Tasks

(1) Read chapter 9:

(2) Solve exercise sheets

16th Lecture	13h00 – 15h00 Chapter 9: tight-binding	
18th Lecture	10h00 – 12h00 Chapter 9: Quantum Oscillation	
23th Lecture	13h00 – 15h00 Chapter 9: Quantum Oscillation	**(Hand-in exercise)**
25th Lecture	10h00 – 12h00 Wrap-up	
30th Exercise	13h00 – 15h00	**(Hand-in exercise)**
01st Lecture	10h00 -- 12h00 Exam focus	

Course Content

I. Crystal structures

II. Structures in reciprocal space

III. Crystal bindings

IV. Crystal vibrations

Crystal structures and Lattice Vibrations

VI. Free electron gasses

VII. Electronic band structure

VIII. Semiconductors

Electronic properties

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7	14.03	Scattering theory	**8-9**
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12	11.04	Thermal properties	**7**
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14	18.04	Electron gasses	**6-7**
15	20.04	Specific heat	**6**
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25	25.05	Exercise	
26	30.05	Repetition	**4**
28	01.06	Repetition	**4**

Repetition Requests

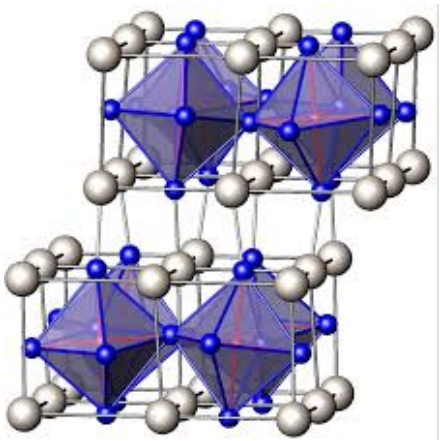
Reciprocal Space
Form Factor
Structure Factor

Optical phonons

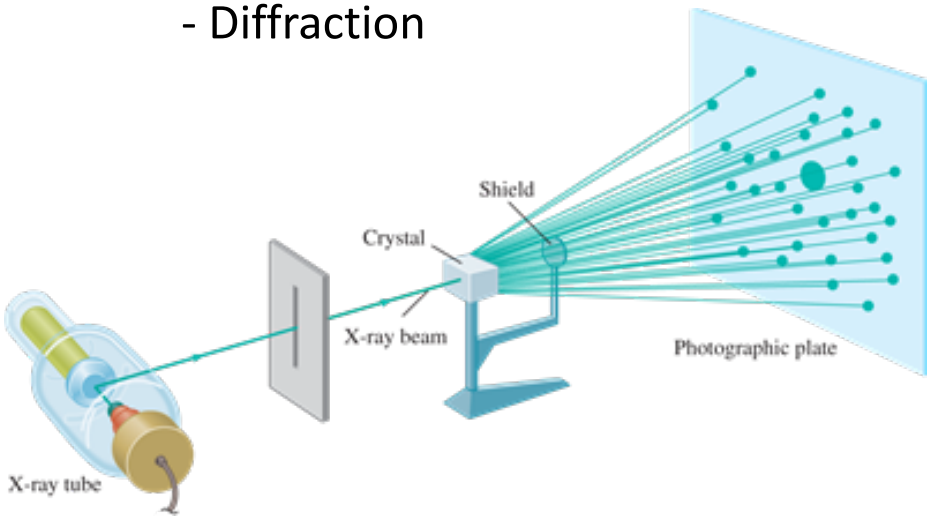
Band structure
Fermi surfaces

Summary of the Course

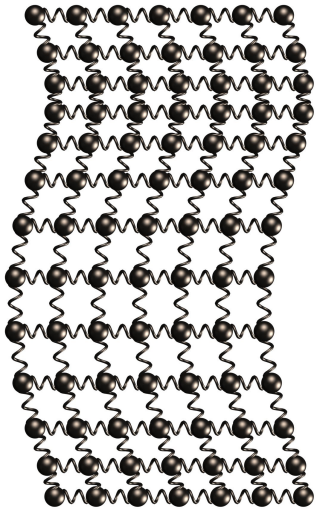
- Crystal Structures
- Crystal Bindings



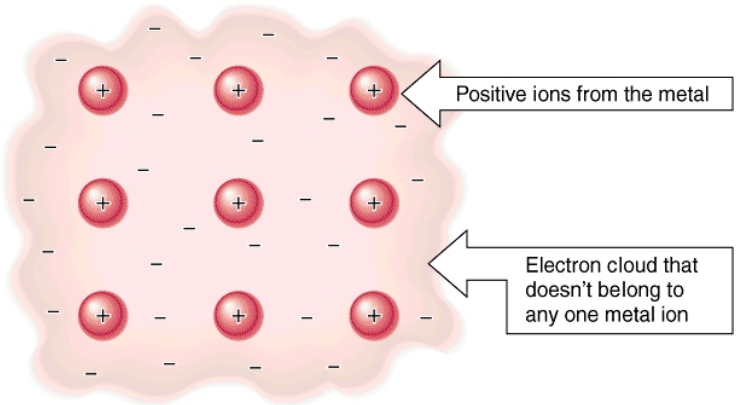
- Reciprocal Space
- Diffraction



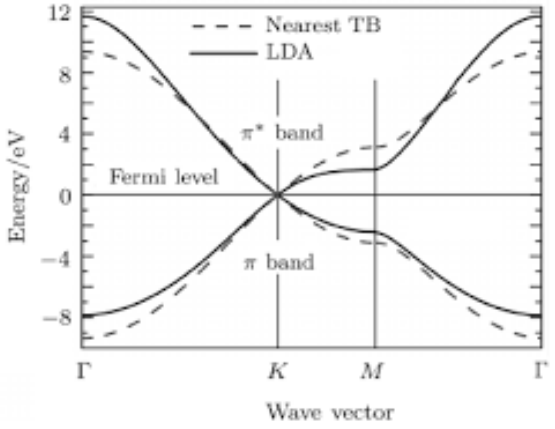
- Phonons
- Heat Capacity



- Free Electron Gas
- Electronic heat capacity
- Electronic properties



- Band structure
- Fermi Surfaces
- Electronic Material Classification

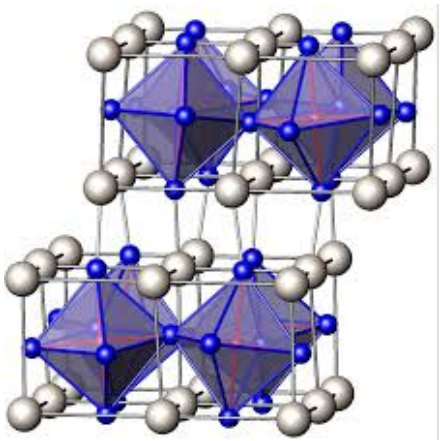


New Concepts

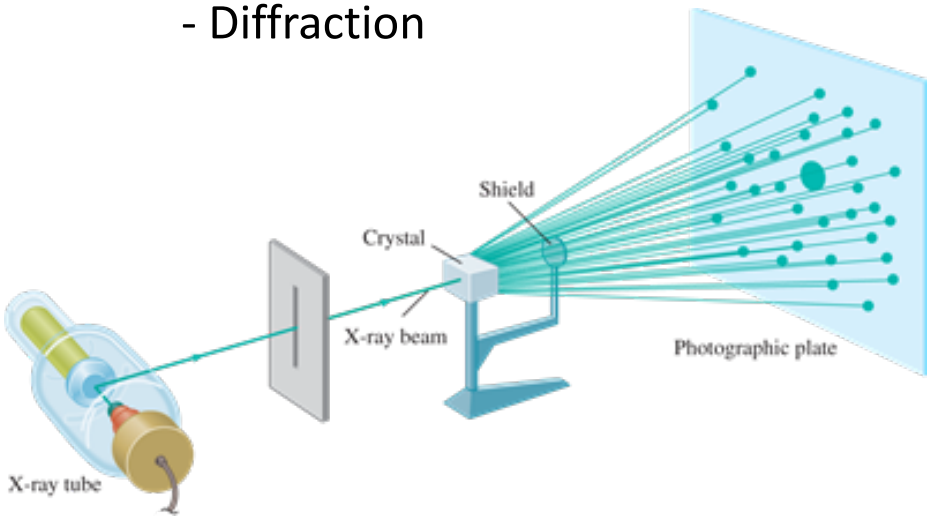
Reciprocal Space
Form Factor
Structure Factor
Phonons
Dispersion
Plancks Distribution
Fermi-Dirac Distribution
Density – of – States
Band structure
Fermi surfaces

Why Care?

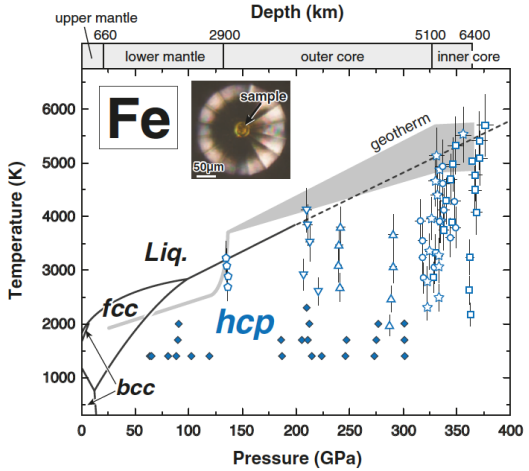
- Crystal Structures
- Crystal Bindings



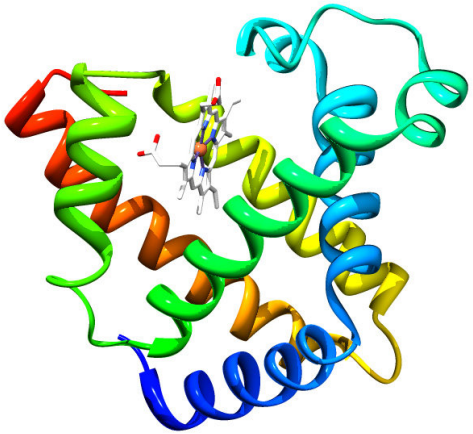
- Reciprocal Space
- Diffraction



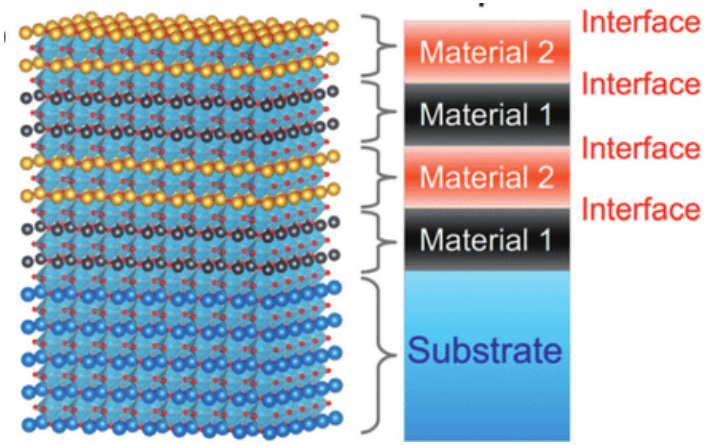
Planetary Science



Protein Structures

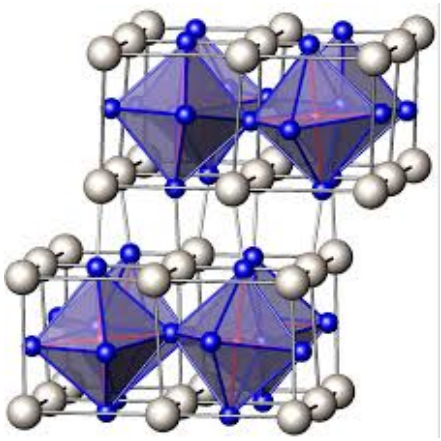


Material Design

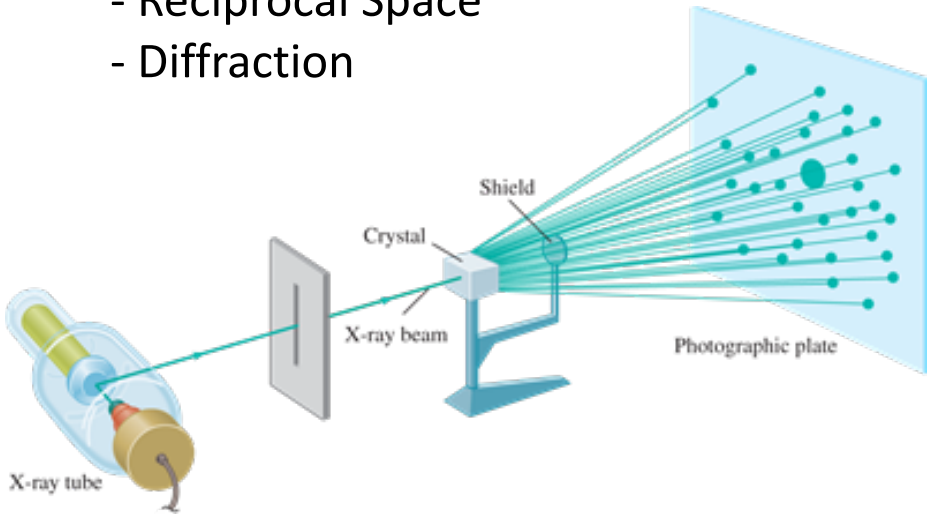


Learn More?

- Crystal Structures
- Crystal Bindings

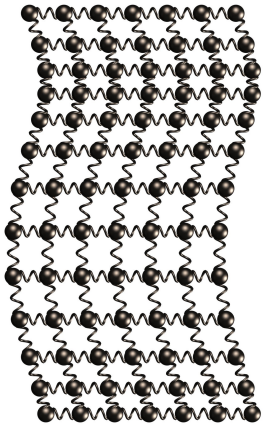


- Reciprocal Space
- Diffraction

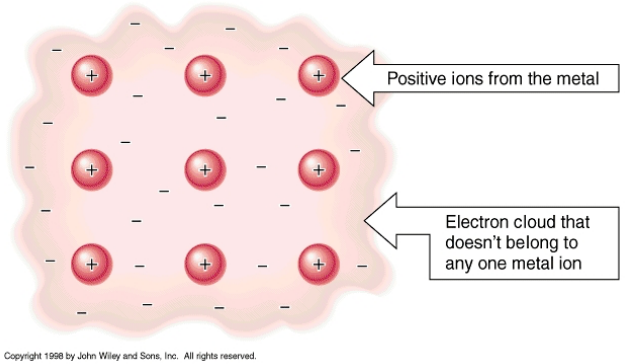


Why Care?

- Phonons
- Heat Capacity



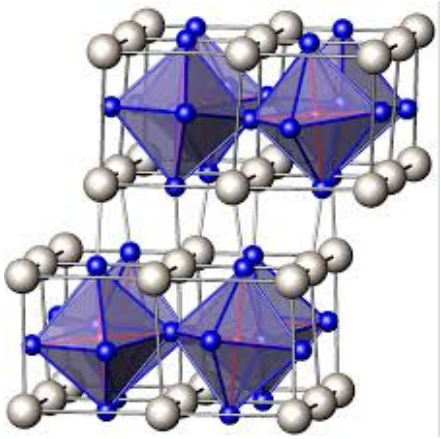
- Free Electron Gas
- Electronic heat capacity
- Electronic properties



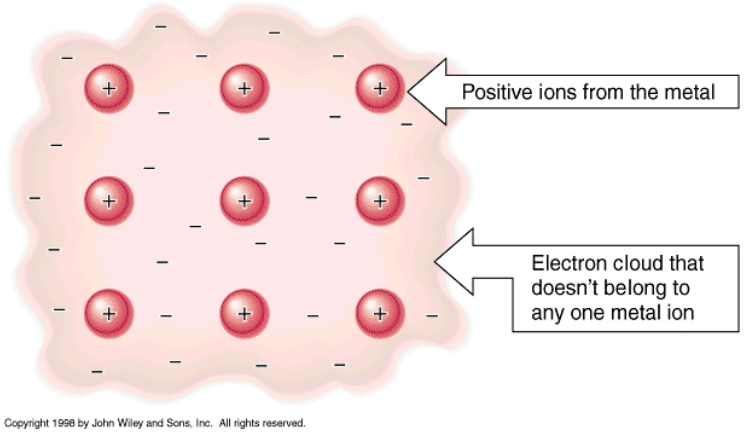
Thermo-Electricity: Converting heat to electricity

Why Care?

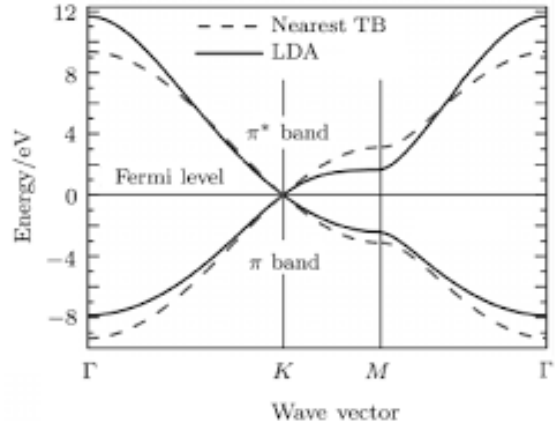
- Crystal Structures
- Crystal Bindings



- Free Electron Gas
- Electronic heat capacity
- Electronic properties



- Band structure
- Fermi Surfaces
- Electronic Material Classification



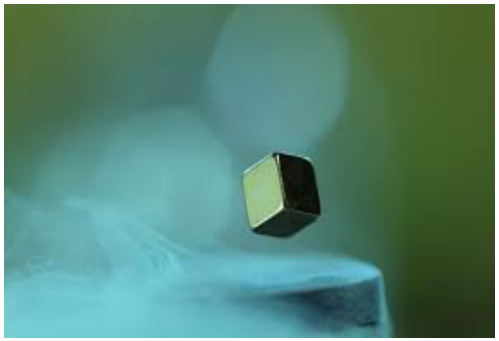
Data Storage

Semiconductor technology

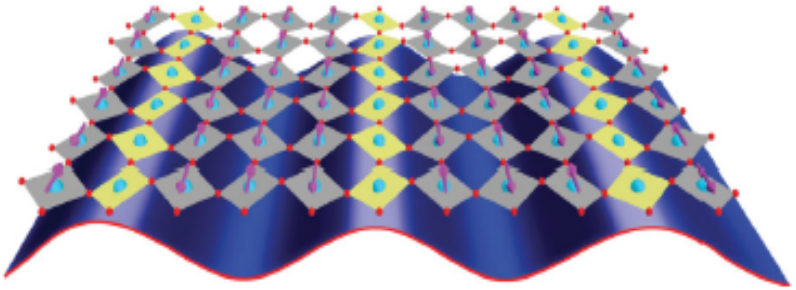
Power Transmission

Other Condensed Matter topics?

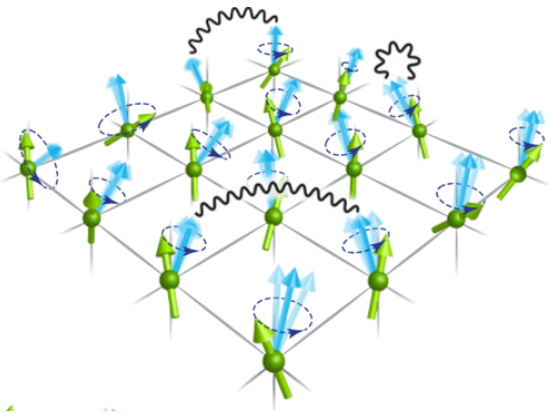
Superconductivity



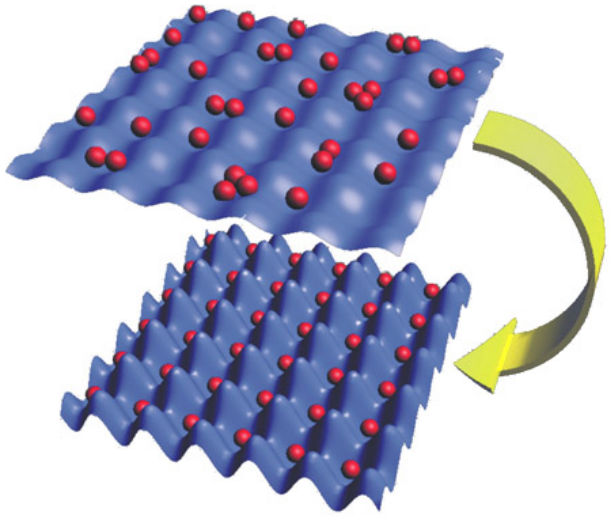
Charge order



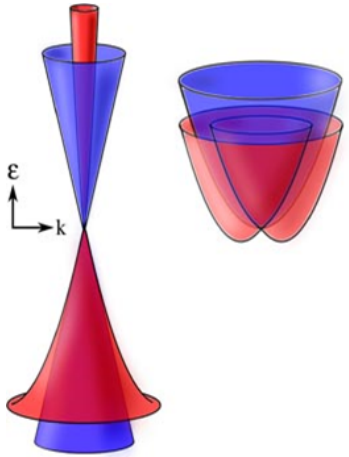
Magnetism



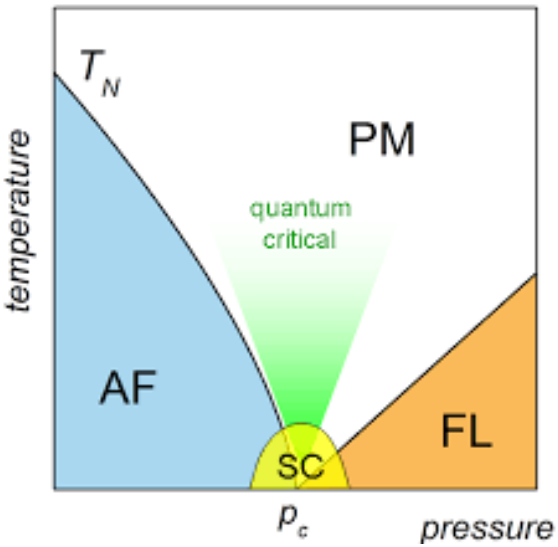
Electron driven insulators



Topology



Phase transitions



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Form Factor
Structure Factor

Optical phonons

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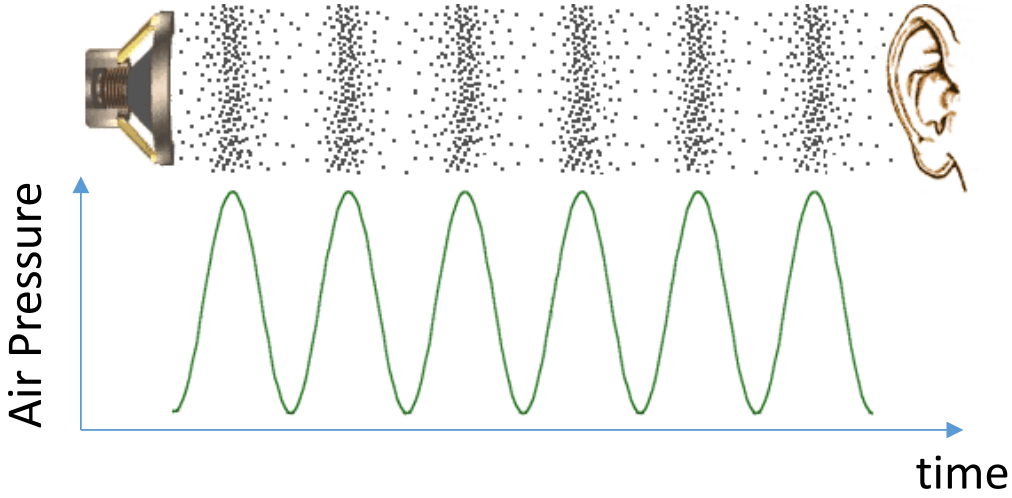
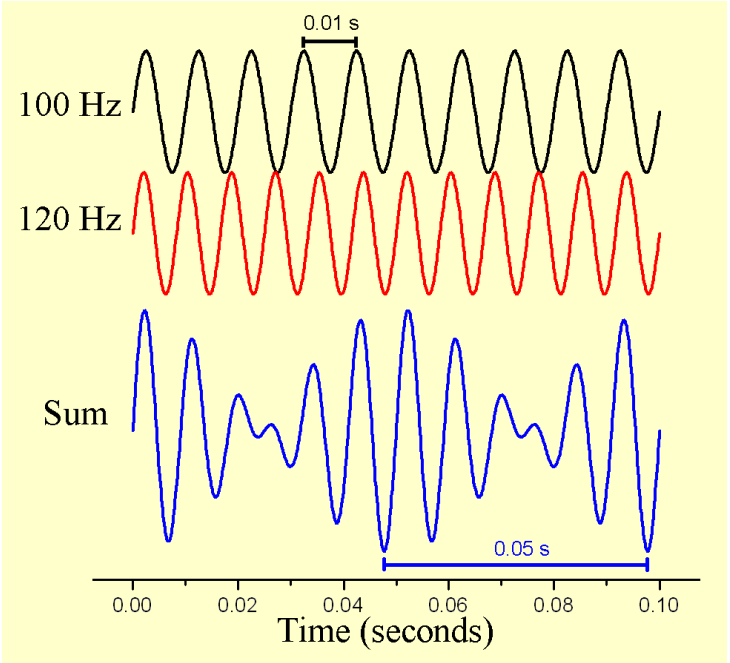
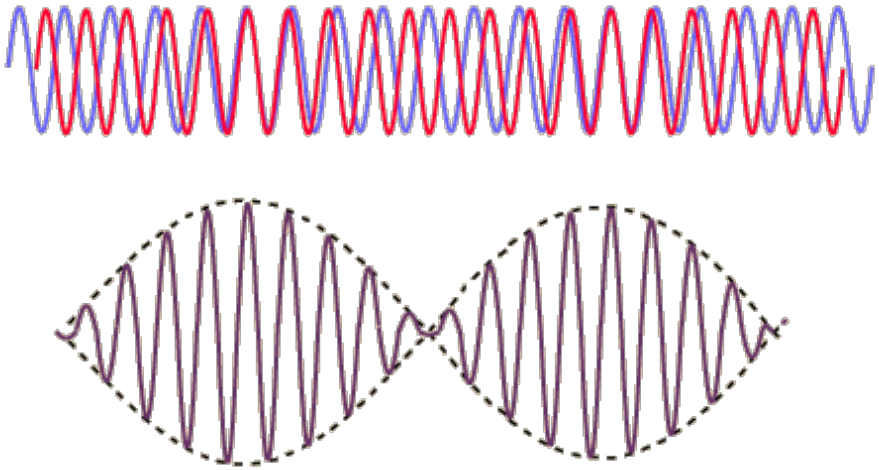
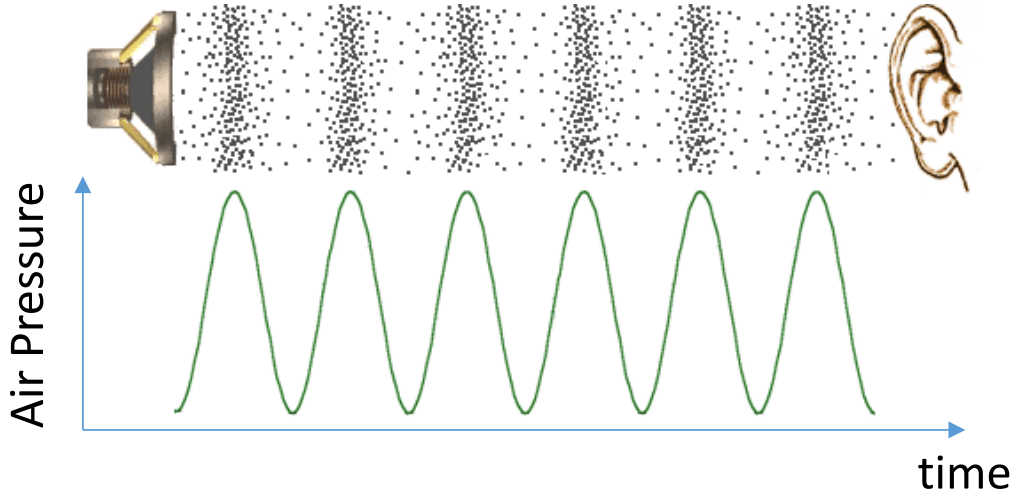


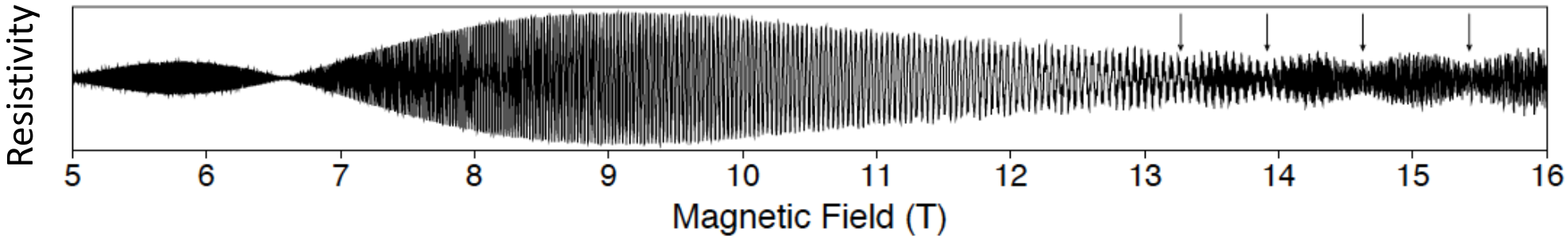


Beatings

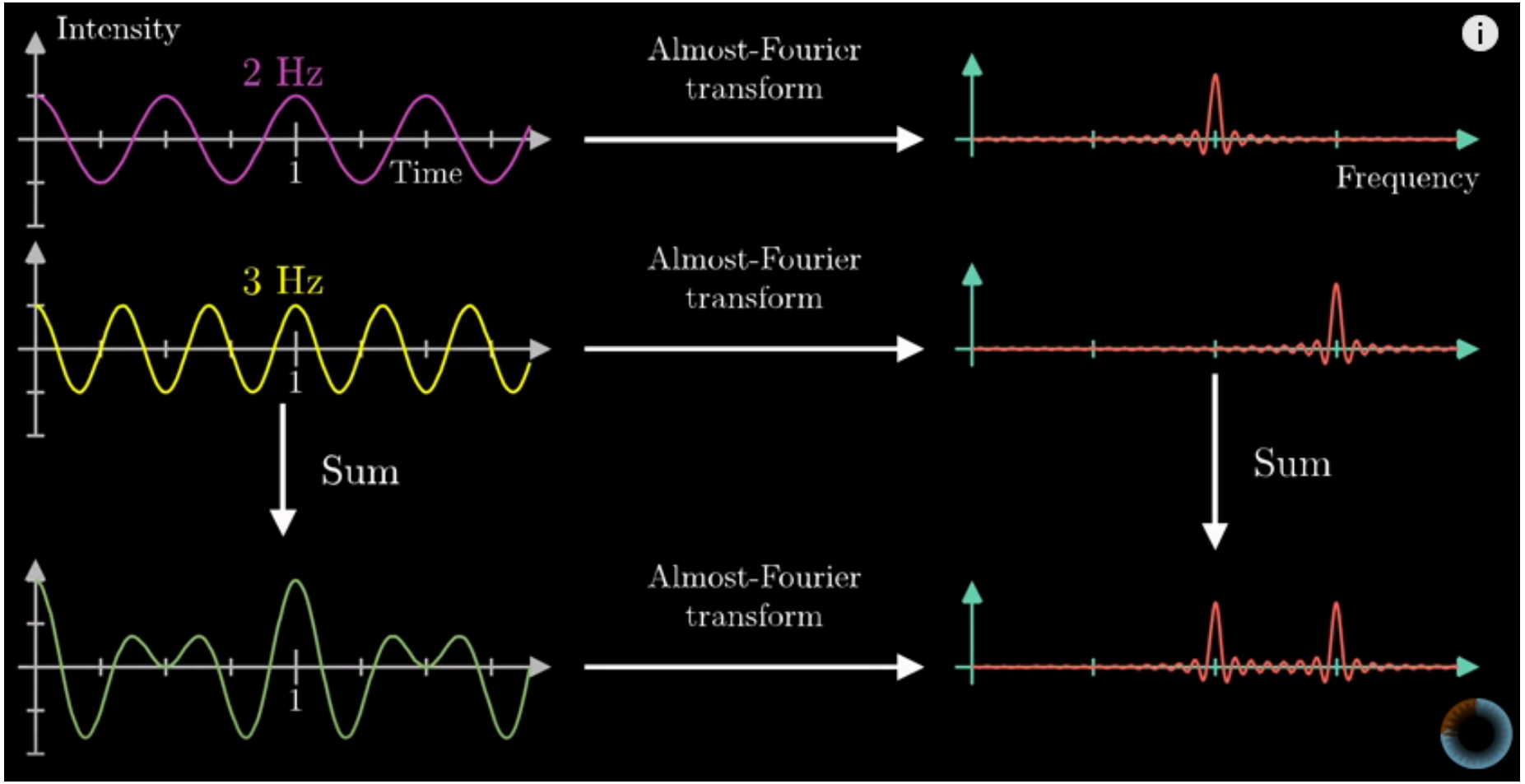


Reciprocal Space





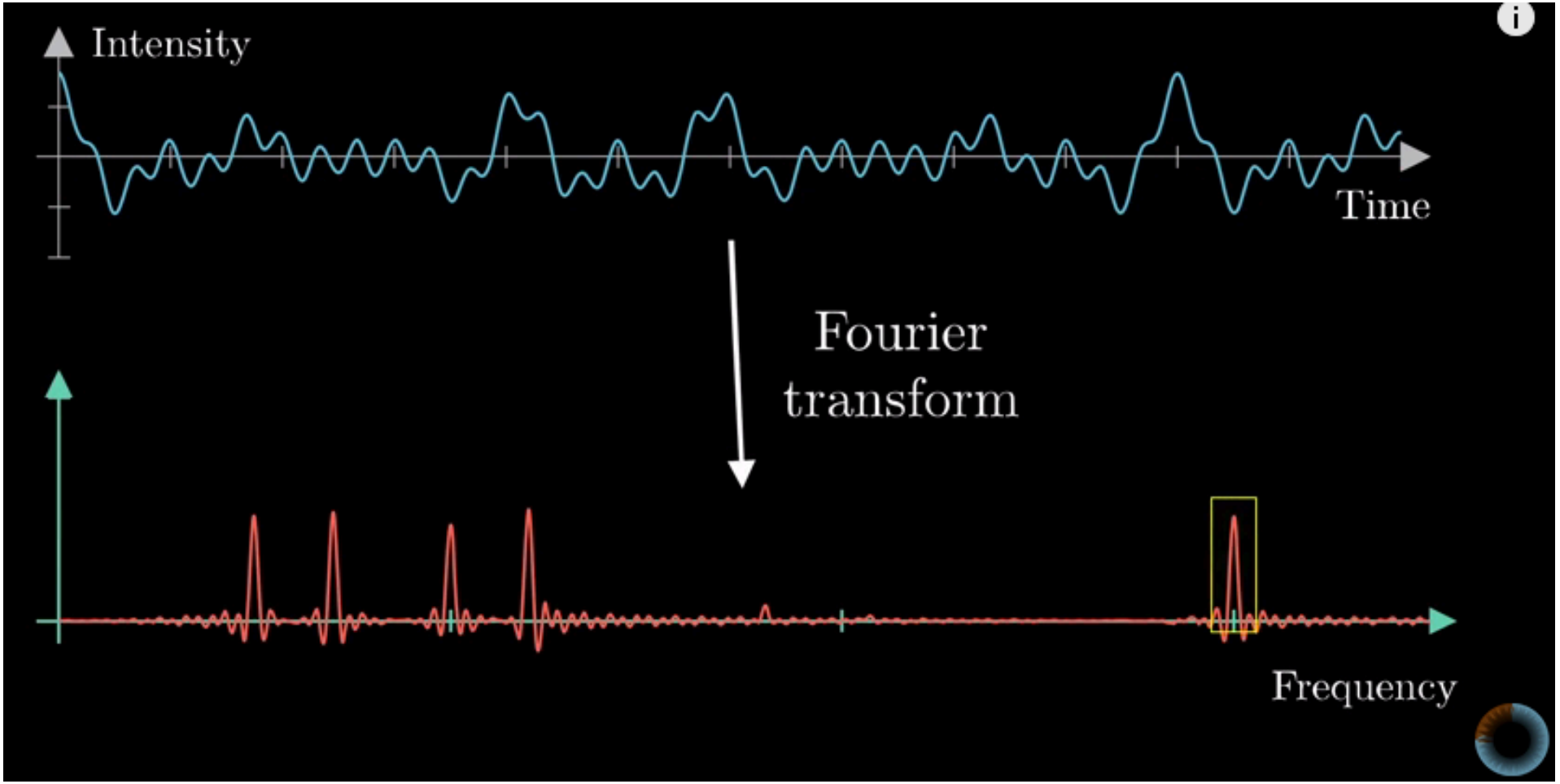
Reciprocal Space



https://www.youtube.com/watch?v=spUNpyF58BY

Nice Tutorial on Fourier Transforms

Reciprocal Space



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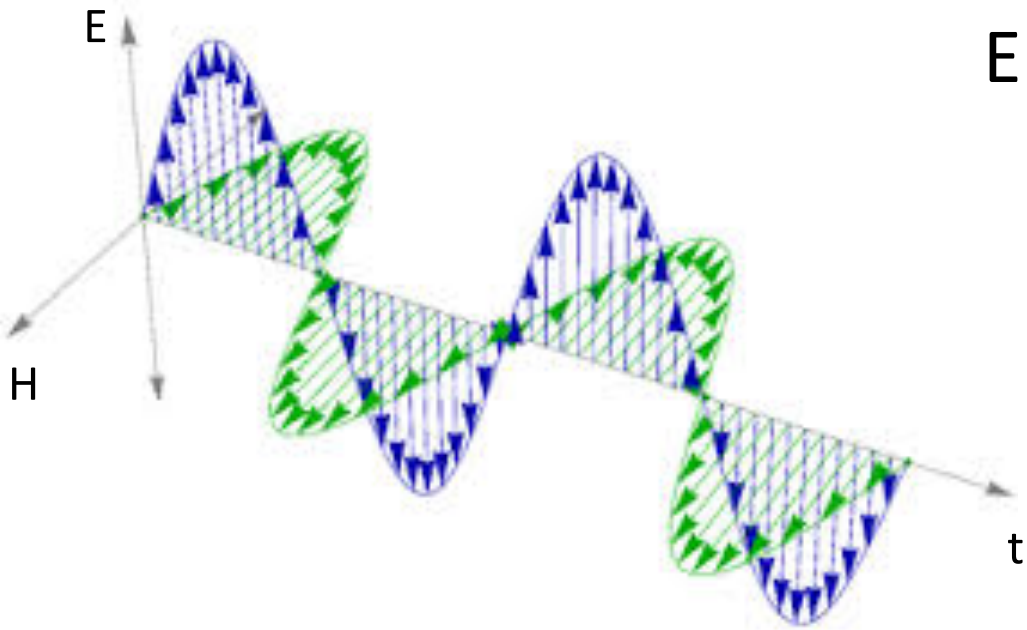
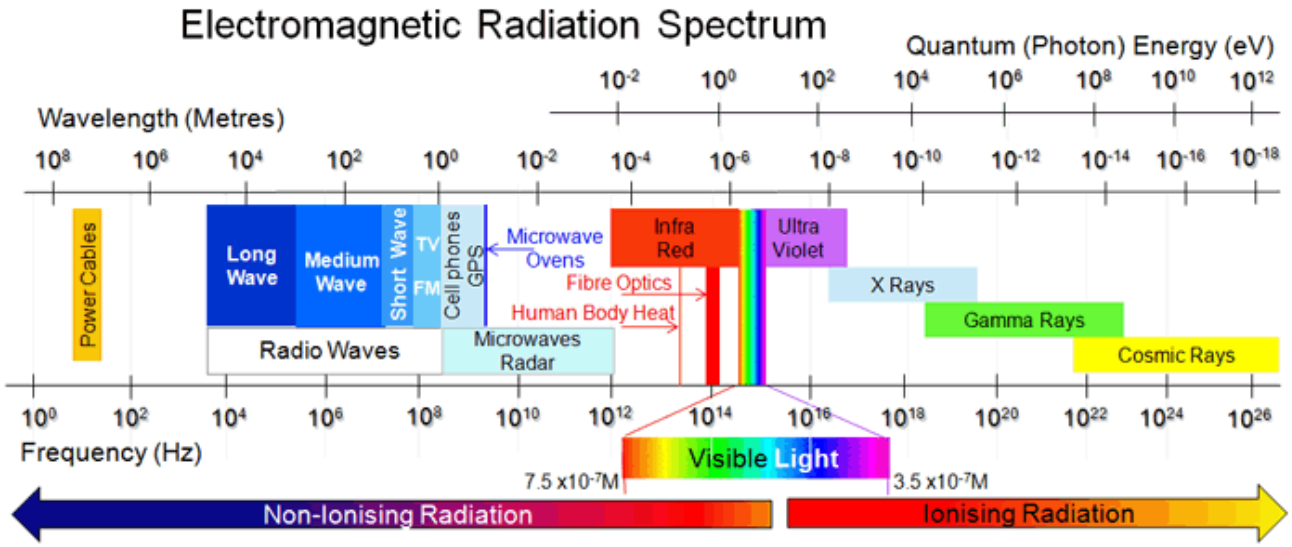
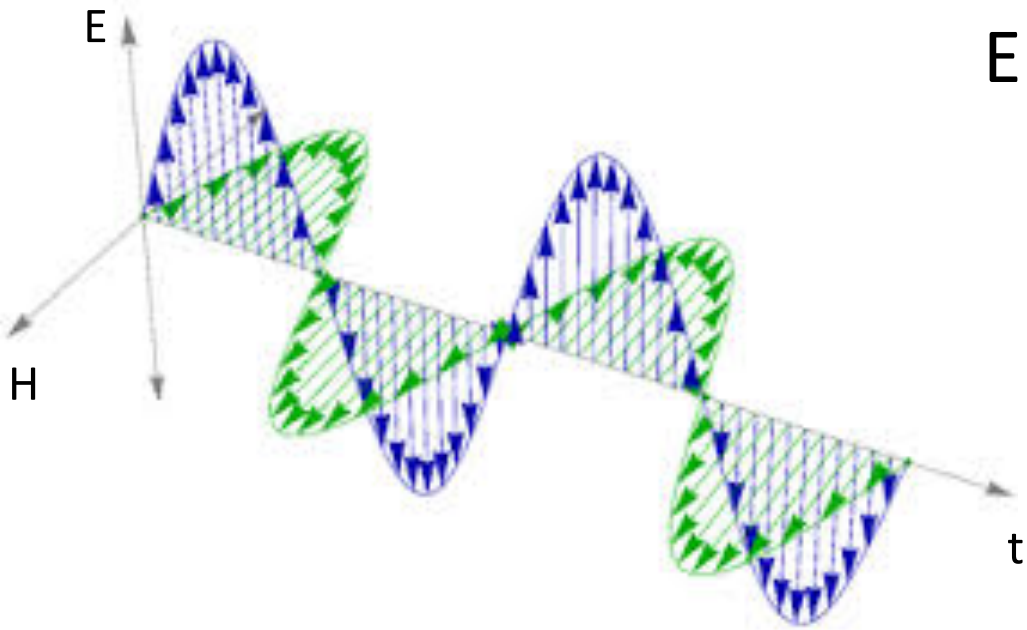


Electromagnetic wave

$$E=E_0\exp(i\omega t)$$



Reciprocal Space



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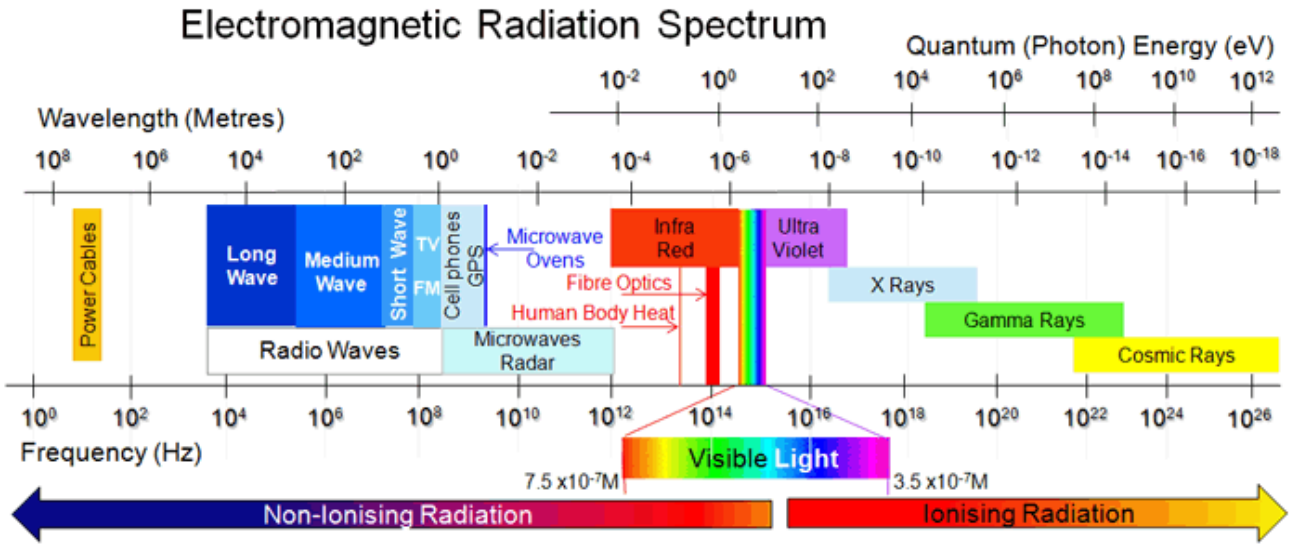
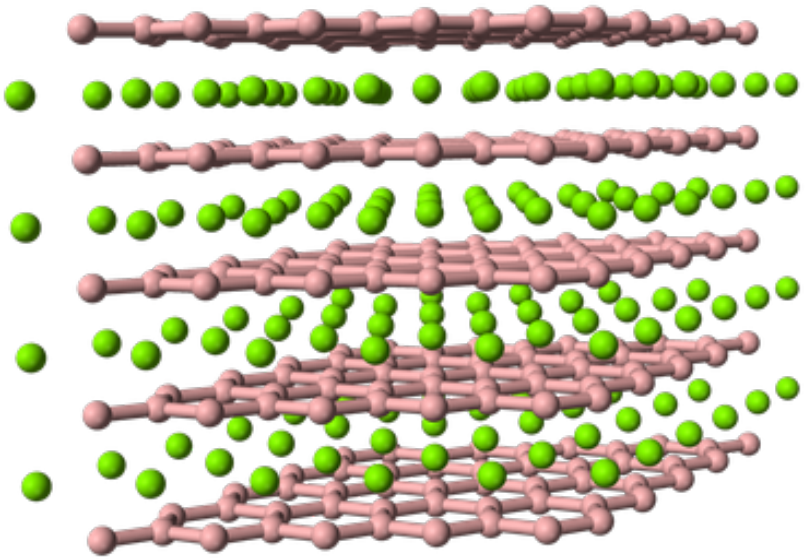
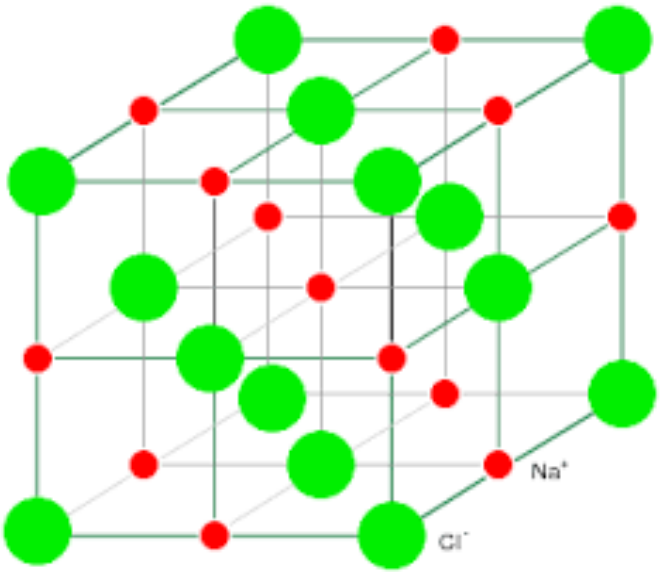
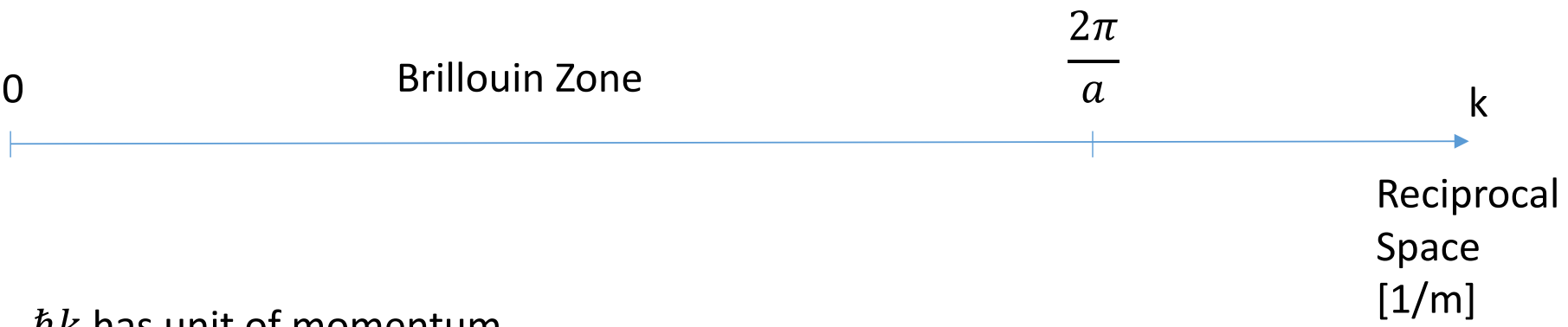


Reciprocal Space



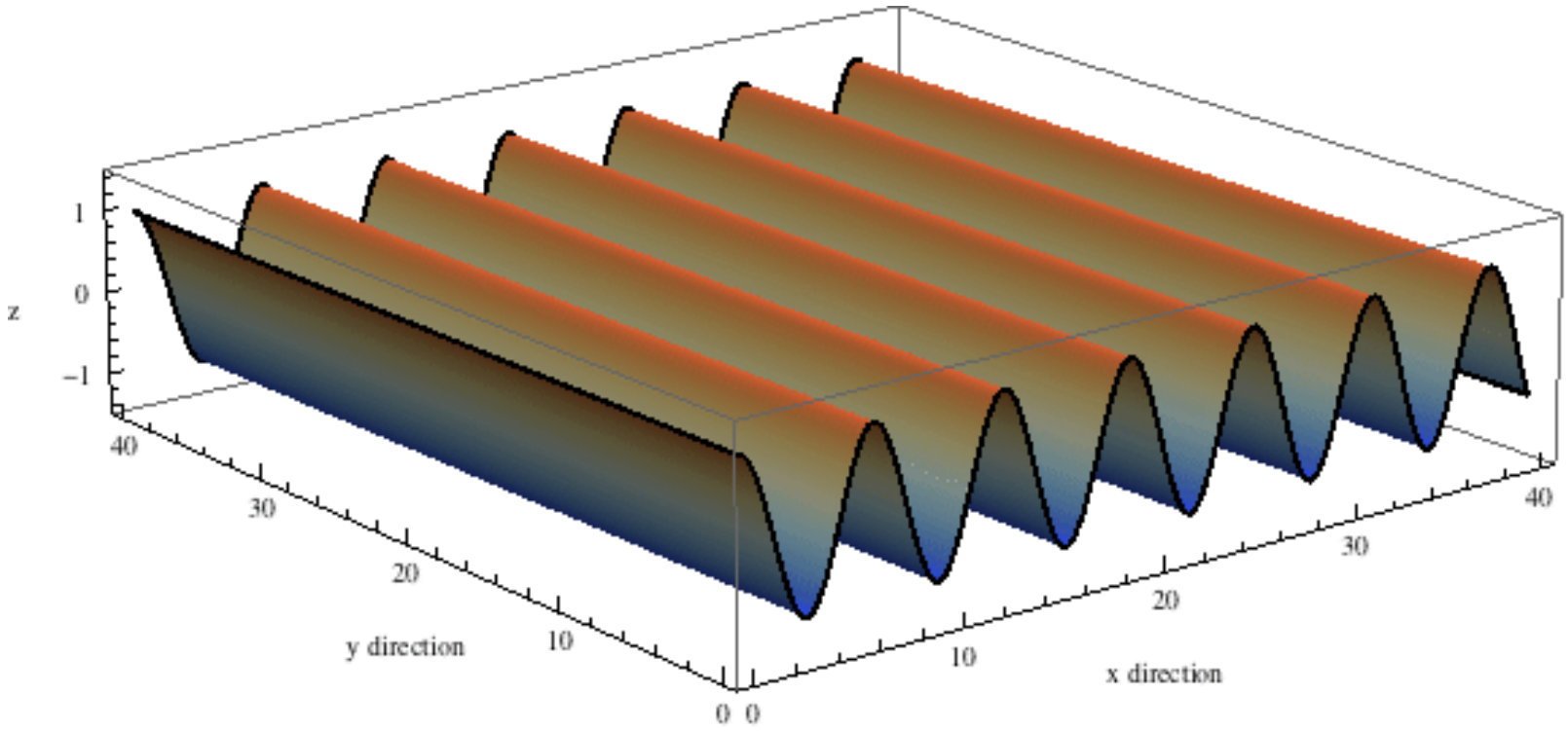




$\hbar k$ has unit of momentum

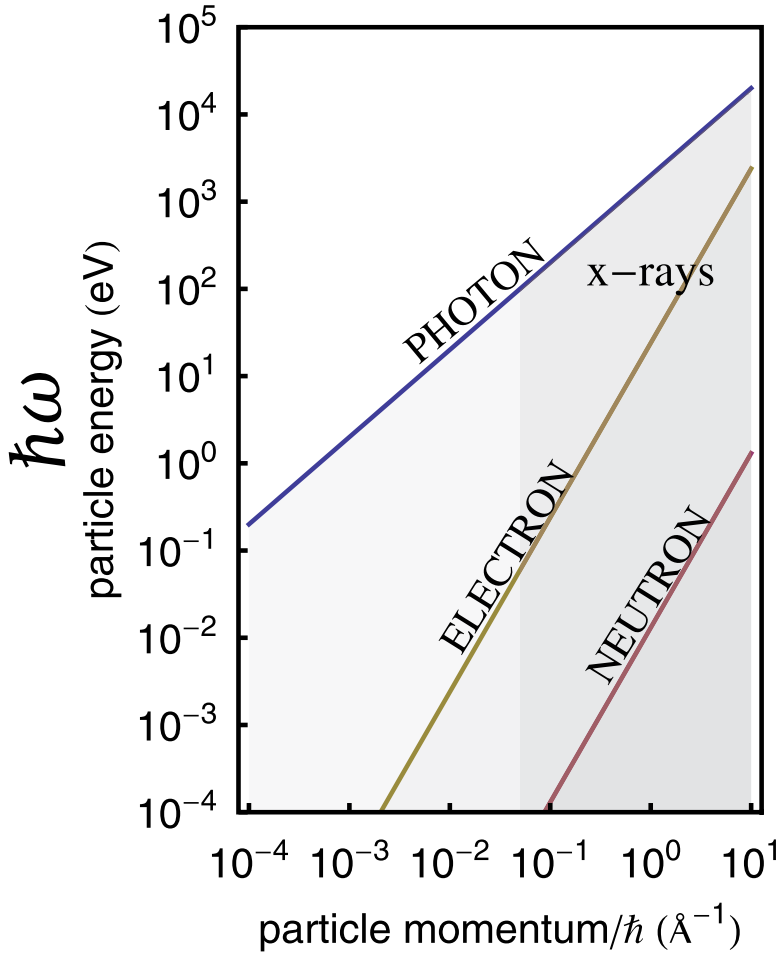
Reciprocal space is a “momentum space”

Reciprocal Space



plane-wave = Amplitude x exp(iωt) x exp(ik$x$)

Particle Dispersion: Particle – wave Duality



Lattice Vibrations - Phonons