

Title: Lecture - Numerical Methods, PHYS 777

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Collection/Series: Numerical Methods (Core), PHYS 777-, January 6 - February 5, 2025

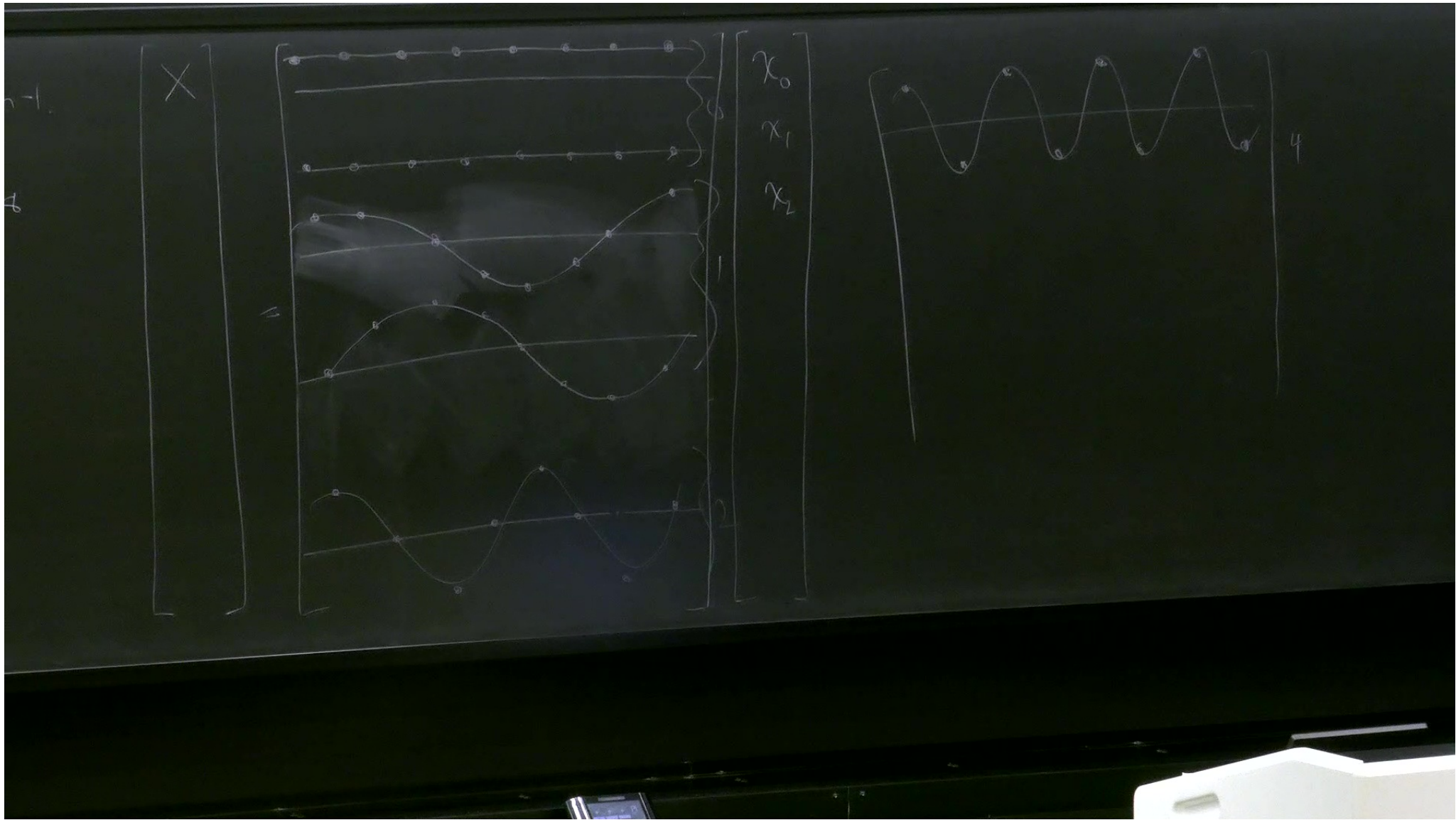
Subject: Other

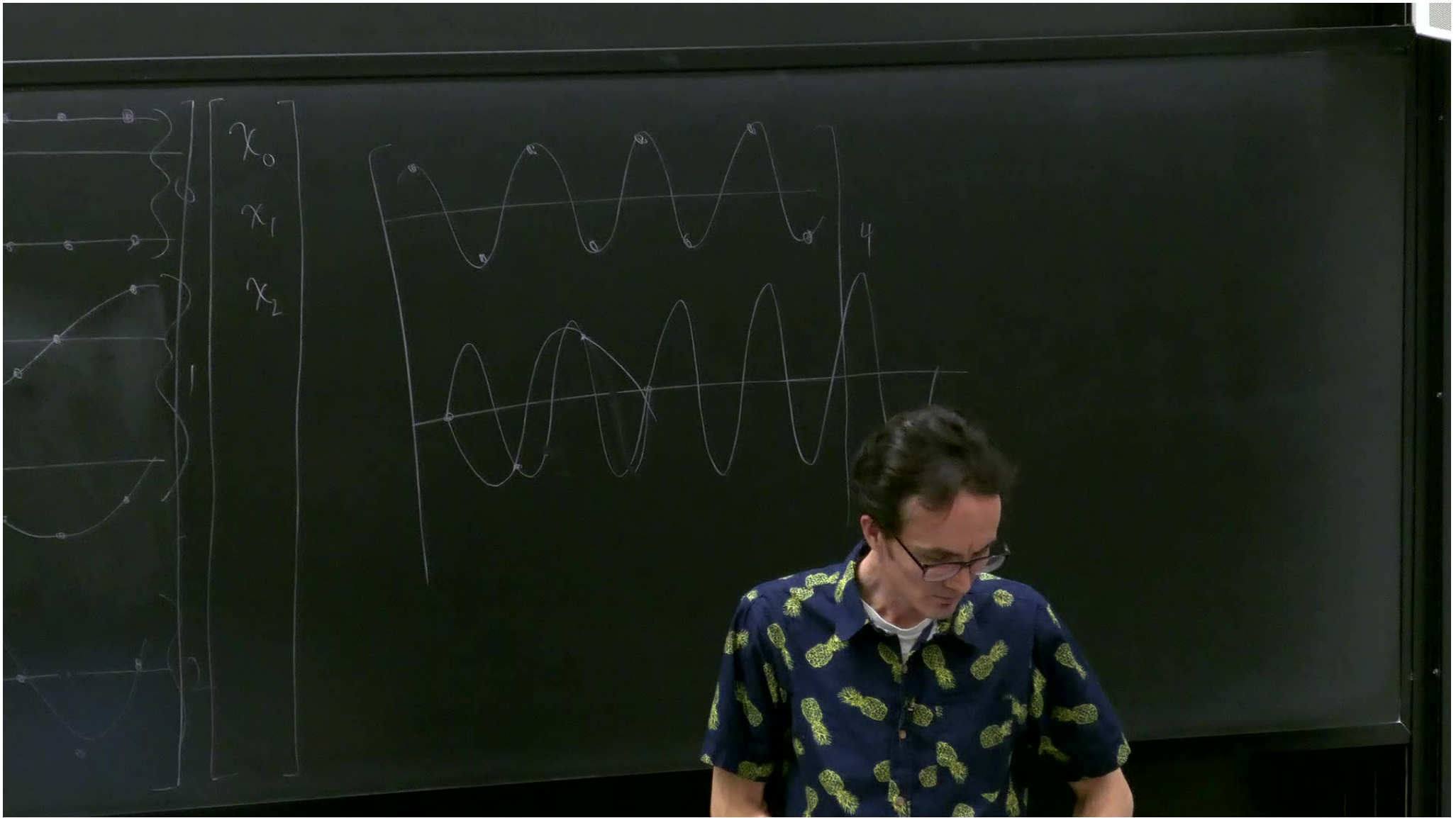
Date: January 28, 2025 - 11:30 AM

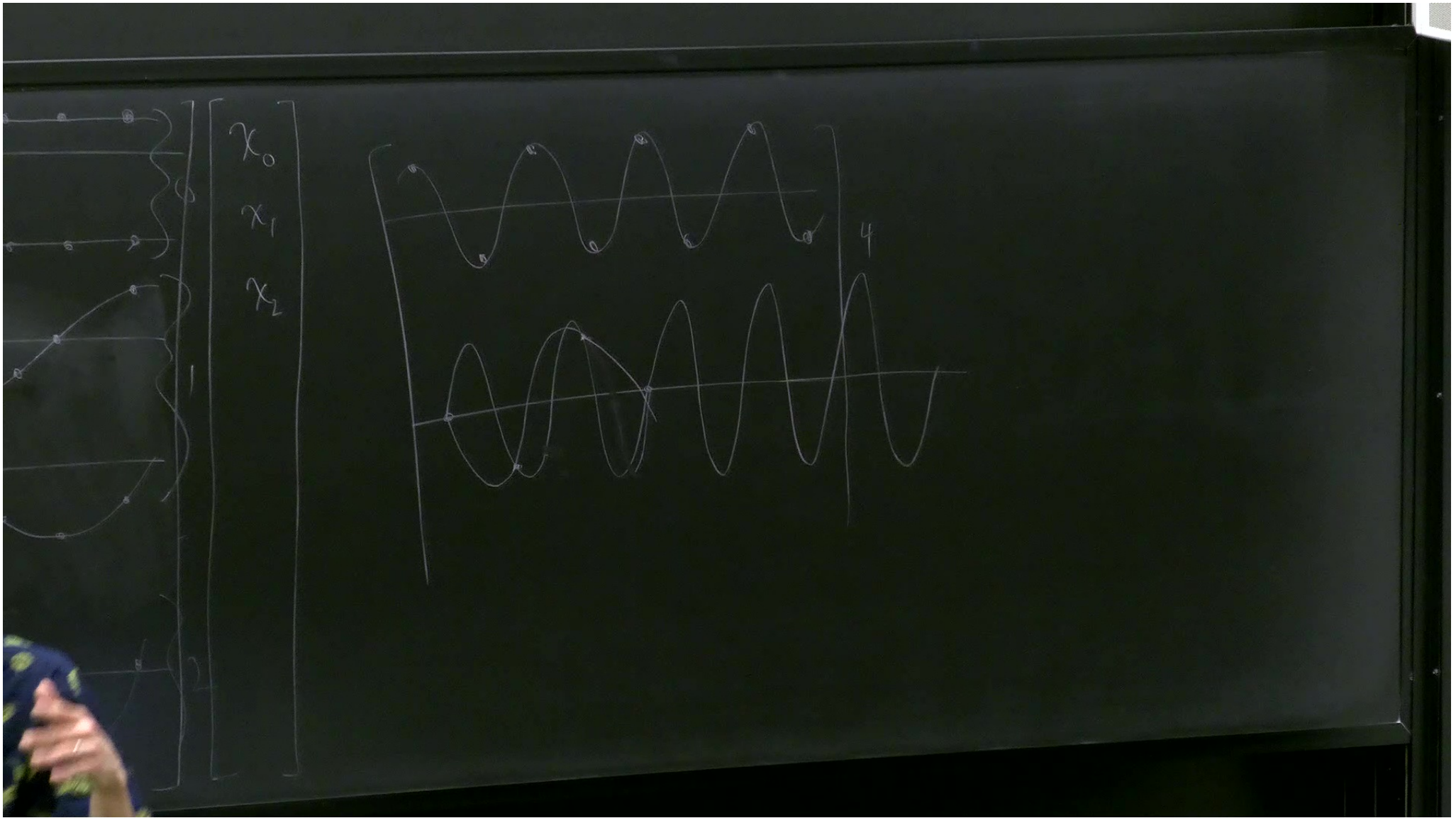
URL: <https://pirsa.org/25010062>

$$X_k = \sum_{m=0}^{n-1} x_m e^{-2\pi i k \frac{m}{N}} \quad k=0 \dots n-1$$









$$X = \text{FFT}(x)$$

x complex

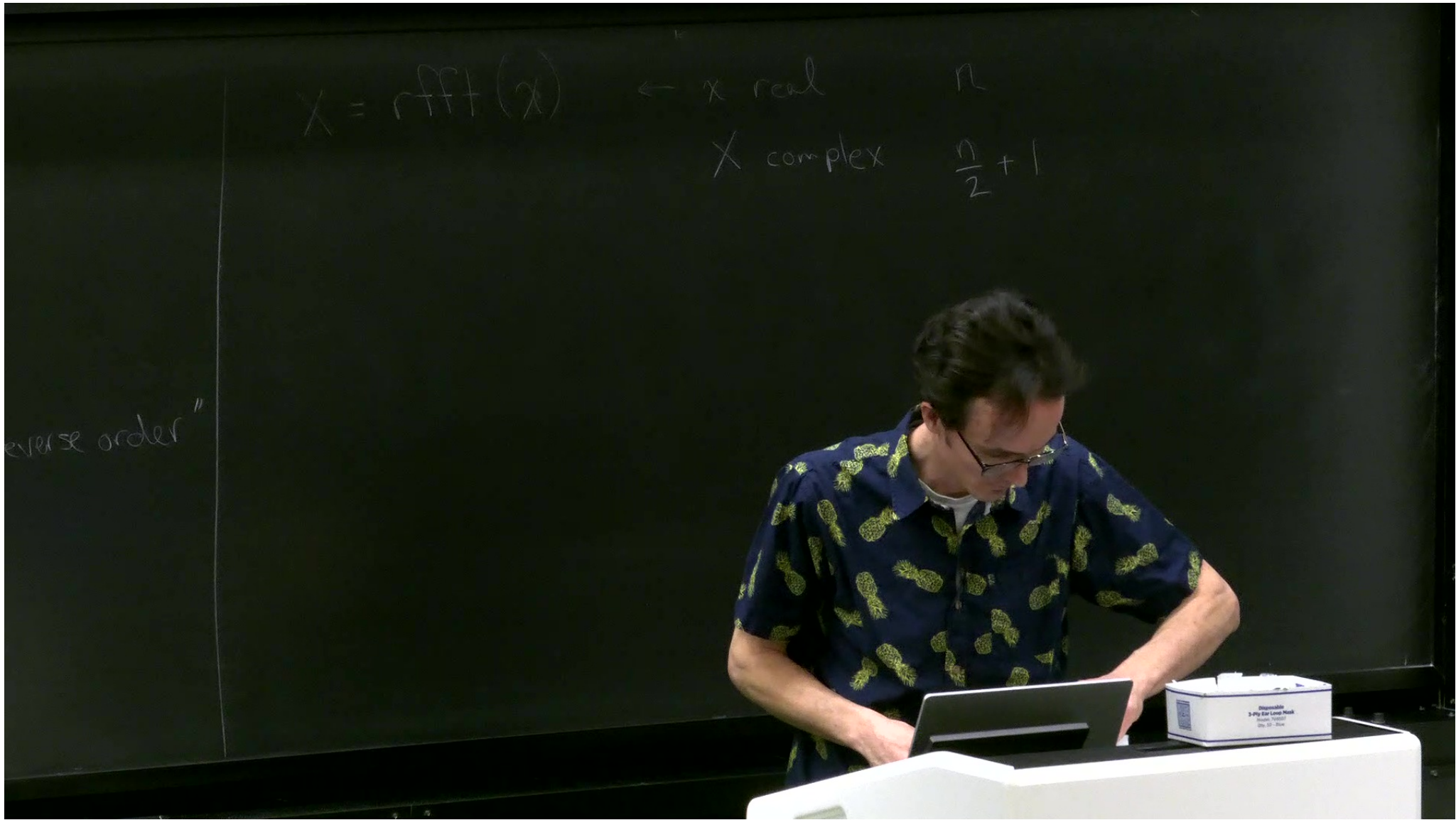
X complex

$X[1]$ happens to be real

$X[2 : n/2 + 1]$: positive-freq. terms

$X[n/2 + 2 : n]$: "negative-freq. terms" "in reverse order"

$X[n/2 + 1]$: Nyquist term, real



```
In [1]: using Pkg
```

```
In [ ]: Pkg.add("LibSndFile")
Pkg.add("FileIO")
#Pkg.add("WGLMakie")
Pkg.add("CairoMakie")
Pkg.add("WAV")
Pkg.add("SampledSignals")
Pkg.add("FFTW")
```

```
In [35]: using LibSndFile
using FileIO
using FFTW
using SampledSignals
```

```
In [36]: #using WGLMakie
using CairoMakie
```

```
In [37]: clip = load("dstn-guitar-2.wav")
```

```
Out[37]: ([0.0; 0.0; ... ; 0.0; 0.0;], 44100.0f0, 0x0010, WAV.WAVChunk[WAV.WAVChunk(Symbol("fmt "), UInt8[0x10, 0x00, 0x00, 0x00, 0x01, 0x00, 0x01, 0x00, 0x44, 0xac, 0x00, 0x00, 0x88, 0x58, 0x01, 0x00, 0x02, 0x00, 0x10, 0x00])])
```

```
In [11]: data = clip[1]
N = length(data)
```

```
Out[11]: 616320
```

```
In [12]: f = Figure()
Axis(f[1,1])
scatter!(data[15000:20000],1)
```



```
Pkg.add("FileIO")  
#Pkg.add("WGLMakie")  
Pkg.add("CairoMakie")  
Pkg.add("WAV")  
Pkg.add("SampledSignals")  
Pkg.add("FFTW")
```

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In [35]: using LibSndFile  
using FileIO  
using FFTW  
using SampledSignals
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In [36]: #using WGLMakie  
using CairoMakie
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In [37]: clip = load("dstn-guitar-2.wav")
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Out[37]: ([0.0; 0.0; ... ; 0.0; 0.0;], 44100.0f0, 0x0010, WAV.WAVChunk[WAV.WAVChunk(Symbol("fmt "), UInt8[0x10, 0x00, 0x00, 0x00, 0x01, 0x00, 0x01, 0x00, 0x00, 0x44, 0xac, 0x00, 0x00, 0x88, 0x58, 0x01, 0x00, 0x02, 0x00, 0x10, 0x00])])
```

```
In [11]: data = clip[1]  
N = length(data)
```

```
Out[11]: 616320
```

```
In [12]: f = Figure()  
Axis(f[1,1])  
scatter!(data[15000:20000],1)  
f
```

```
Out[12]:
```

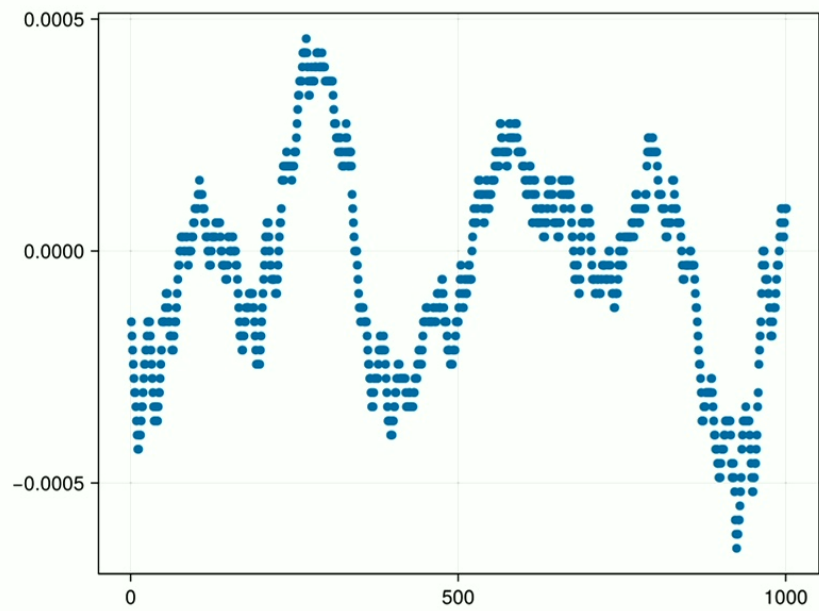


```
N = length(data)
```

Out [39]: 616320

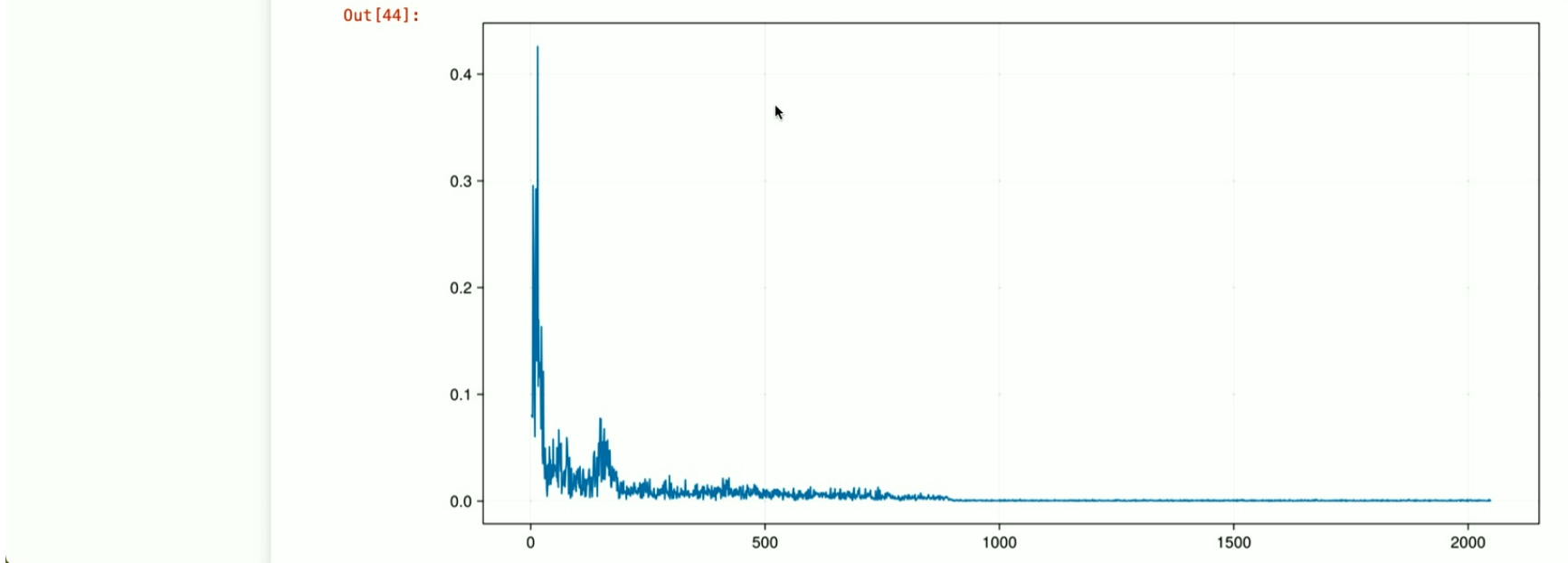
```
In [42]: f = Figure()
Axis(f[1,1])
scatter!(data[15000:16000,1])
#scatter!(data[:,1])
f
```

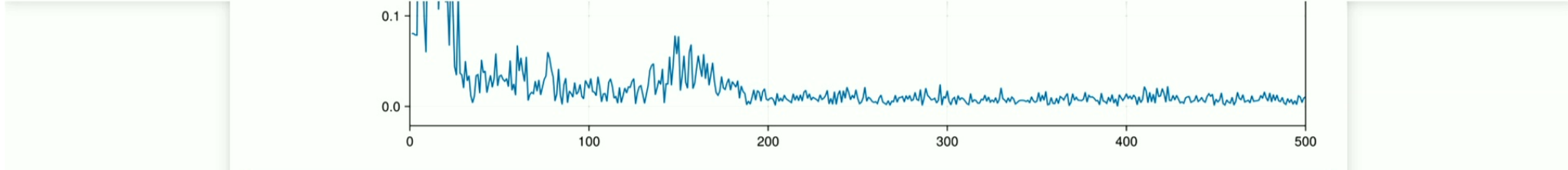
Out [42]:



```
sub = data[i0:i0+cs*2-1]
spec = rfft(sub)
i = argmax(abs.(spec))
outspec = zero(spec)
outspec[i] = spec[i]
out = irfft(outspec, 2*cs);
```

```
In [44]: f = Figure(size=(1000,500))
ax = Axis(f[1,1])
lines!(abs.(spec), label="FT")
f
```





```
In [ ]: f = Figure(size=(1000,500))
        ax = Axis(f[1,1])
        lines!(sub, label="Signal")

        mx = maximum(abs.(spec))
        outsum = 0.
        for i in 1:5
            outspec = zero(spec)
            outspec[i] = spec[i]
            out = irfft(outspec, 2*cs)
            lines!(out, color=:gray, alpha=abs.(spec[i]) / mx)
            outsum = outsum .+ out
        end
        lines!(outsum, label="Sum")
        f[1, 2] = Legend(f, ax)
        f
```

In []:

In []:

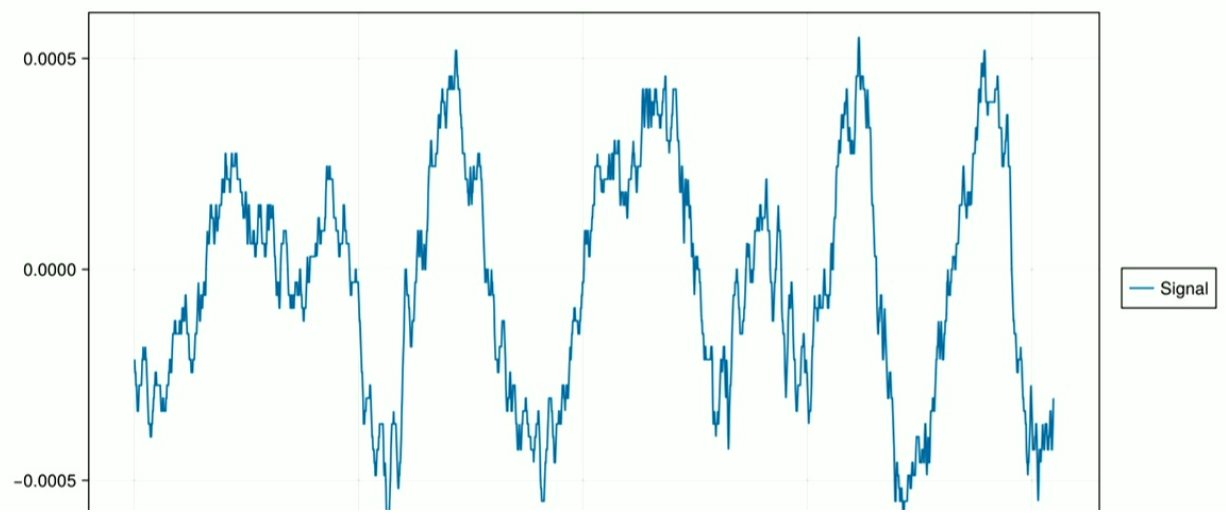
In []:

```
In [30]: f = Figure(size=(1000,500))
         ax = Axis(f[1,1])
         lines!(sub, label="Signal")
         mx = maximum(abs.(spec))
```

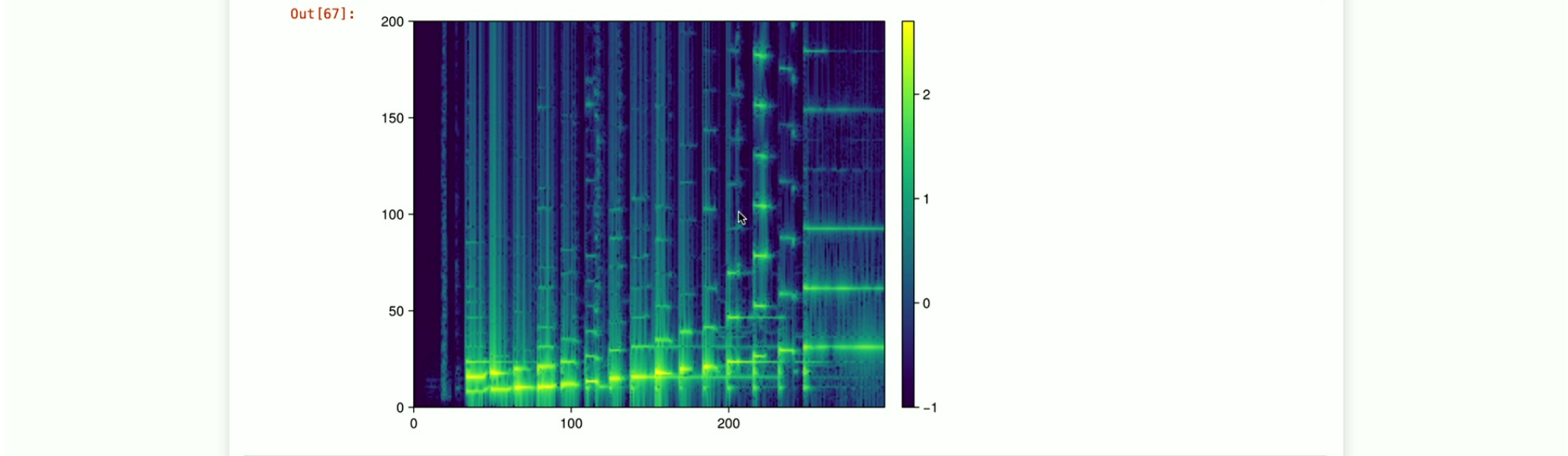
```
In [52]: f = Figure(size=(1000,500))
ax = Axis(f[1,1])
lines!(sub, label="Signal")

s|
#order = maximum(abs.(spec))
#outsum = 0.
#for i in 1:5
#   outspec = zero(spec)
#   outspec[i] = spec[i]
#   out = irfft(outspec, 2*cs)
#   lines!(out, color=:gray, alpha=abs.(spec[i]) / mx)
#   outsum = outsum .+ out
#end
#lines!(outsum, label="Sum")
f[1, 2] = Legend(f, ax)
f
```

Out [52]:



```
In [67]: f = Figure()  
ax, img = image(f[1,1][1,1], log10.(specgram[1:200,:]', colormap=:viridis,  
              colorrange=(-1,2.7))  
Colorbar(f[1, 1][1, 2], img)  
f
```



```
In [ ]:
```