879541985573656

Jöfnur og útreikningar fyrir b og Δb

[ ]:
```
@variables   R M Δ  ΔR ΔM
b = -1/2 *M*R^2*
```

$$-0.5R^2M\kappa \tag{2}$$

[ ]:
```
Δb = findErrorFromSym(b,errorPrefix = "Δ")
```

$$\sqrt{0.25\Delta\kappa^2R^4M^2 + 0.25\kappa^2\Delta M^2R^4 + \kappa^2\Delta R^2R^2M^2} \tag{3}$$

[ ]:
```
b= substitute(b,
        Dict([  => k.a,
                R => val(r),
                M => val(m)
        ]))
b = Float64(b.val)
```

7.020145456746813e-5

[ ]:
```
Δb = substitute(Δb,
        Dict([
                  => k.a,
                M => val(m),
                R => val(r),
                Δ  => Δk,
                ΔM => err(m),
                ΔR => err(r)
        ])
)
Δb = Float64(Δb.val)
```

1.4335338291857347e-5

[ ]:
```
b = (b ± Δb)*u"kg * m^2 * s^-1"
```

7.0e-5 ± 1.4e-5 kg m^2 s^-1

[ ]:
```
I = 0.5*m*r^2
T = 2 /sqrt(k /I-b^2/4I^2)
```

```
1.433 ± 0.016 s
```

```
[ ]: @variables K i B ΔK Δi ΔB
     t = 2 /sqrt(K/i-B^2/4i^2)
     Δt = findErrorFromSym(t,errorPrefix = "Δ")
```

$$\sqrt{\left(- \frac{\frac{\frac{1}{2}\Delta K \frac{6.283185307179586}{\left(\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}\right)^2}}{\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}}}{i} \right)^2 + \left(\frac{\frac{B\Delta B \frac{6.283185307179586}{\left(\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}\right)^2}}{\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}}}{4i^2} \right)^2 + \frac{\frac{1}{4}\left(\frac{6.283185307179586}{\left(\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}\right)^2}\right)^2 \left(\frac{-K}{i^2} - 8i\frac{-B^2}{16i^4}\right)^2 \Delta i^2}{\left(\sqrt{\frac{K}{i} + \frac{-B^2}{4i^2}}\right)^2}} \tag{4}$$

```
[ ]: Δt = substitute(Δt,
             Dict([
                     K => val(k ),
                     i => val(I),
                     B => val(b),
                     ΔK => err(k ),
                     Δi => err(I),
                     ΔB => err(b),

             ])
     )

     T = (val(T) ± Δt.val)*1u"s"
```

```
1.433 ± 0.016 s
```