First Congress

International Society of Diamagnetic Therapy

“The physical phenomenon”

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13th – 14th September 2024
Magna Graecia University - Catanzaro

ISDT
International Society of Diamagnetic Therapy

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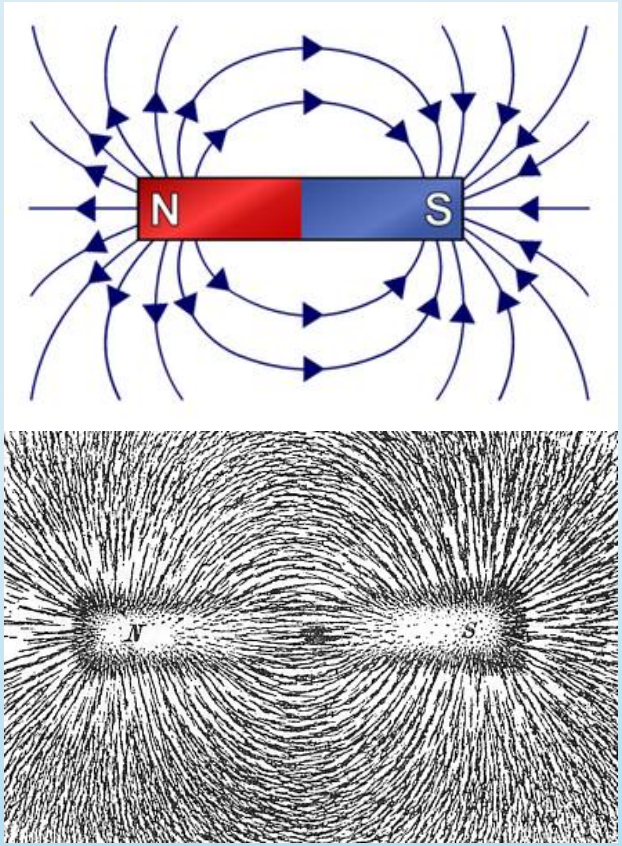
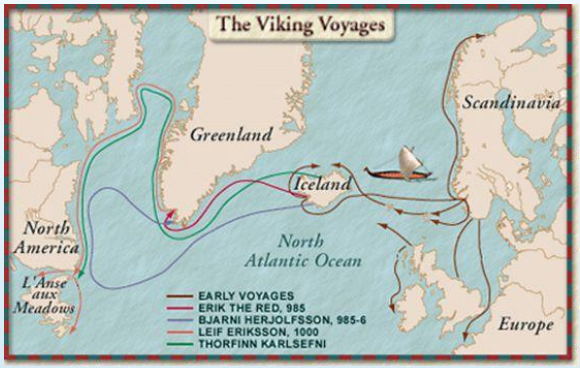
ΒΡΕΤΤΙΩΝ
Dubium sapientiae initium

- Electricity and magnetism are different facets of *electromagnetism*
  - a moving electric charge produces magnetic fields
  - changing magnetic fields move electric charges
- This connection first elucidated by Faraday, Maxwell
- Einstein saw electricity and magnetism as frame-dependent facets of *unified* electromagnetic force

- **Magnetic field** is a solenoidal vector field generated in space by the motion of an electric charge or a time-varying electric field. The magnetic field can also be generated with special materials (permanent magnets)



	Constituents									
	Major						Minor			
Soft Magnetic Materials										
Iron	**Fe**									
Silicon Steel	**Fe**						**Si**			
Nickel-Iron	**Fe**	Ni								
Moly Permalloy	Ni	**Fe**					Mo			
Iron-Cobalt	**Fe**	Co					V			
Soft Ferrite	**Fe**	**Mn**	Ni	Zn			O			
Metallic Glasses	**Fe**	Co	Ni				**B**	**Si**	**P**	
Permanent Magnets										
Co-Steels	**Fe**	Co								
Alnico	**Fe**	Ni	Co	**Al**	Cu		**Ti**	**Si**		
Platinum Cobalt	**Pt**	Co								
Hard Ferrites	**Fe**	**Sr**								
SmCo	Co	Sm	Gd	**Fe**	Cu	**Zr**				
Neodymium-iron-boror	**Fe**	Nd	Dy	(Y)	**B**	Co	Cu	Ga	**Al**	Nb
Cerium-iron-boron	**Fe**	Nd	Ce	B						
SmFeN	**Fe**	Sm	**N**							
MnBi	**Mn**	**Bi**								
MnAl(C)	**Mn**	**Al**					Cu	**C**		



Viking Discovery in the New World

Erik the Red

Leif Erikkson

[redacted]

Oersted Experiment

Erik the Red landing in Iceland

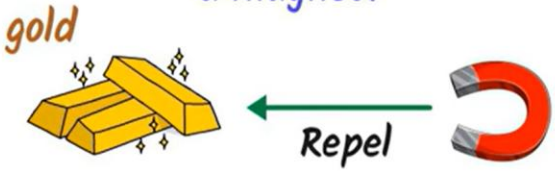
Viking Ship

Faraday *discovered that a current-carrying wire in addition to influencing a needle can be influenced by a magnet.*

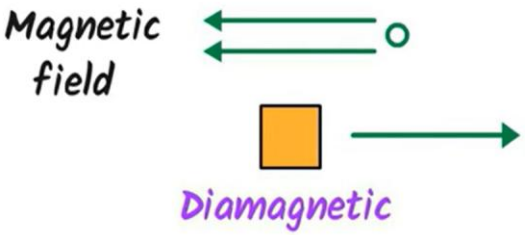
Ampère *hypothesized that all magnetic phenomena were due to electric currents.*

Diamagnetic materials

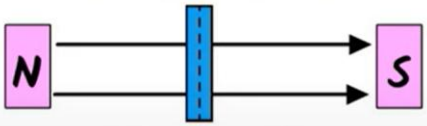
They are weakly repelled by a magnet.



They are weakly magnetised in opposite direction of magnetic field.



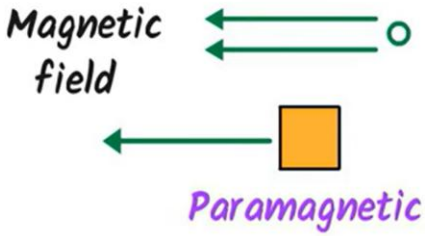
In a uniform magnetic field, they slowly align in perp direction.



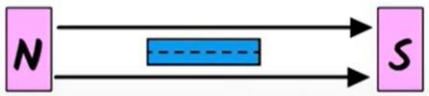
Paramagnetic materials

They are weakly attracted by a magnet.

They are weakly magnetised in same direction of magnetic field.



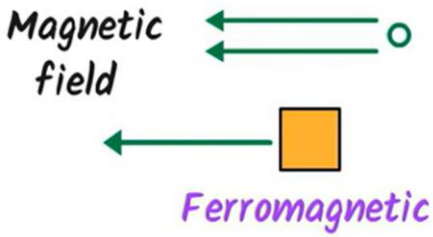
In a uniform magnetic field, they slowly align in parallel...



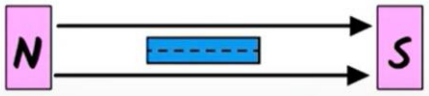
Ferromagnetic materials

They are weakly strongly attracted by a magnet.

They are strongly magnetised in same direction of magnetic field.

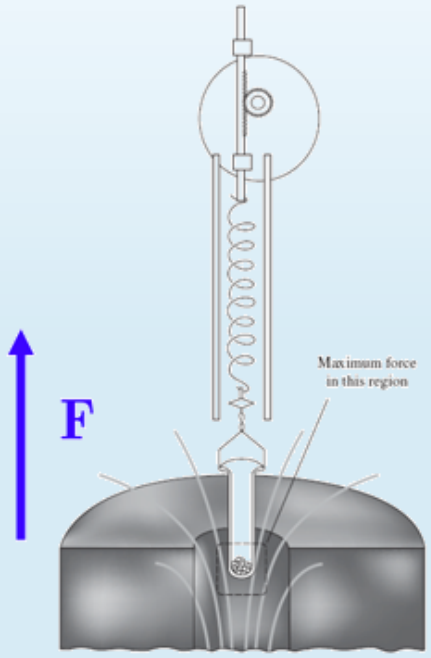


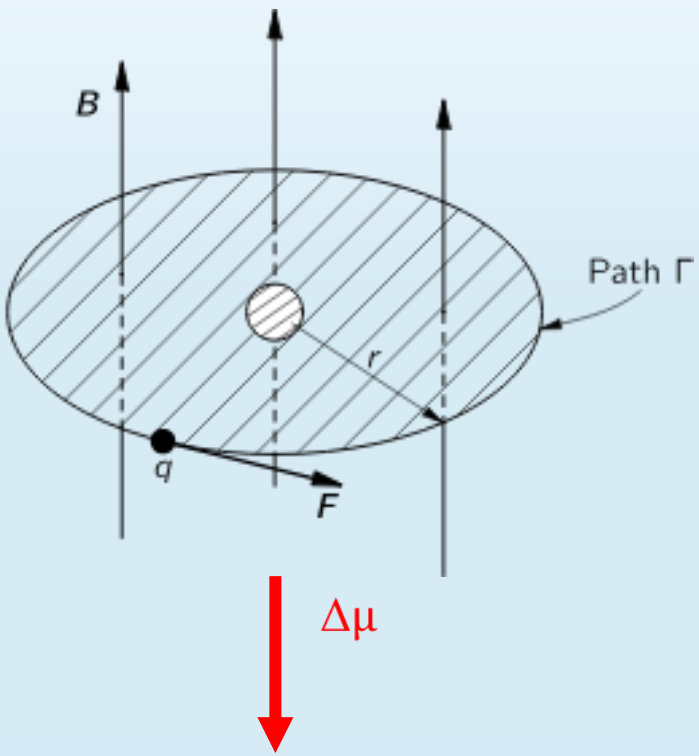
In a uniform magnetic field, they quickly align in parallel...



Force per kilogram near the upper end of the coil in our experiment, where $B_z = 1.8$ tesla and $dB_z/dz = 17$ tesla/m

Substance	Formula	Force (newtons)
Diamagnetic		
Water	H_2O	−0.22
Copper	Cu	−0.026
Sodium chloride	NaCl	−0.15
Sulfur	S	−0.16
Diamond	C	−0.16
Graphite	C	−1.10
Liquid nitrogen	N_2	−0.10 (78 K)
Paramagnetic		
Sodium	Na	0.20
Aluminum	Al	0.17
Copper chloride	$CuCl_2$	2.8
Nickel sulfate	$NiSO_4$	8.3
Liquid oxygen	O_2	75 (90 K)
Ferromagnetic		
Iron	Fe	4000
Magnetite	Fe_3O_4	1200





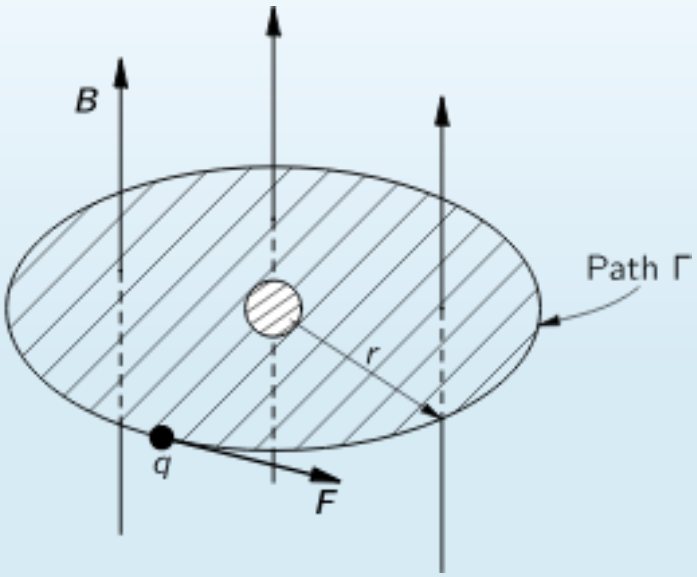
1) As the magnetic field changes an *electric* field is generated by magnetic induction $E = -\frac{r}{2}\frac{dB}{dt}$

2) The induced electric field acting on an electron in the atom produces a torque equal to $-qEr$ which must equal the rate of change of the angular momentum dJ/dt

3) Extra angular momentum from the twist given to the electrons as the field is turned on $\Delta J = \frac{qr^2}{2} B$

4) ΔJ makes an extra magnetic moment (Δμ) which, because it is an orbital motion, is just −q/2m times the angular momentum $\Delta\mu = -\frac{q^2\langle r^2\rangle_{av}}{6m} B$

Magnetic moment quantifies the force that the magnetic field exerts on an electric current



Limits

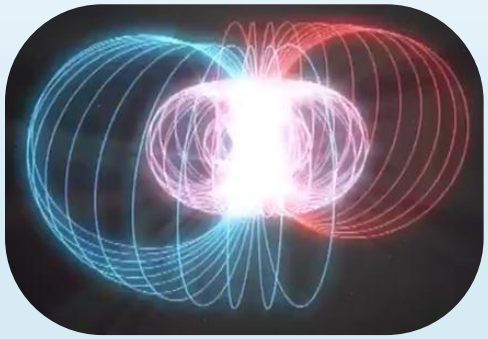
1) What is the mean square radius? Classical mechanics cannot supply an answer
2) Isolated system
3) Not valid for metals

Quantuum Mechanics

1) The Langevin theory is not the full picture for metals because there are also non-localized electrons.
2) The theory that describes diamagnetism in a free electron gas is called Landau diamagnetism

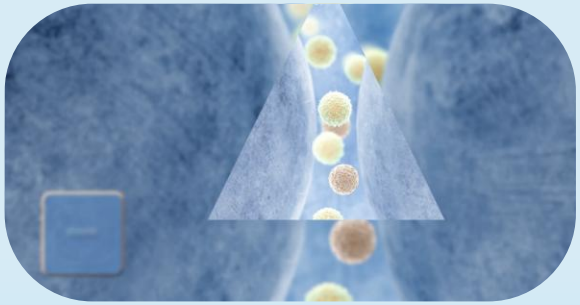
$$F = -\nabla E_{mag} = \frac{\chi}{2\mu_0} \nabla B^2$$

Biological effects of magnetic field are manifold and sometimes complex.

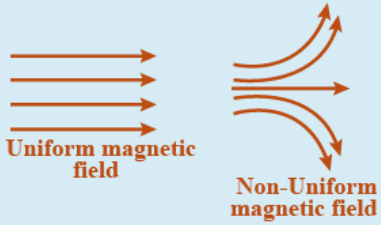


Parameters

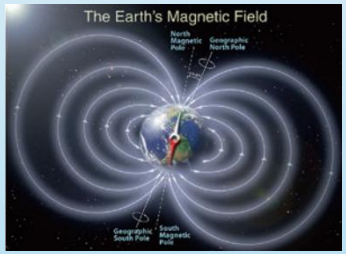
Frequency
- static magnetic field
- time-varying magnetic field



Homogeneity



Intensity
- Weak (<1 mT)
- Moderate (1 mT<MF< 1 T)
- High (>1 T)

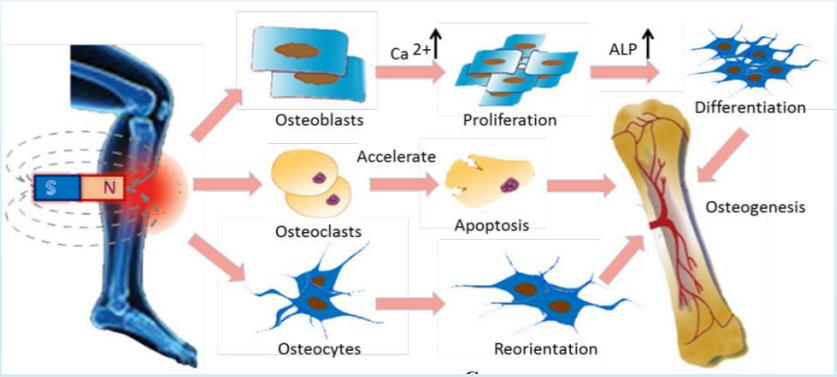


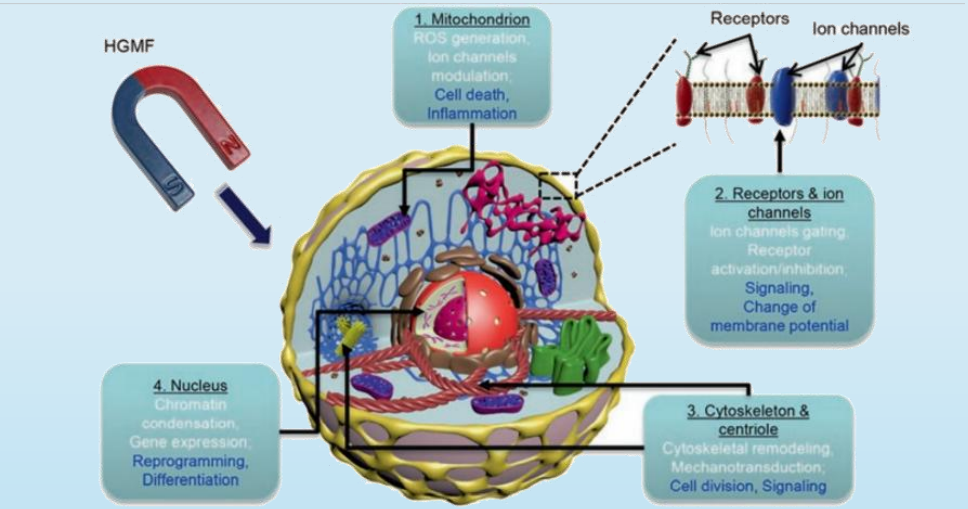
0.05 mT

3T

Physical interactions of the SMF with biological systems

1) Induced electric fields and current
2) Magneto-mechanical effects
    1) Magnetically induced torque
    2) Magnetically induced displacement force
    3) Electronic spin





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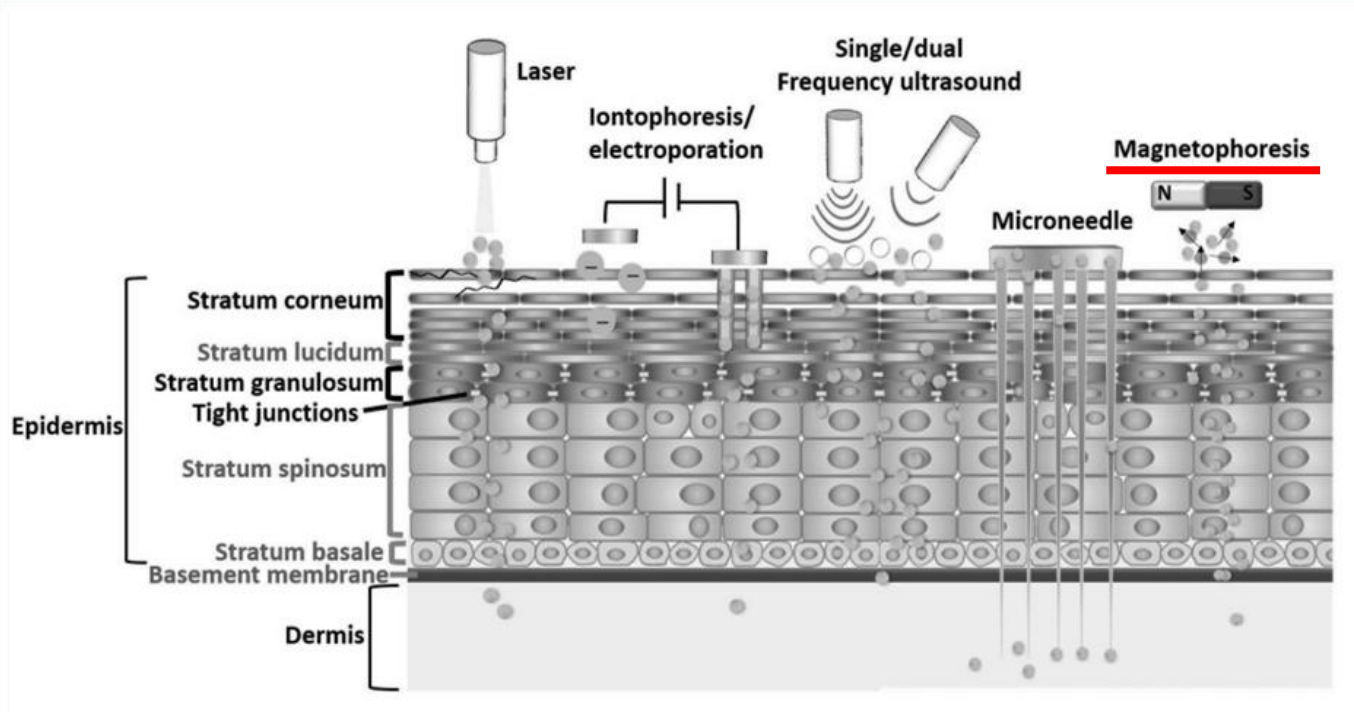

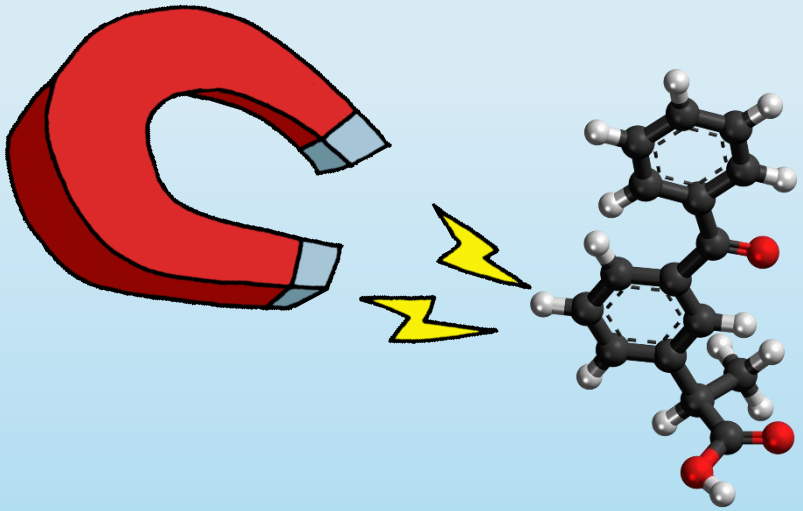

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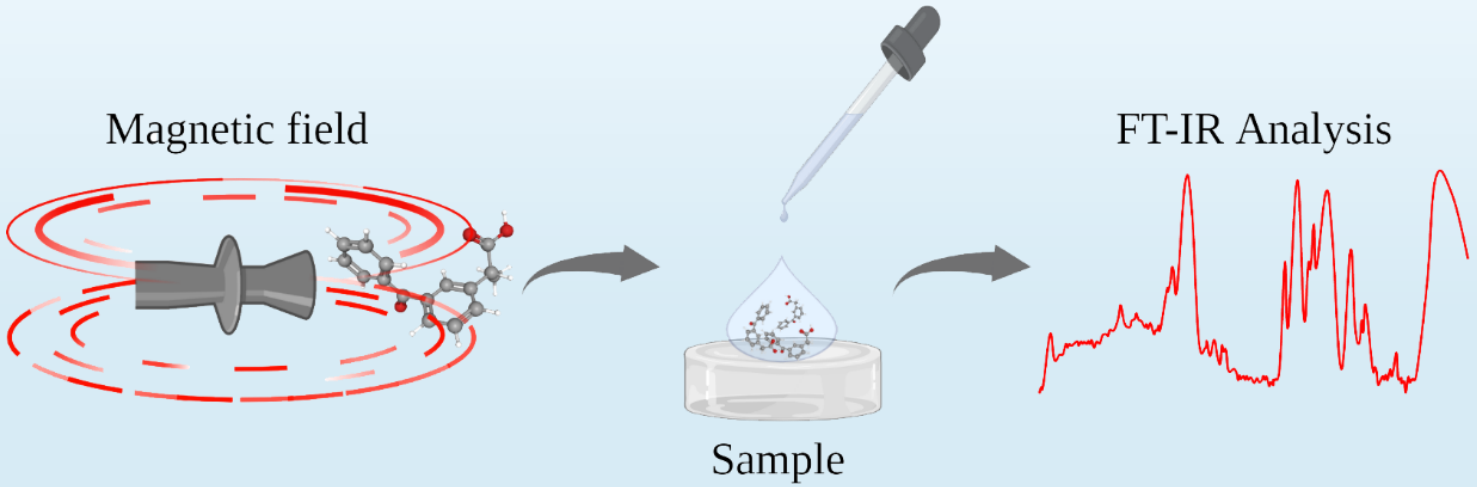


CTU Mega 20:

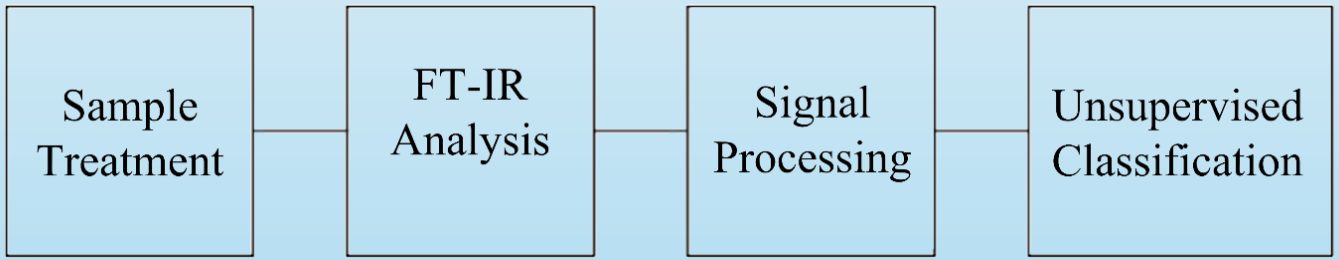
1. 25 minutes

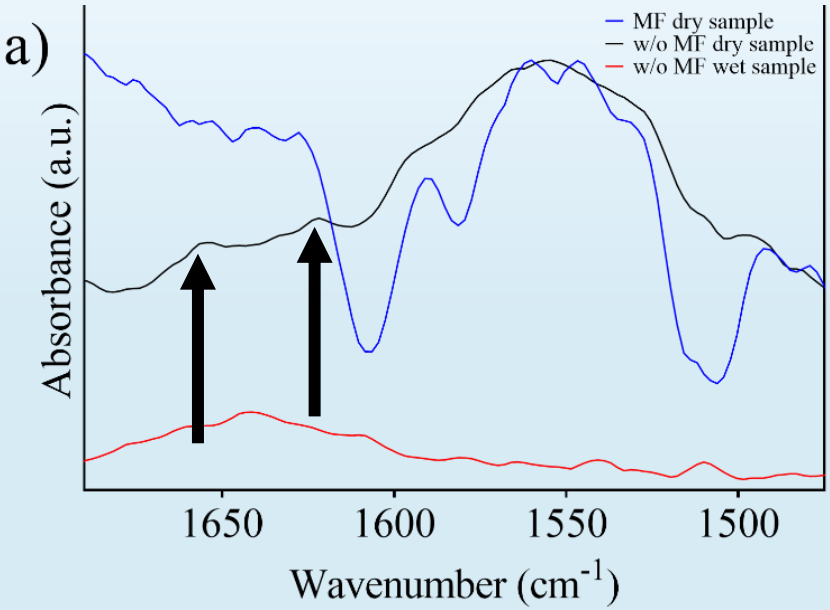
Molecules:

- Ketoprofen

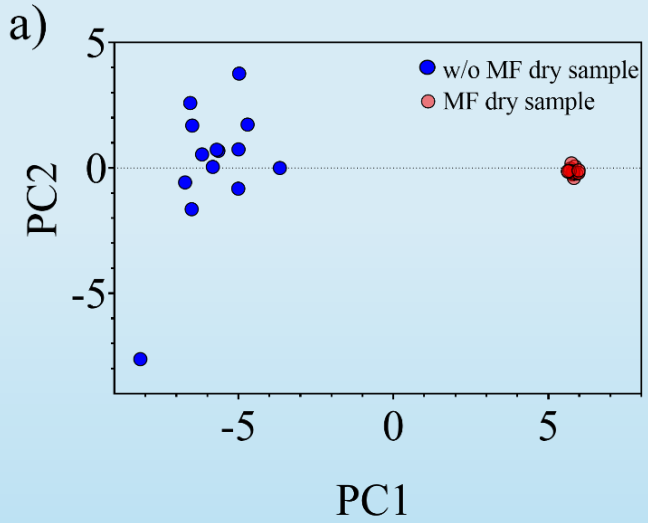
Analysis:

- Within 5 minutes





A bit of Machine Learning



Ketoprofen

- Pure Ketoprofen is characterized by two absorption peaks at about 1655 cm^{-1} and 1697 cm^{-1} due to C=O stretching

Outlook: What is the clinical effect of such changes ?

Unit of Electronics UMG –BATSLAB

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- Filippo Laganà
- Michele Menniti

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- Dott. V. Rania
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Thank you!!