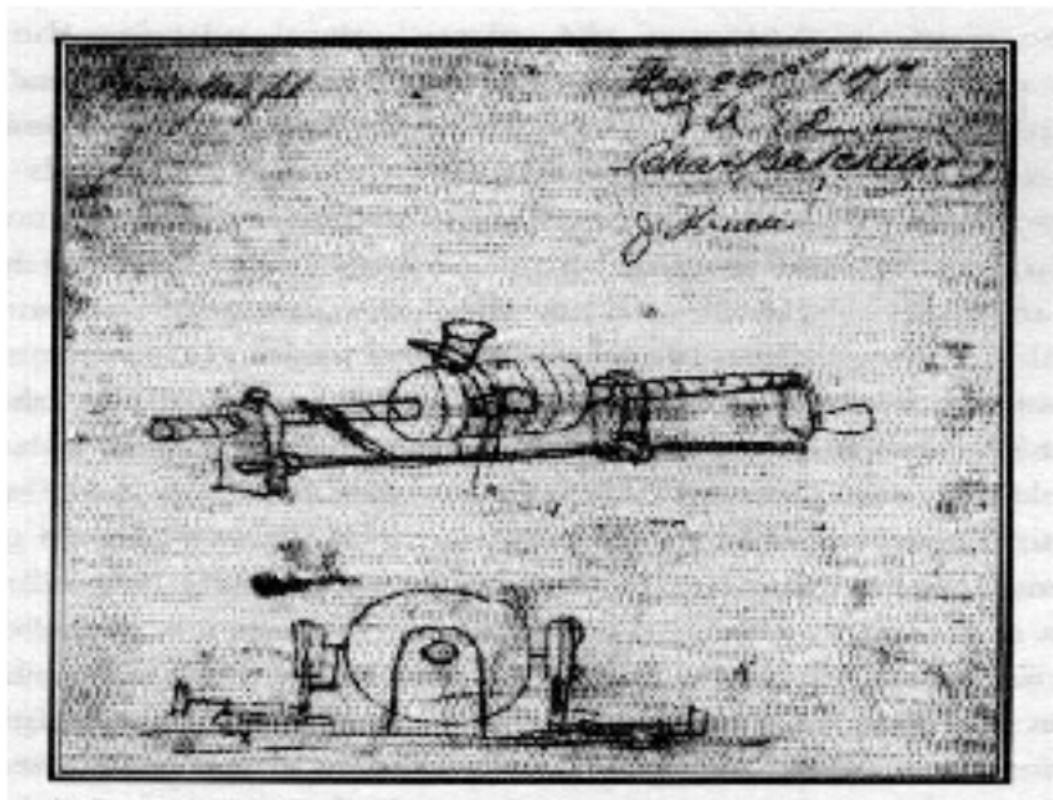


# 6.003: Signals and Systems

From LPs to CDs –  
and how 6.003 helps get you there

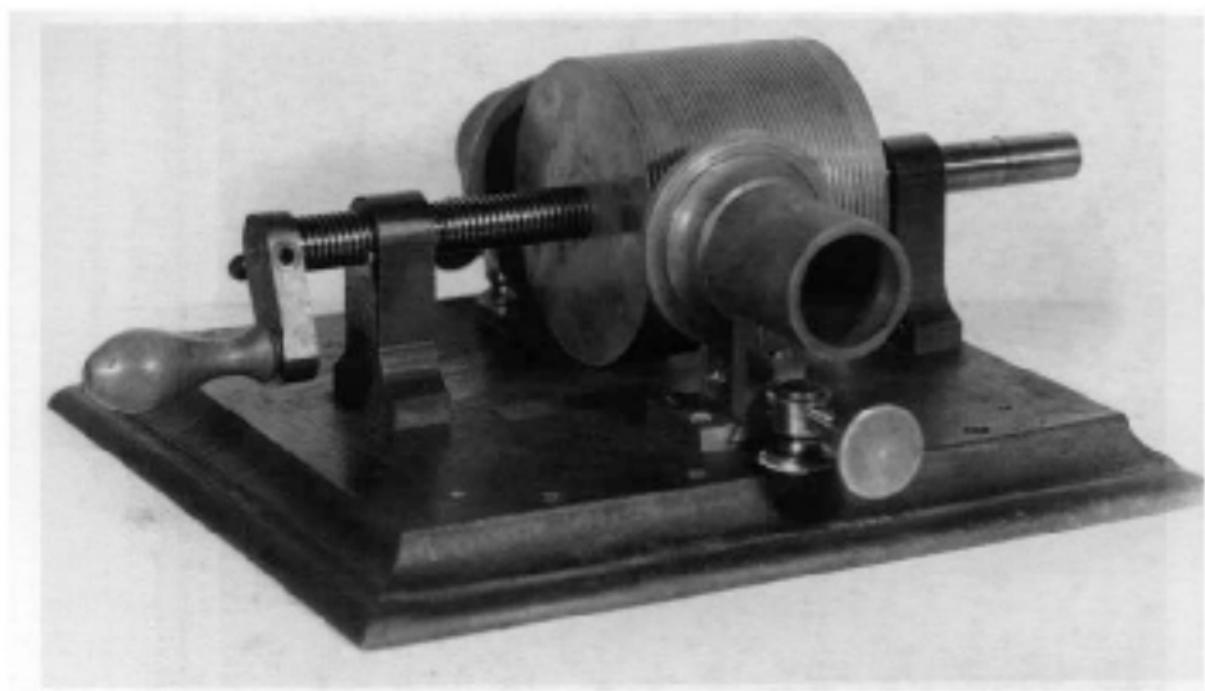
*December 8, 2011*

# Edison's Phonograph



## Edison's Phonograph

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## Edison's Phonograph



## Edison's Phonograph

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## Edison's Phonograph

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Image by [Information on Wikimedia Commons](#).

# Edison's Phonograph

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Photo of Pioneer record player removed due to copyright restrictions.

## Edison's Phonograph

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# Edison's Phonograph

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Photo of Grado phono cartridge removed due to copyright restrictions.

## Edison's Phonograph

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LPs: 100 years of optimization → good fidelity, but

- fragile: easily scratched
- lots of distortions: e.g., wow and flutter
- expensive

CDs: much higher fidelity

- nearly indestructible
- very low distortion
- inexpensive

→ many of these advantages made possible by concepts from Signals and Systems!

## Edison's Phonograph

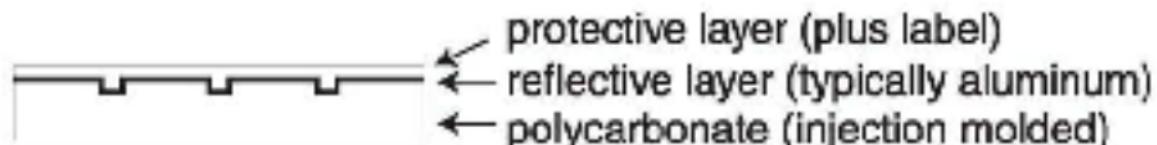
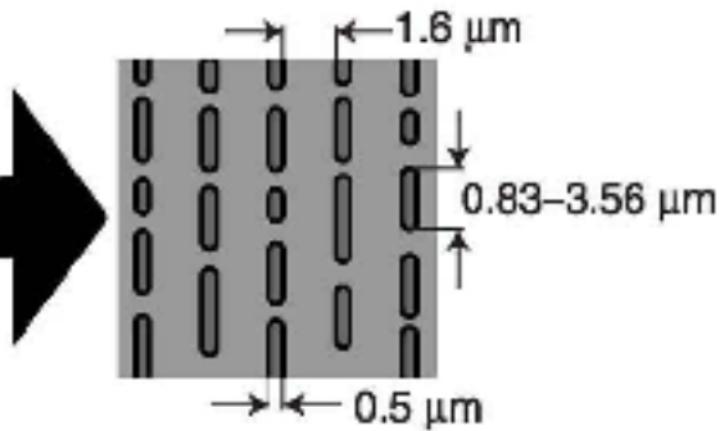


Image by [Dartie Alighieri](#) on Wikimedia Commons.

## What's on a CD?



Image by [Dante Alighieri](#)  
on Wikimedia Commons.



## Edison's Phonograph

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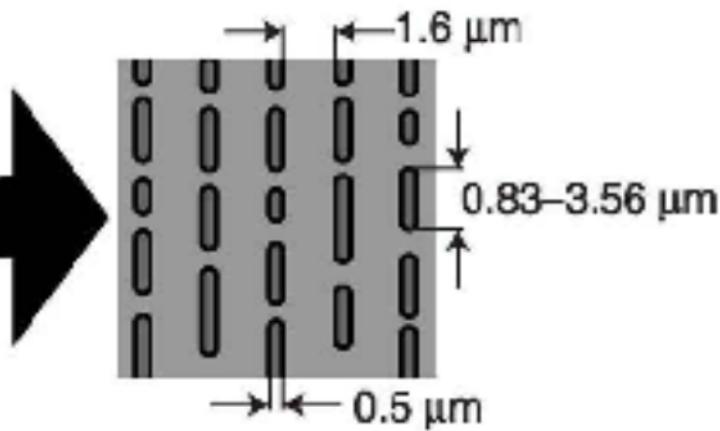
- nearly indestructible ✓
- very low distortion
- inexpensive

→ many of these advantages made possible by concepts from Signals and Systems!

## What's on a CD?



Image by [Dante Alighieri](#)  
on Wikimedia Commons.



- protective layer (plus label)
- reflective layer (typically aluminum)
- polycarbonate (injection molded)

## What's on a CD?

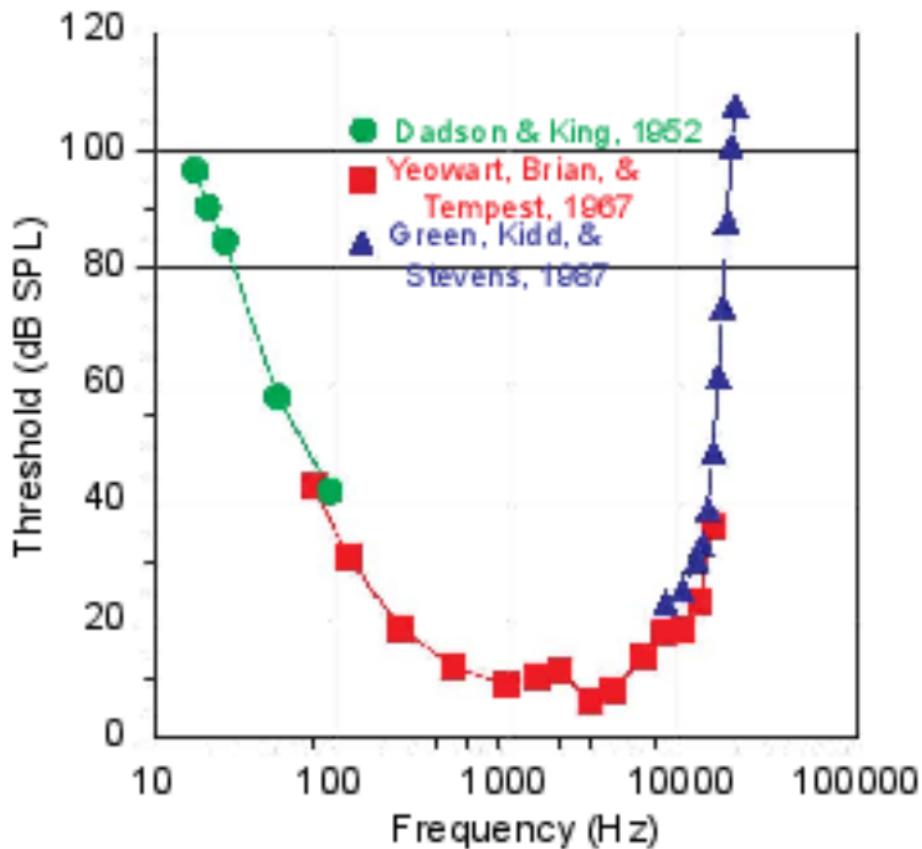
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Continuous signal (audio)

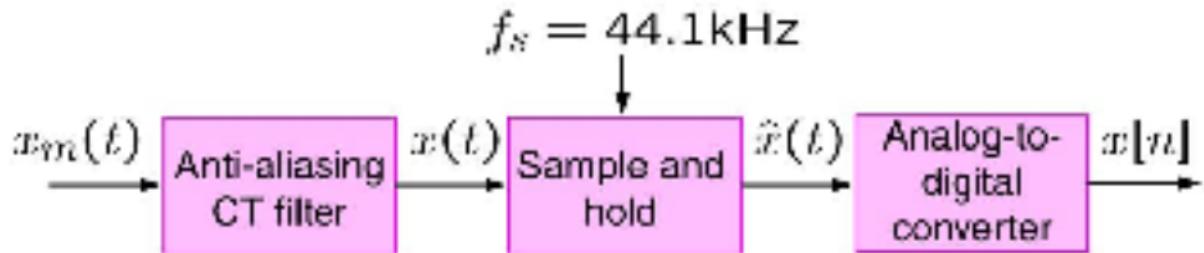
Discrete storage (pits and lands)

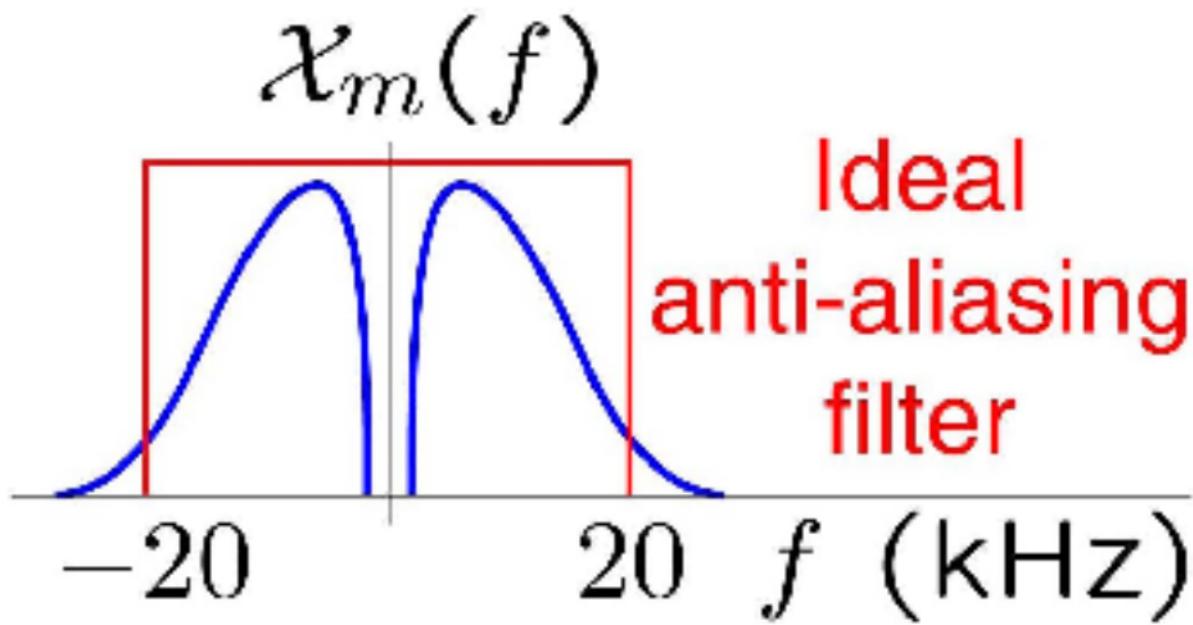
→ sampling!

## What's on a CD?

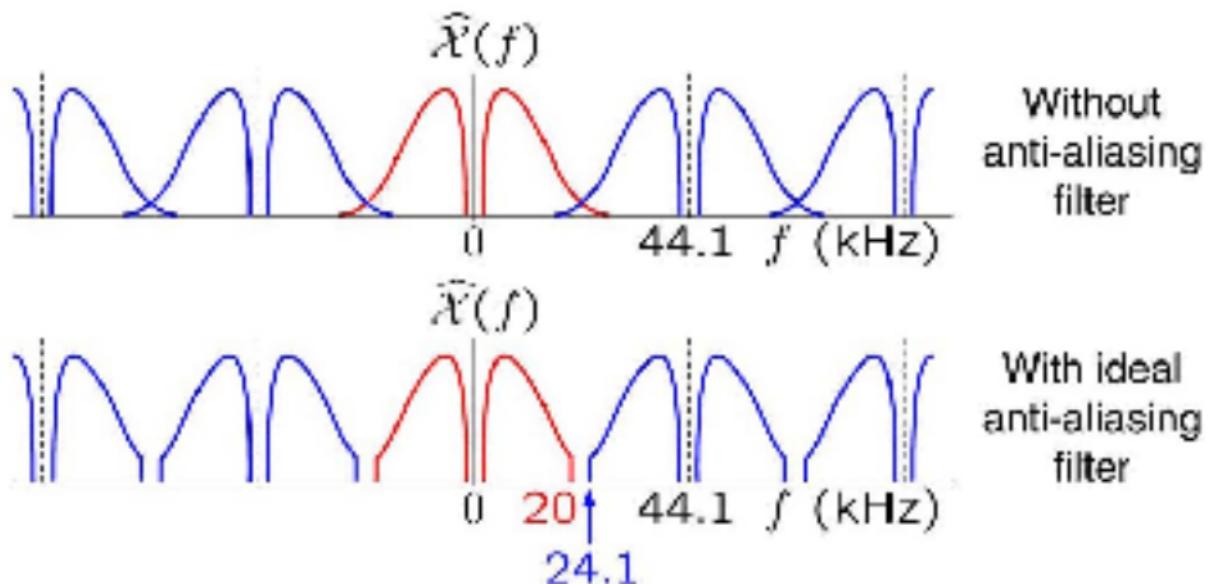


## What's on a CD?

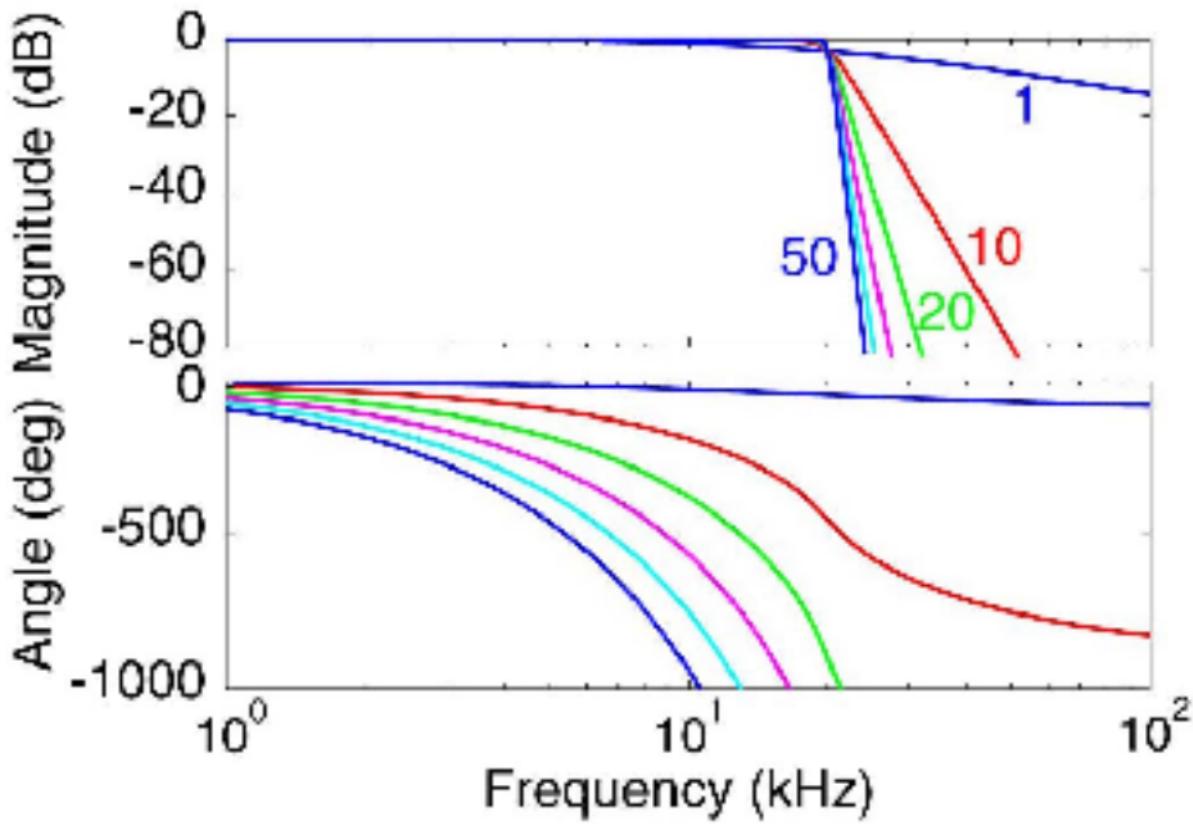




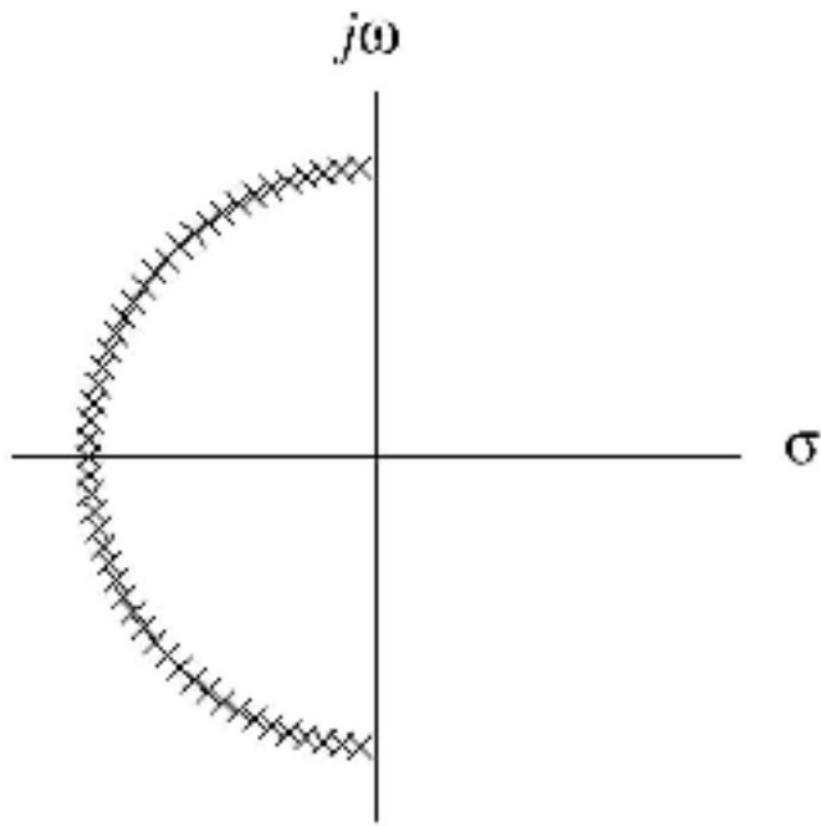
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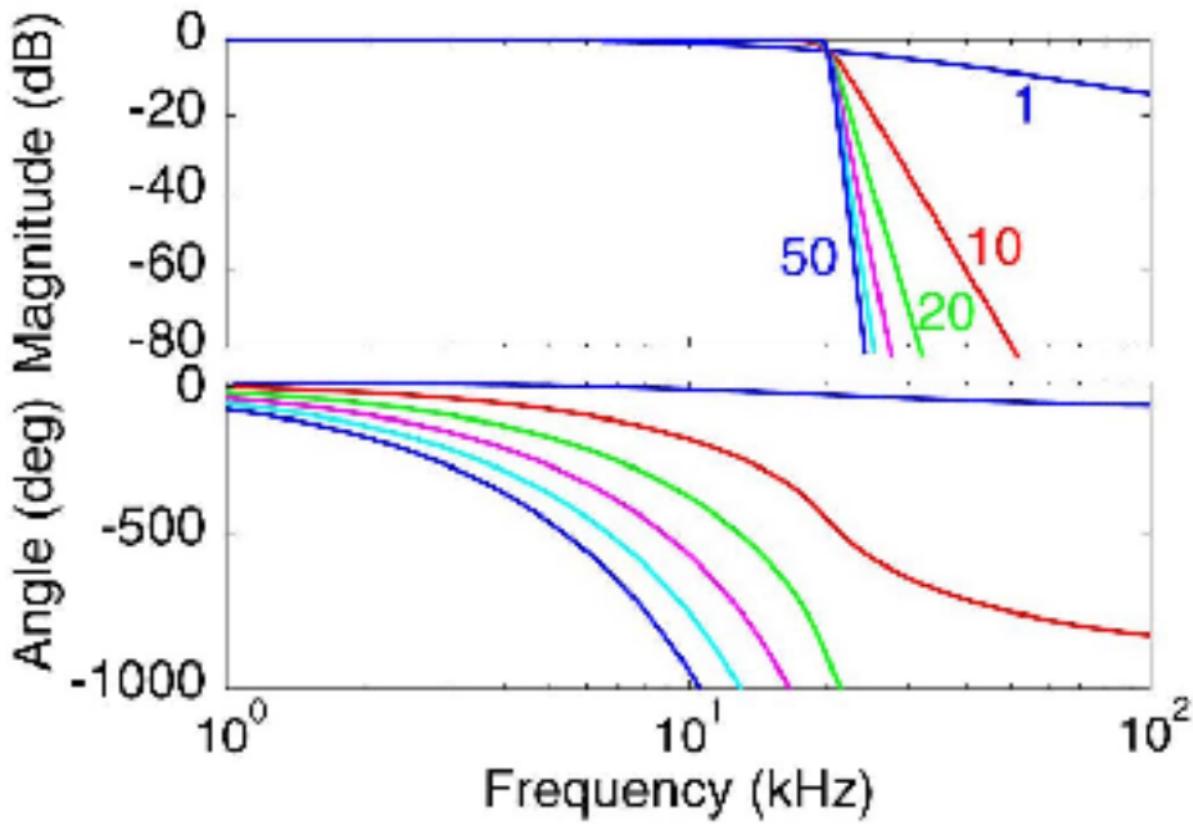
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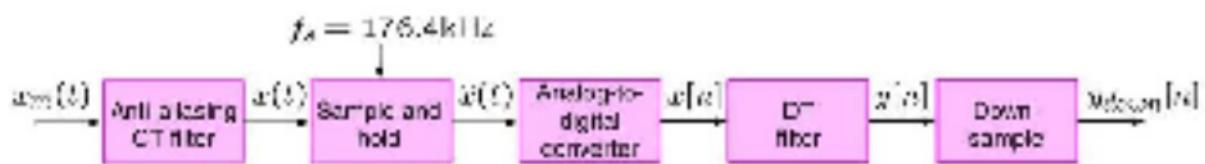
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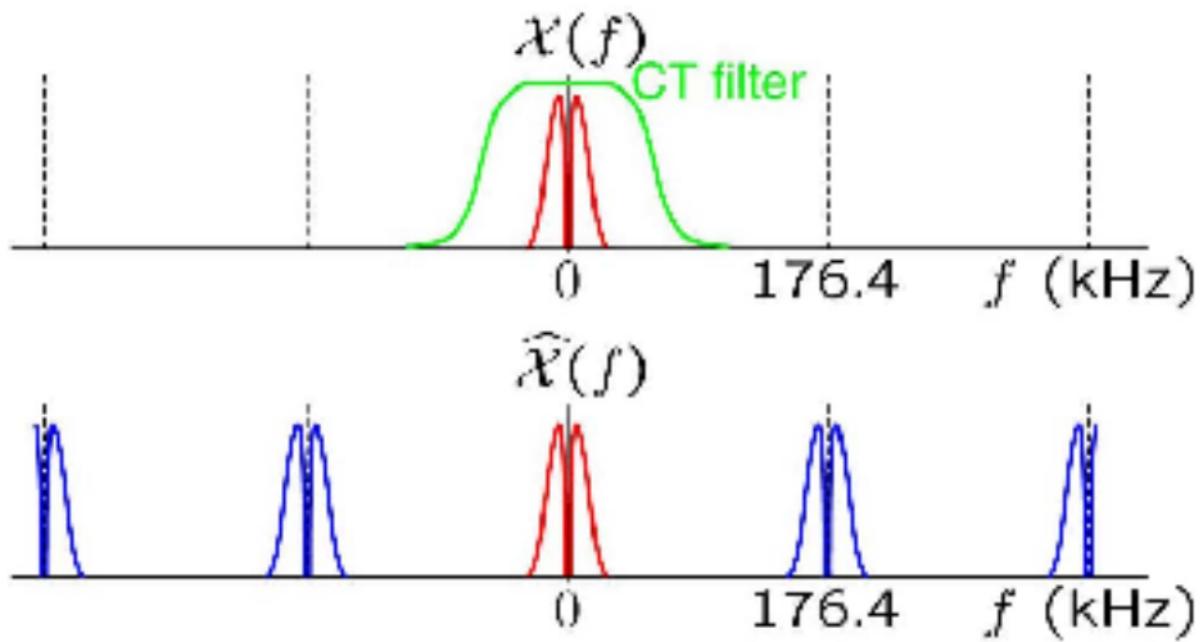
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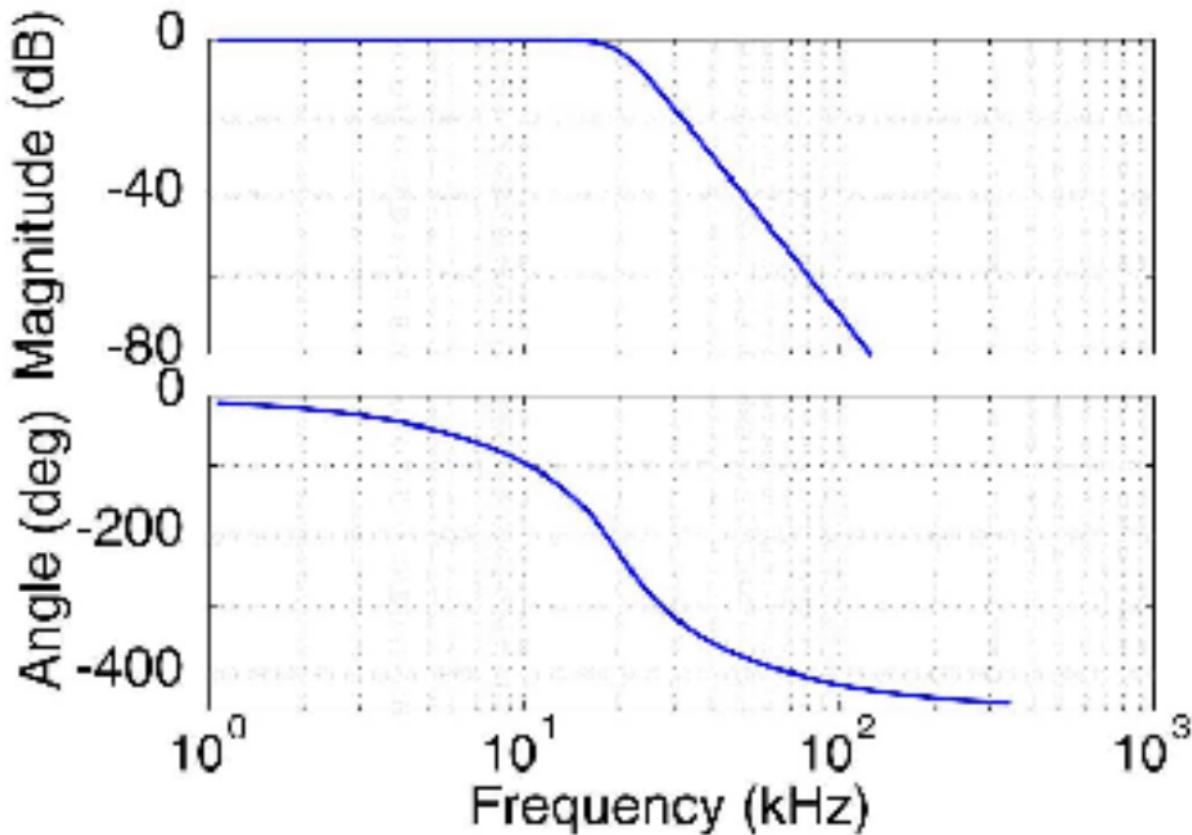
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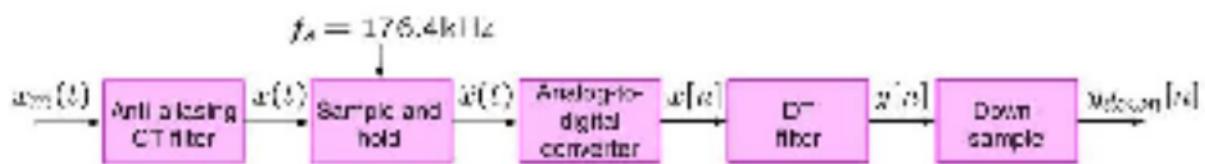
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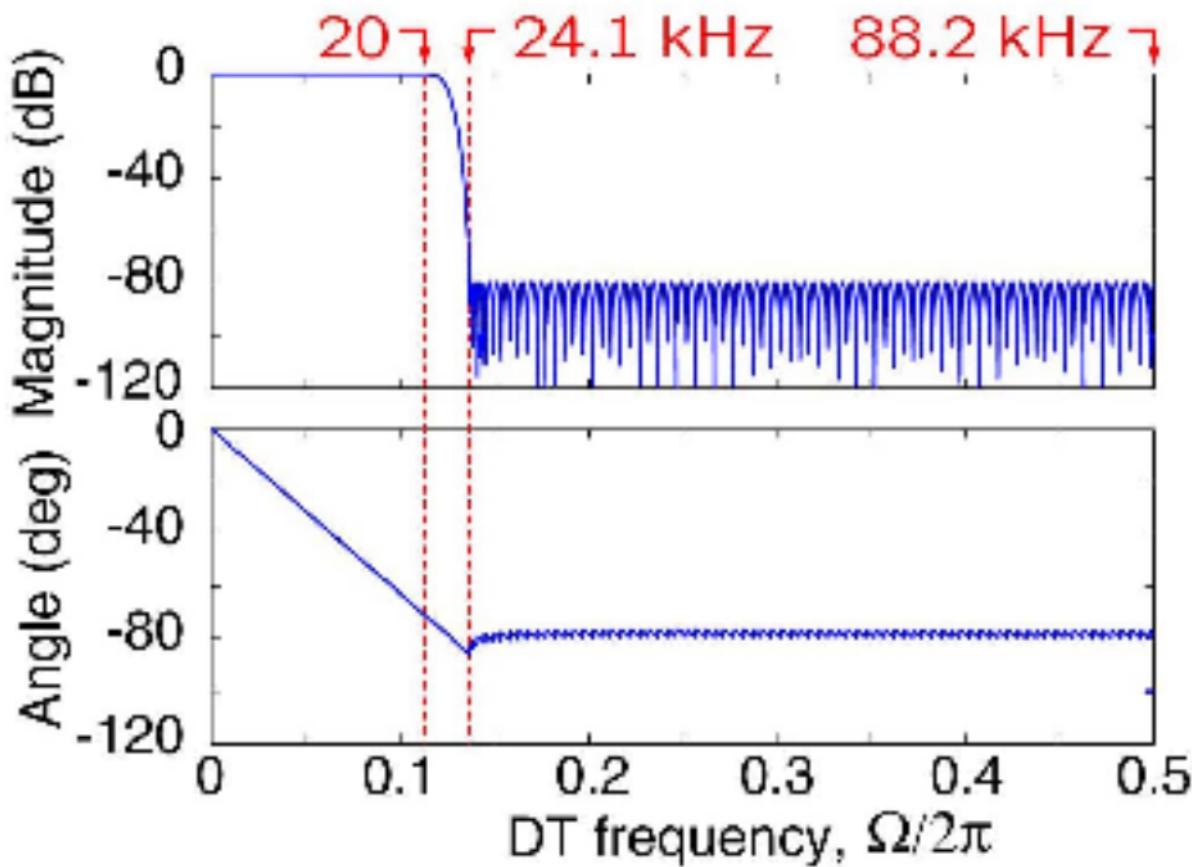
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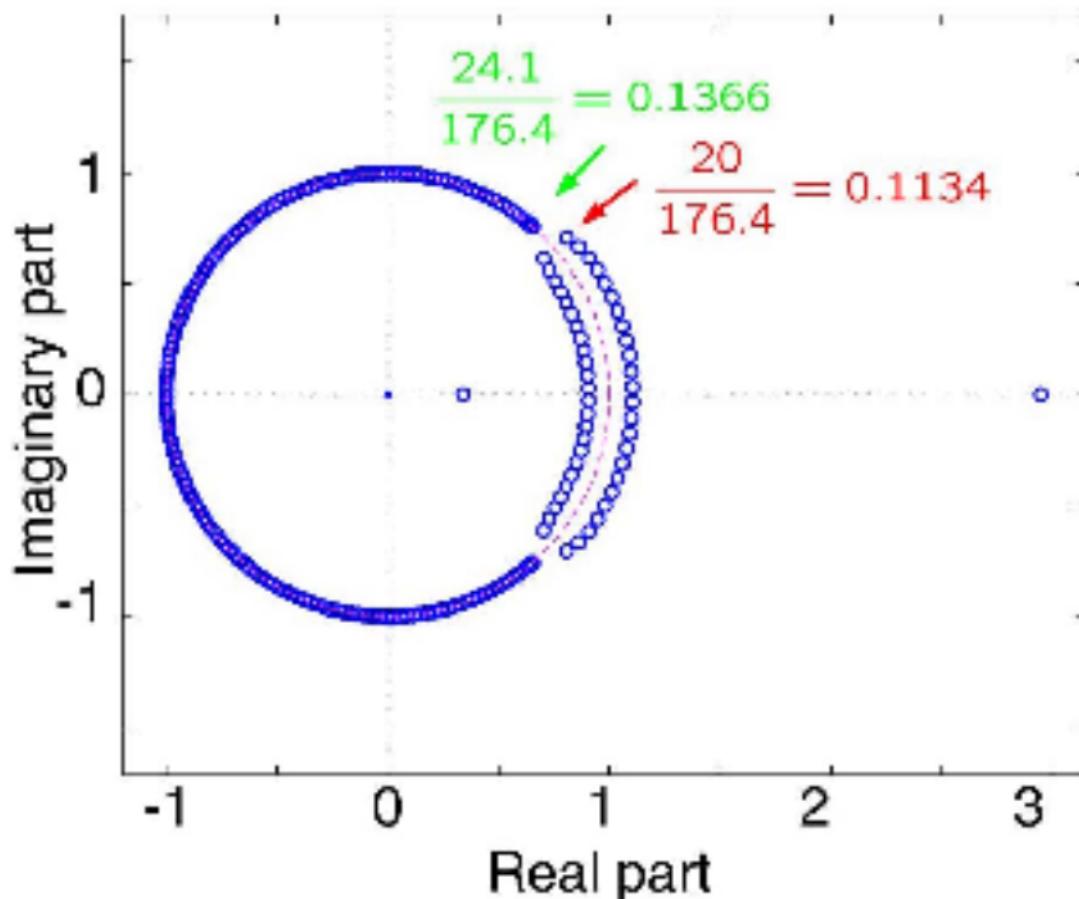
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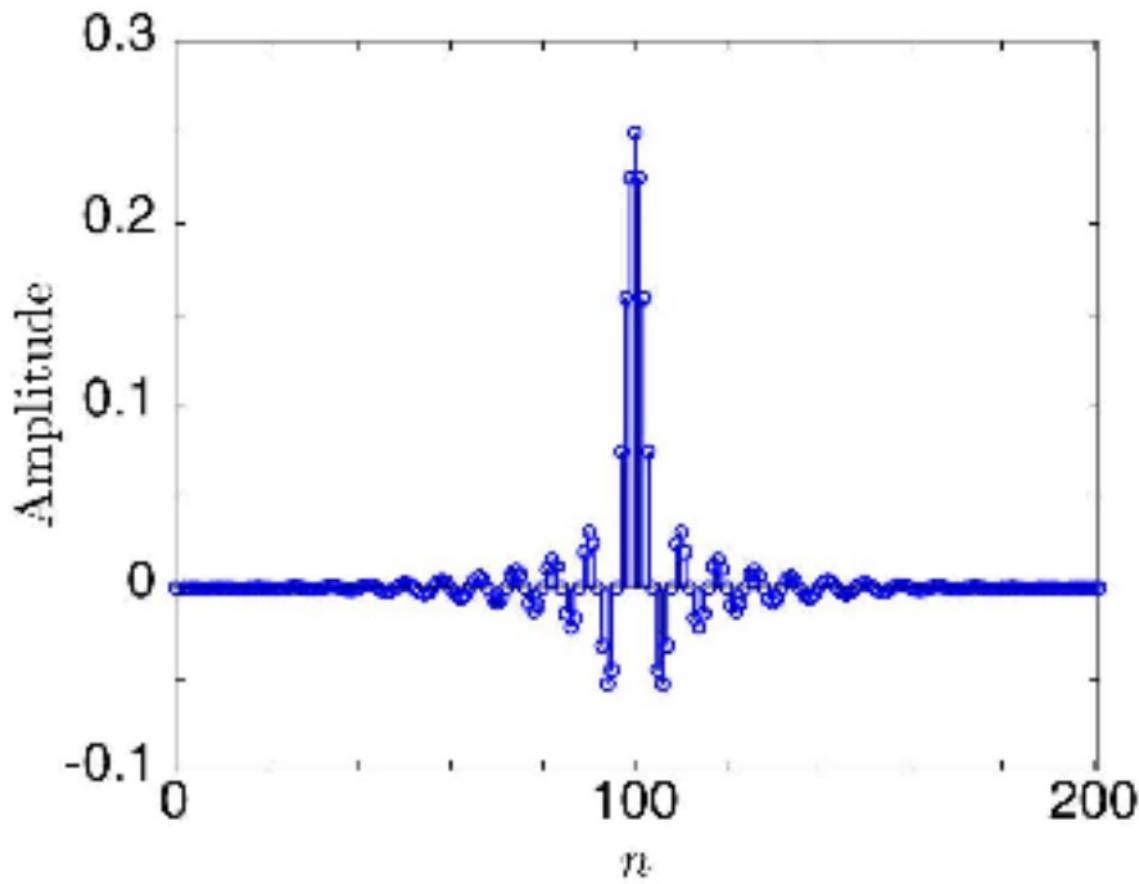
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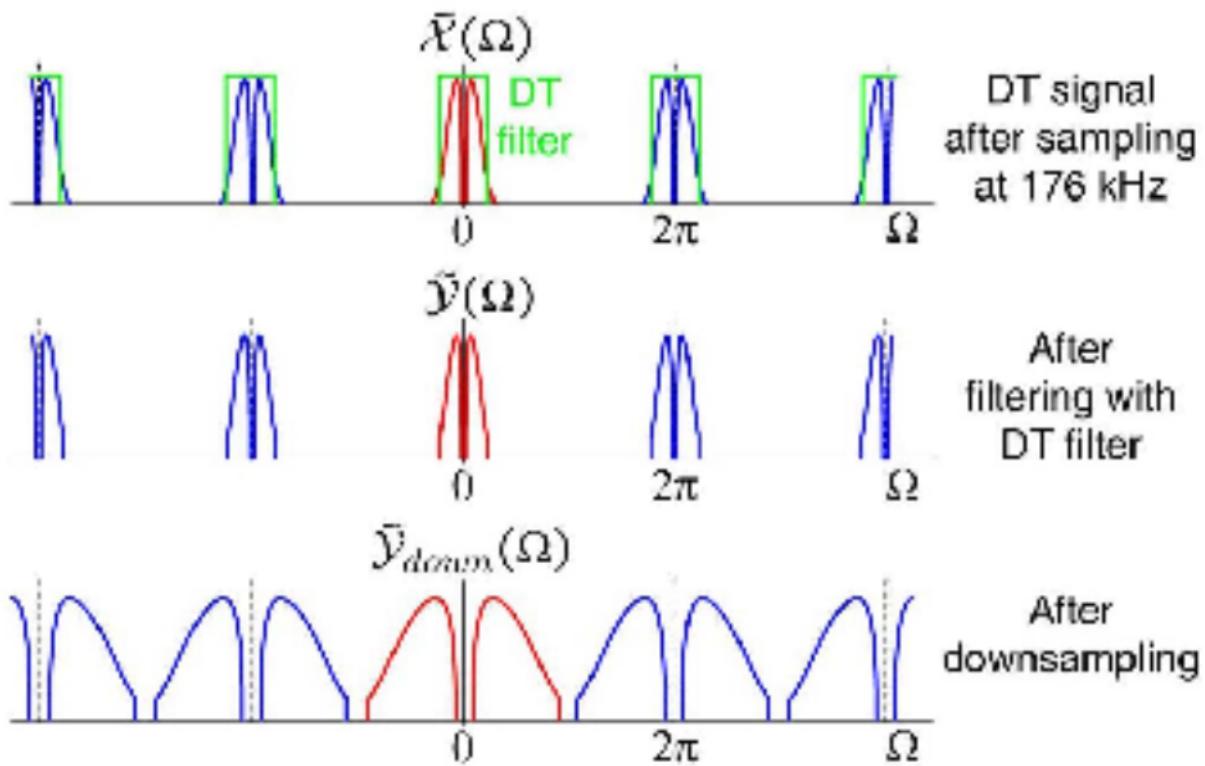
## What's on a CD?



## What's on a CD?



## What's on a CD?



## What's on a CD?

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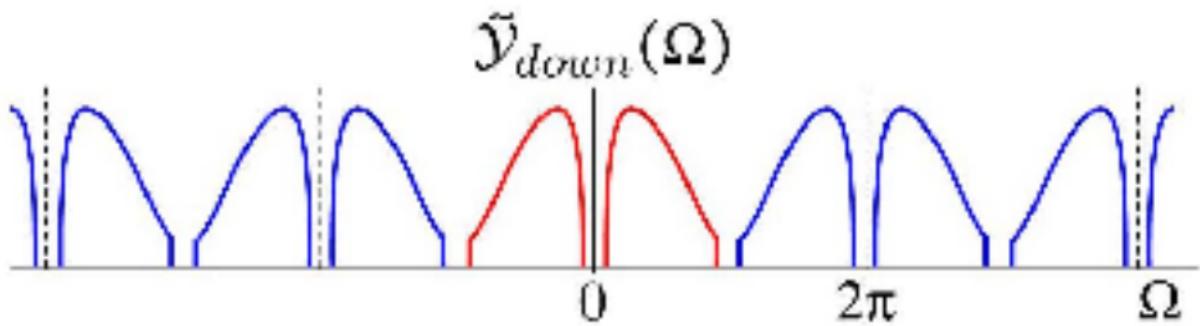
## What's on a CD?

Audio → bits:

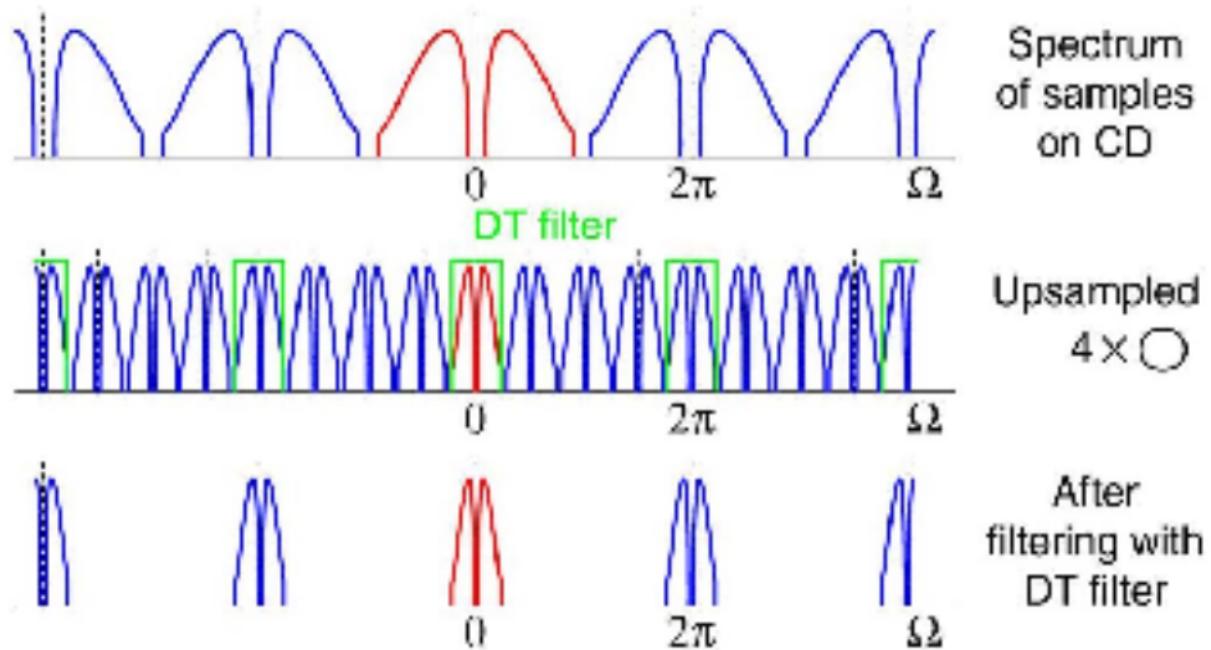
- sampling
- filtering
- DT processing of CT signals
- downsampling

Next issue: how to you build a player?

## What's on a CD?



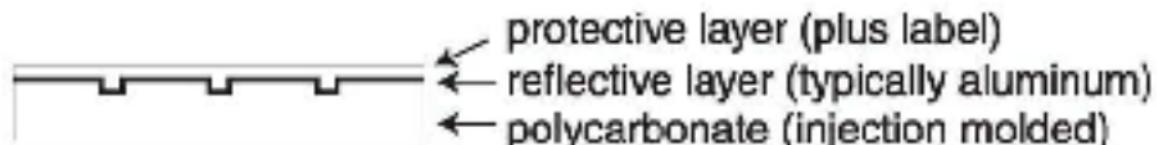
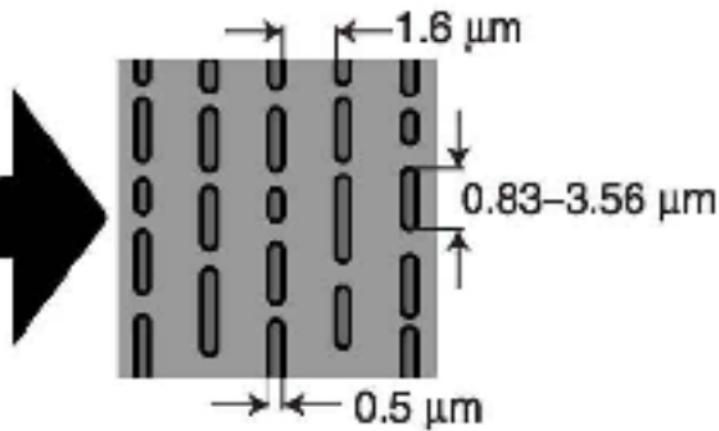
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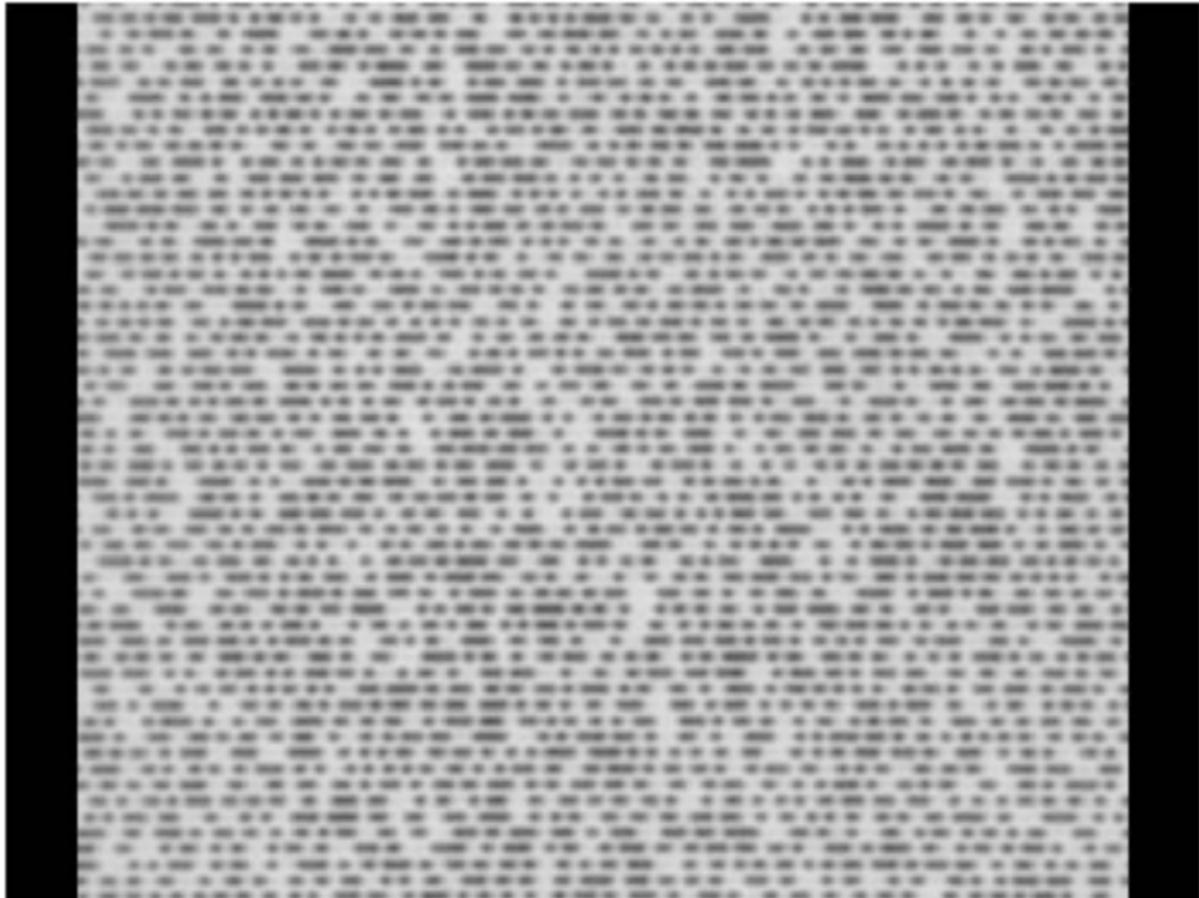
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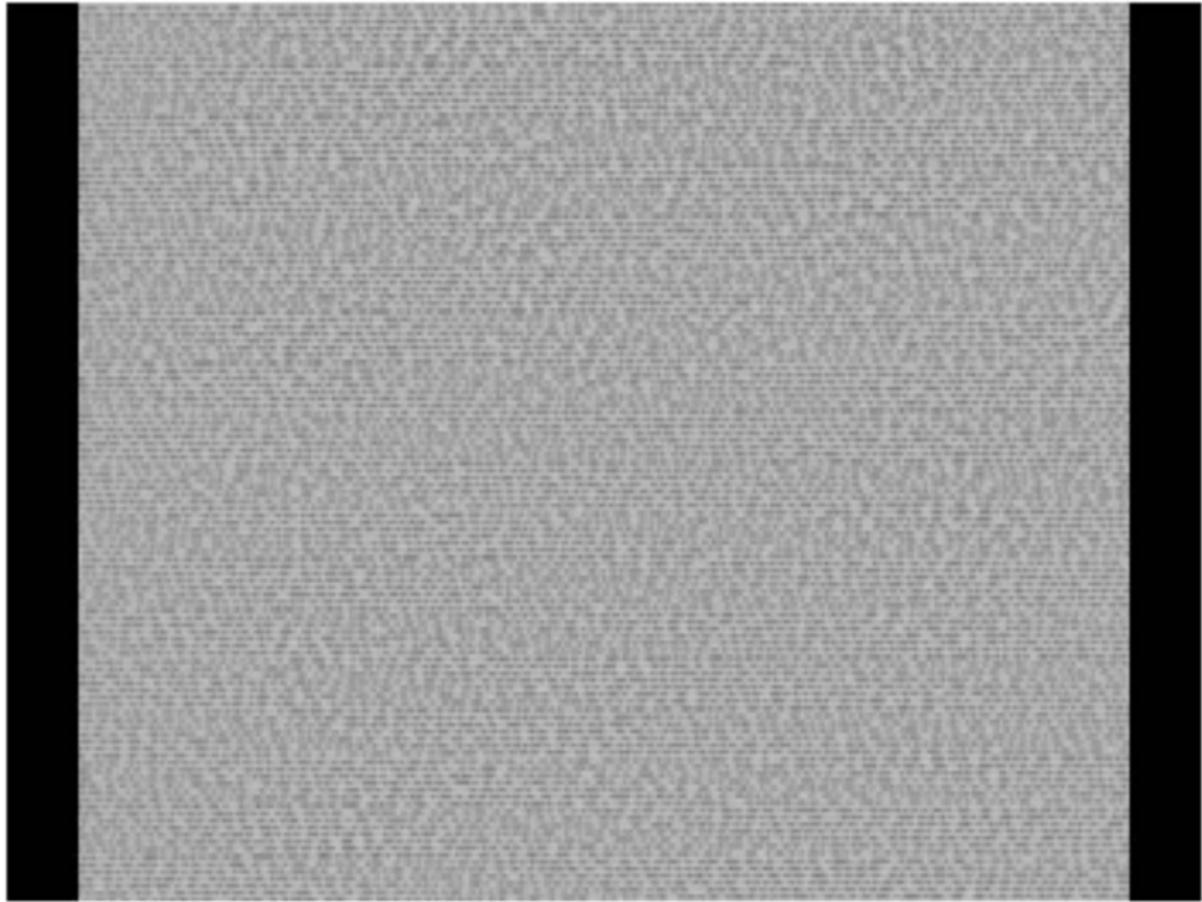
Image by [Dante Alighieri](#)  
on Wikimedia Commons.



## What's on a CD?

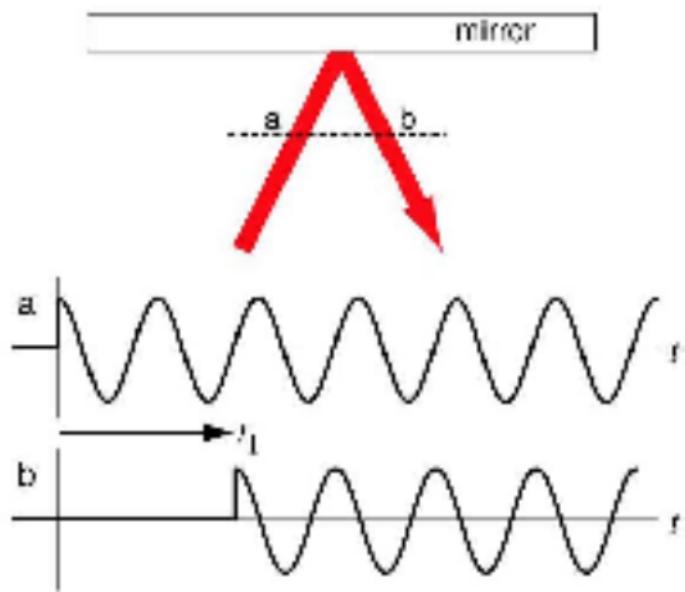


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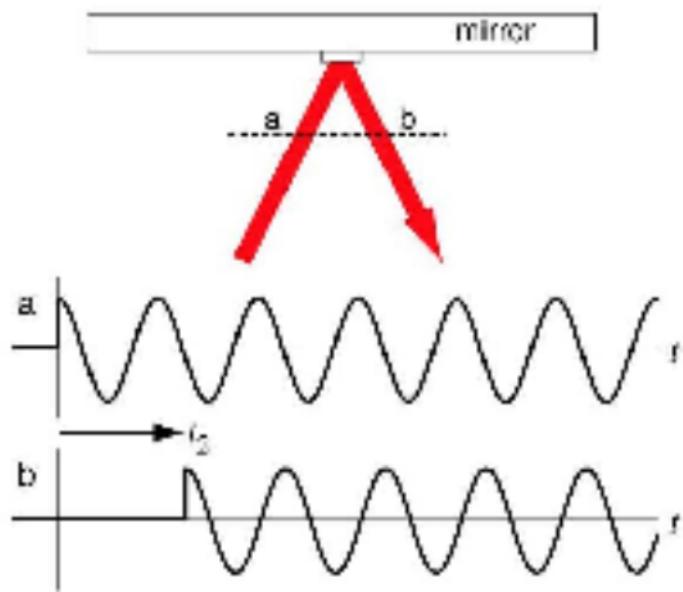
## What's on a CD?

Interferometric sensing: 6.003 explanation



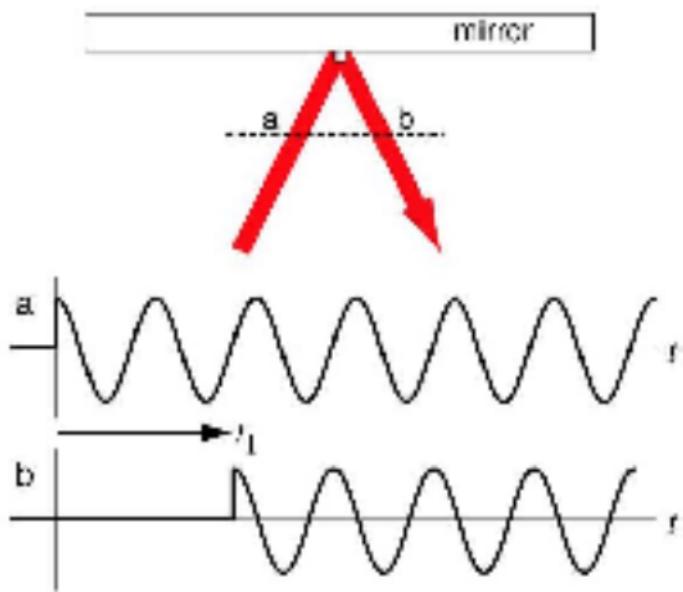
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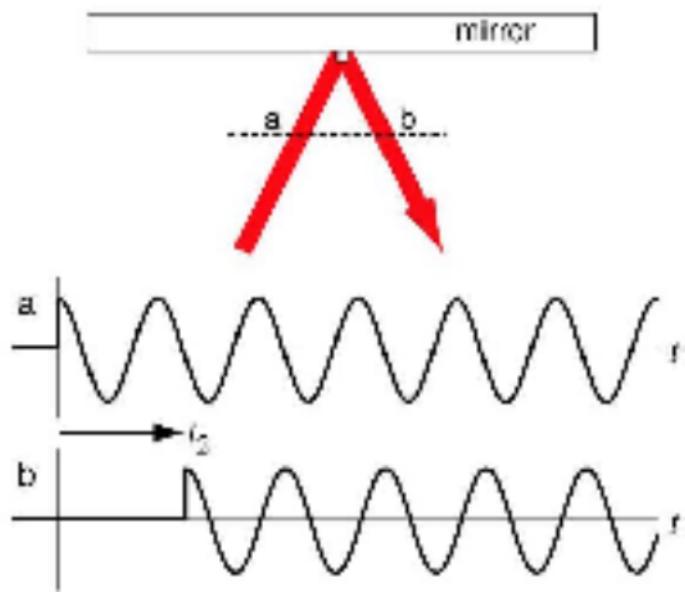
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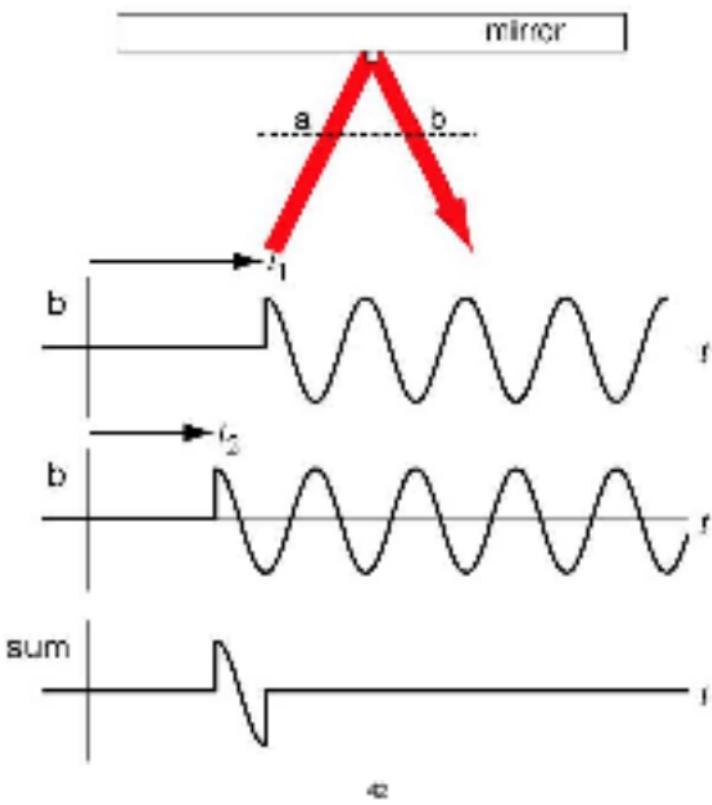
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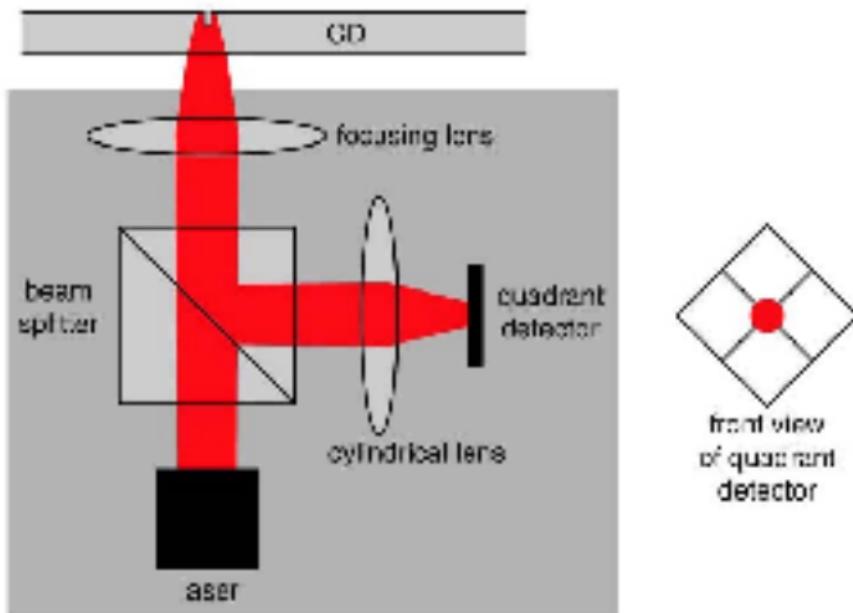
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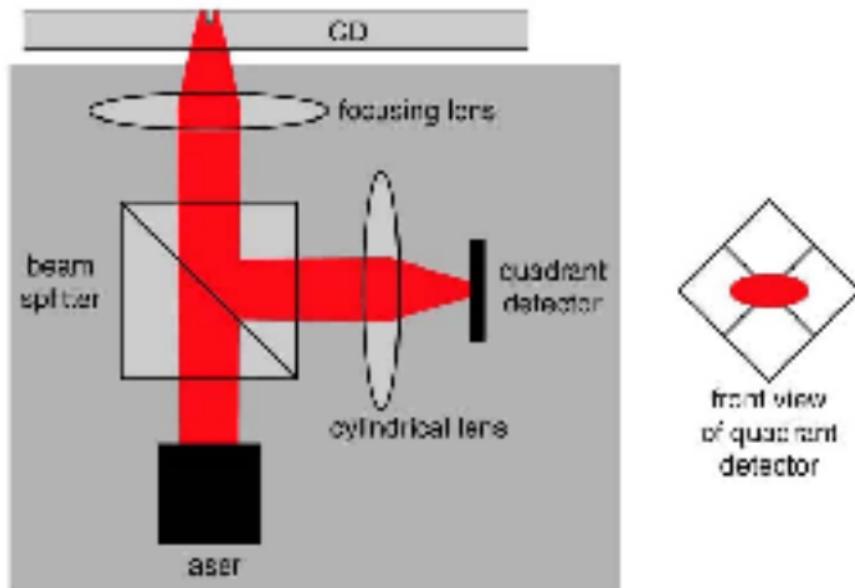
## What's on a CD?

### Focusing with feedback control



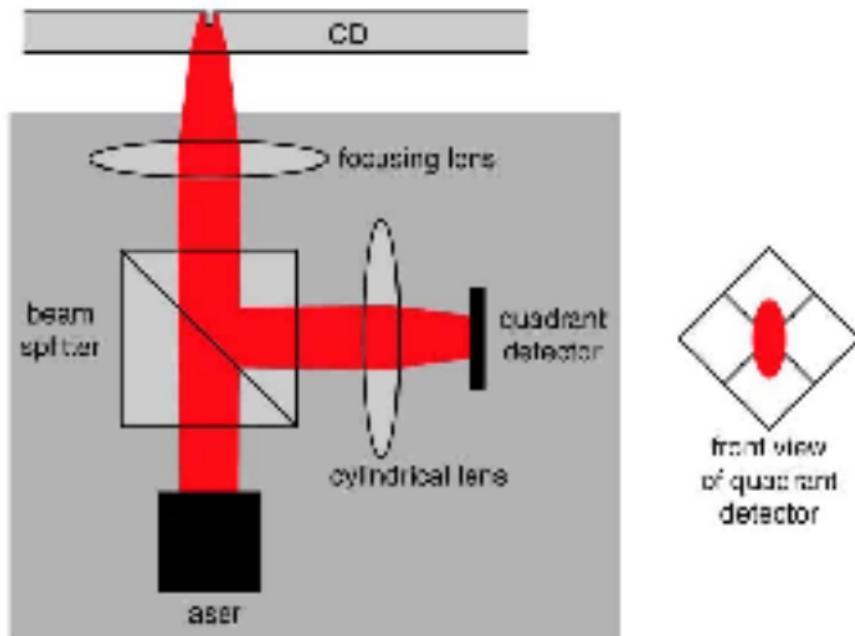
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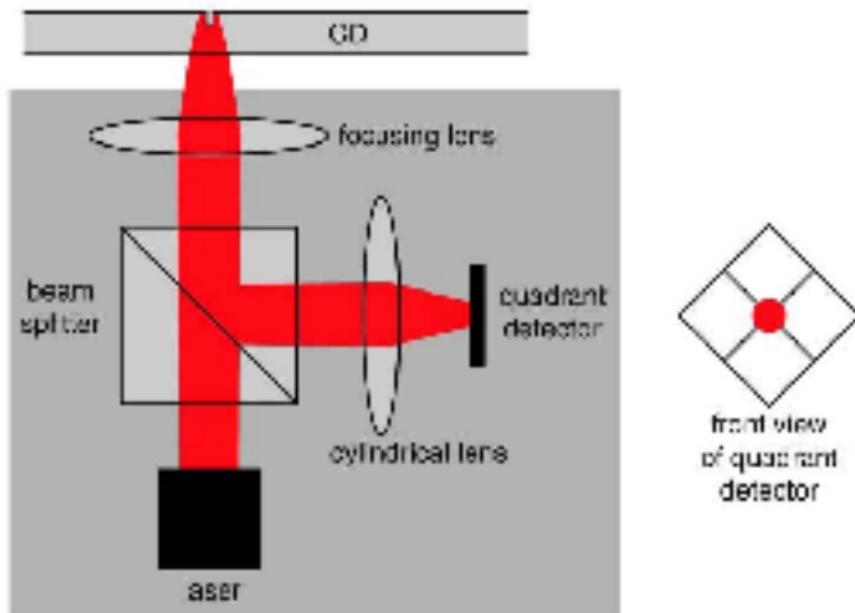
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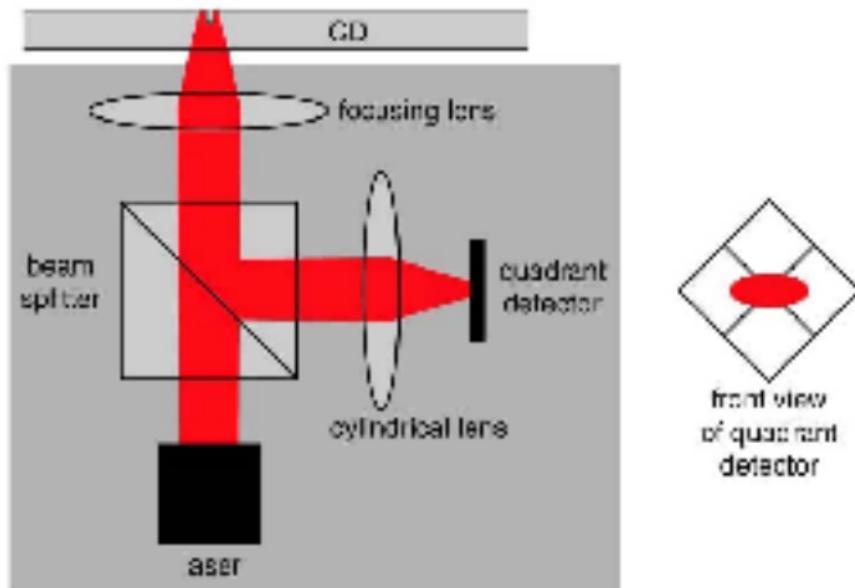
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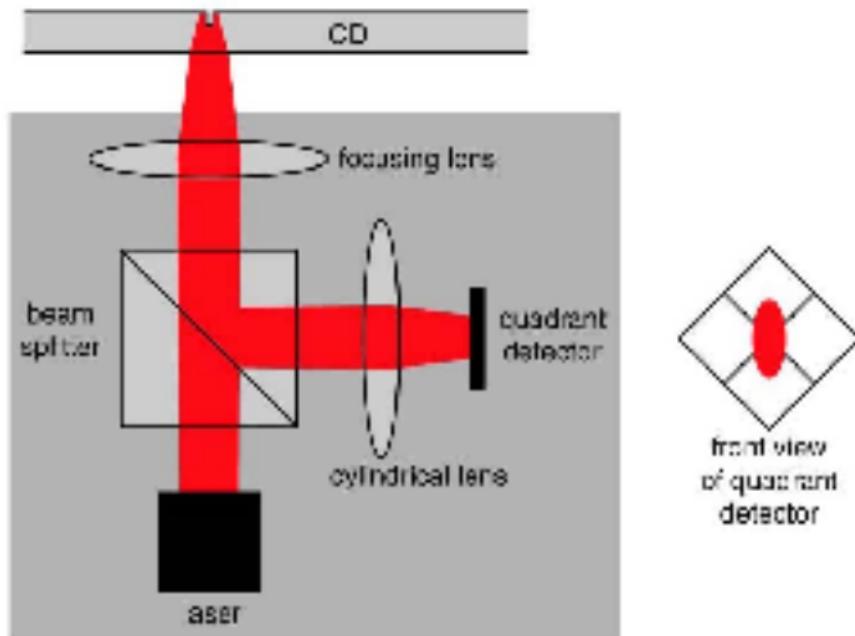
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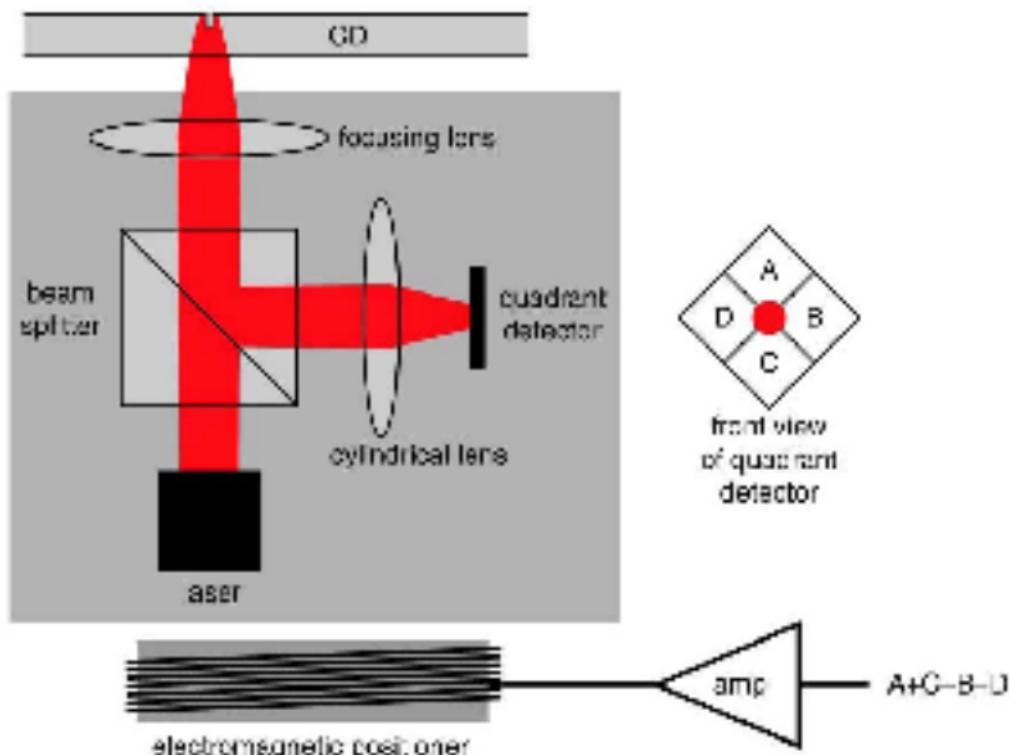
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# What's on a CD?

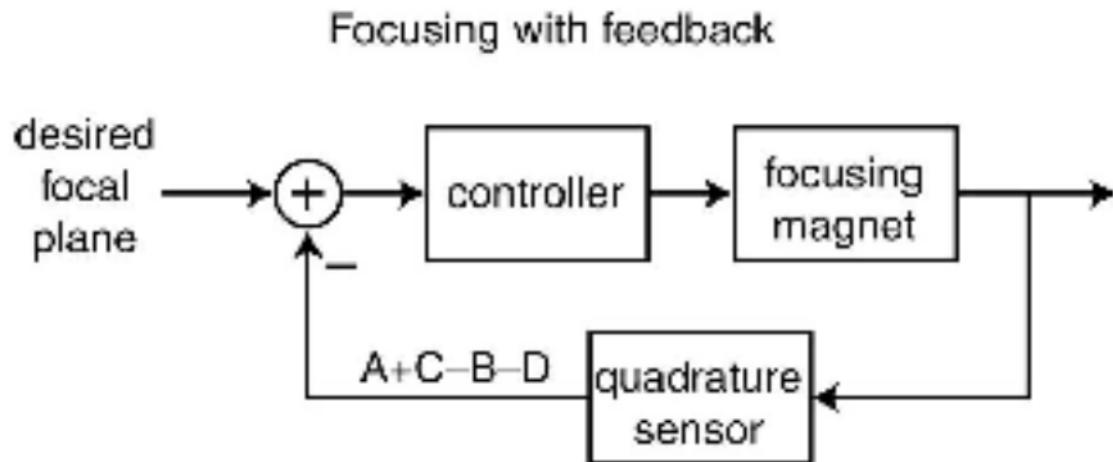
## Focusing with feedback control



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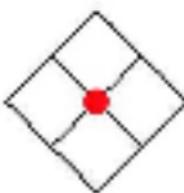
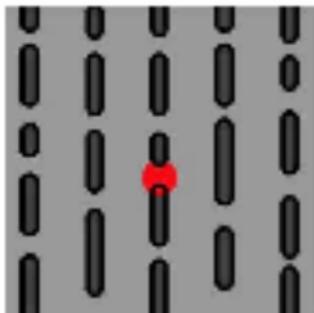
Image removed due to copyright restrictions. Please see Brain, Marshall.  
["How CDs Work: CD Player Components."](#) HowStuffWorks, April 2000.

## What's on a CD?



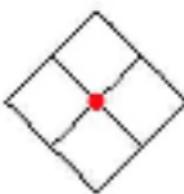
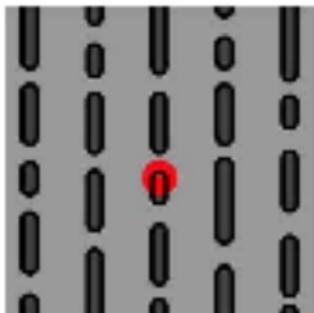
## What's on a CD?

Translating pits to bits



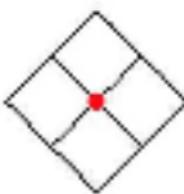
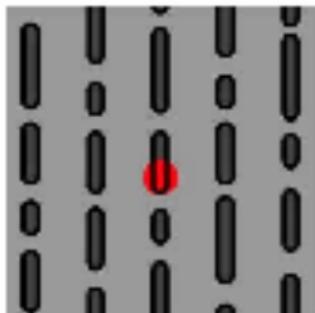
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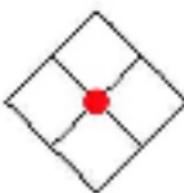
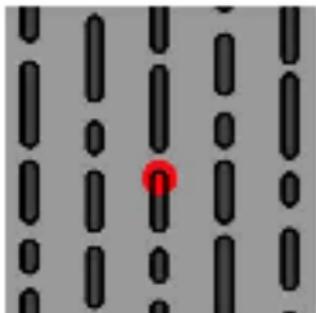
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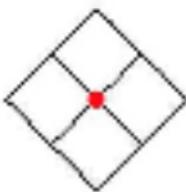
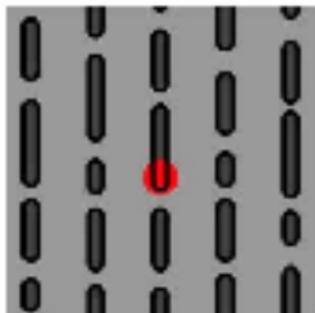
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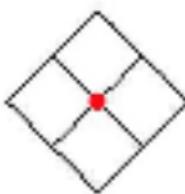
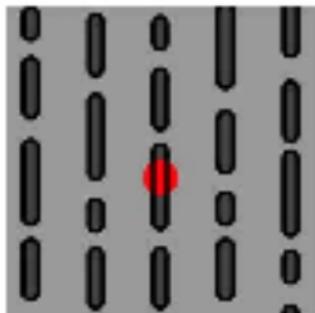
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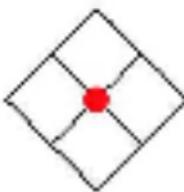
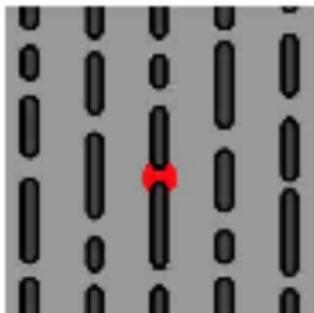
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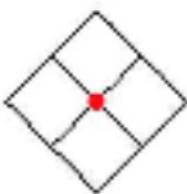
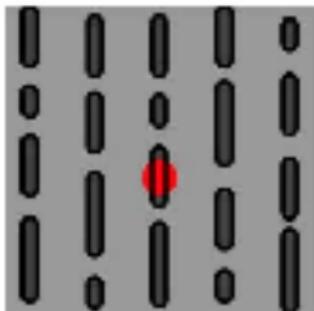
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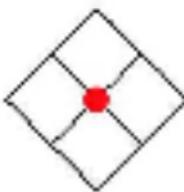
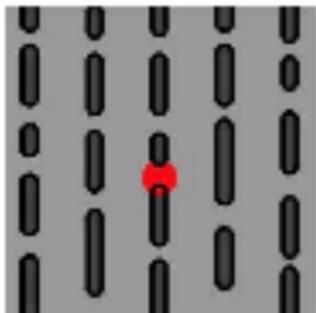
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Translating pits to bits



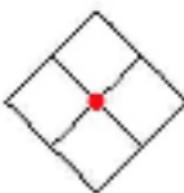
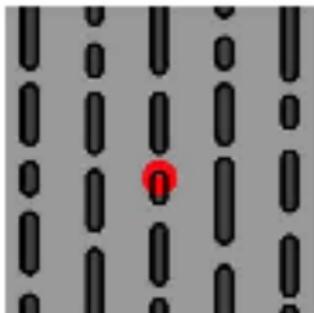
## What's on a CD?

Translating pits to bits



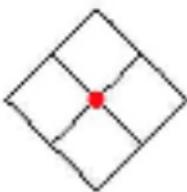
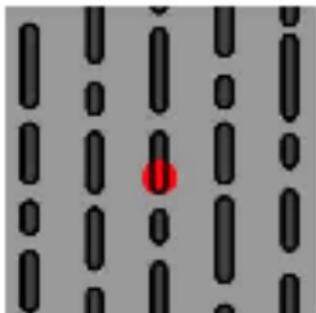
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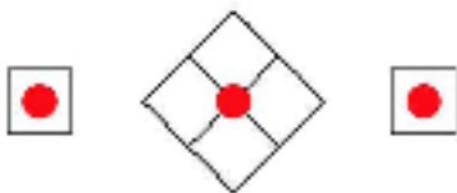
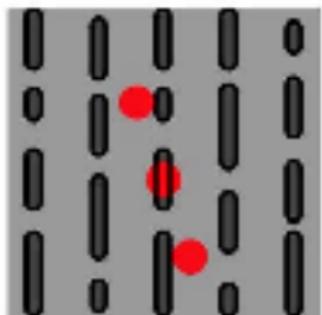
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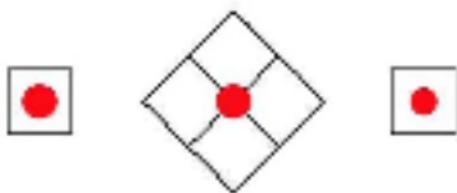
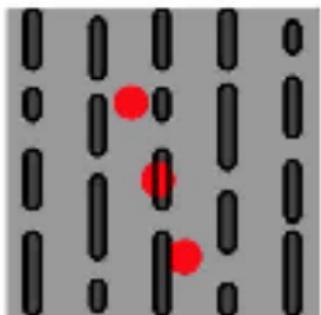
## What's on a CD?

Tracking with feedback control



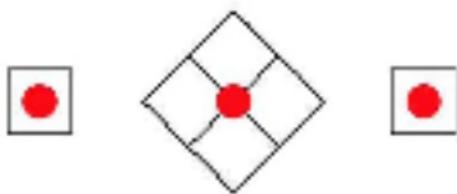
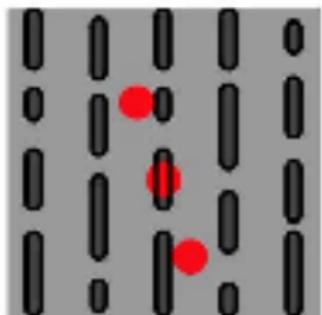
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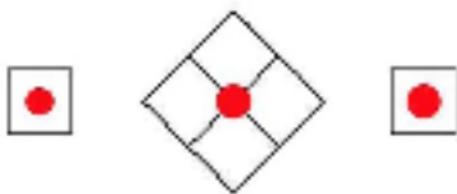
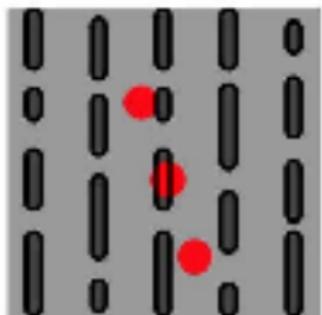
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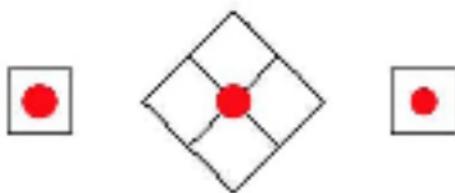
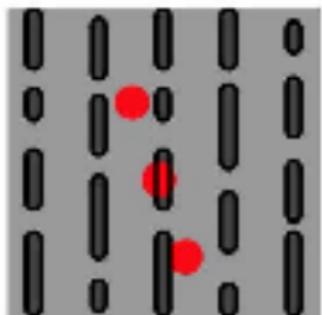
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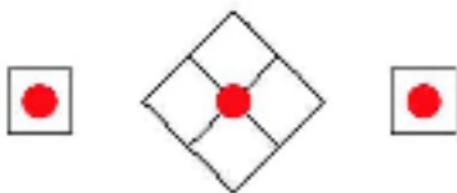
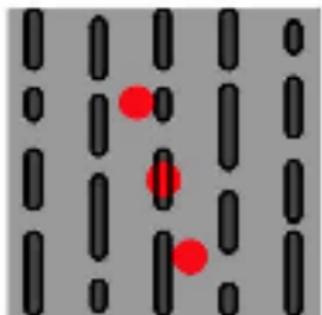
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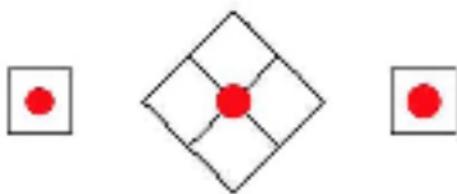
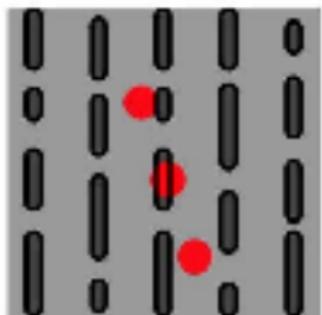
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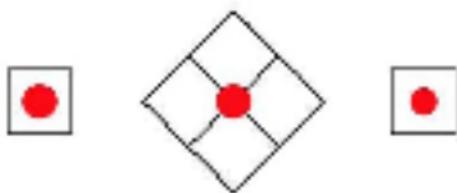
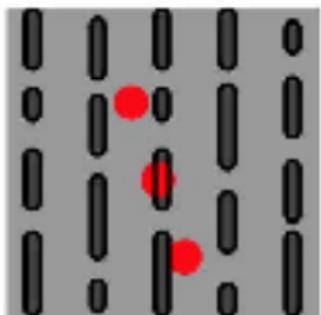
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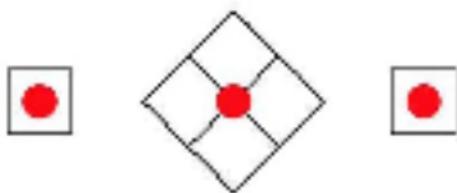
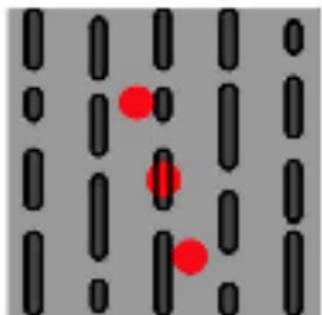
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Tracking with feedback control



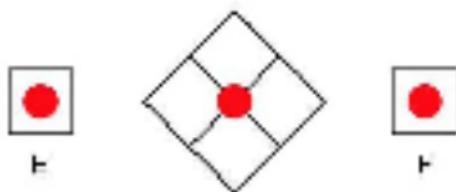
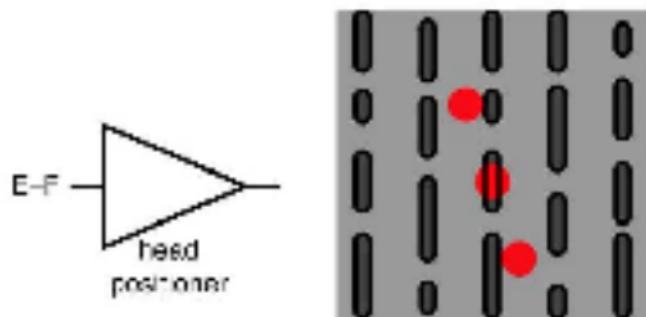
## What's on a CD?

Tracking with feedback control



## What's on a CD?

Tracking with feedback control

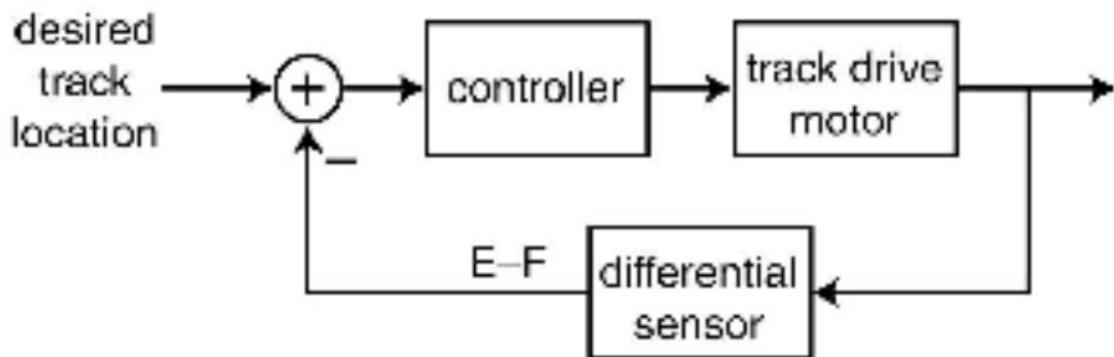


## What's on a CD?

Image removed due to copyright restrictions. Please see Brian Marshall,  
"How CDs Work: CD Layer Components." HowStuffWorks, April 2000.

## What's on a CD?

Tracking the tracks with feedback



## What's on a CD?

LPs: 100 years of optimization, good fidelity, but

- fragile: easily scratched
- lots of distortions: e.g., wow and flutter
- expensive

CDs: much higher fidelity

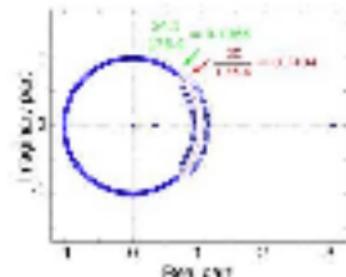
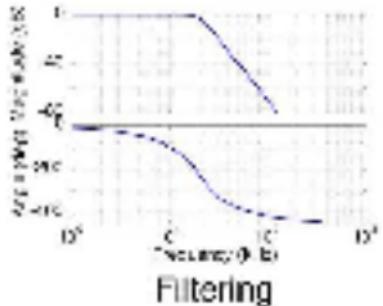
- nearly indestructible
- very low distortion
- very cheap



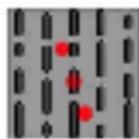
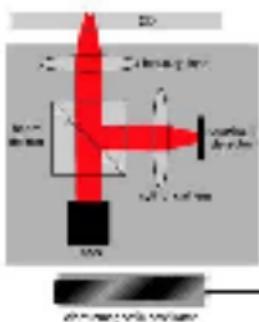
→ many of these advantages made possible by concepts from Signals and Systems!

# What's on a CD?

From LPs to CDs –  
and how 6.003 helps get you there



DT processing of CT signals



Feedback



## What's on a CD?

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### References:

"The history of the Edison Cylinder Phonograph"

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<http://electronics.howstuffworks.com/cd.htm>

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## 6.003 Signals and Systems

Fall 2011

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