

# Lesson 1: Introduction to MRI

## **A Journey Through Time and Technology**



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# **MRI Marvels**

Your Journey into Biomedical Engineering

# Lesson Objective

Our goal is to uncover the origins and learn about the technology behind **MRI machines**.

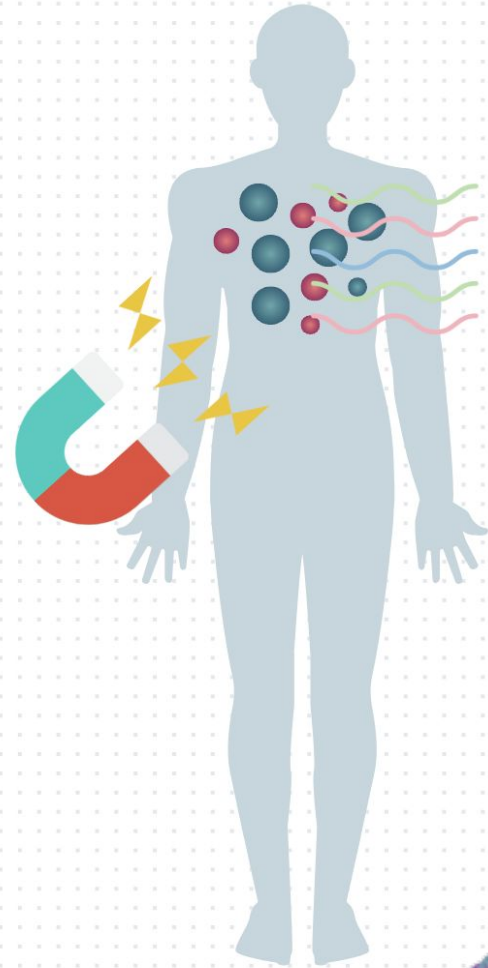
By the end of this **lesson**, you will learn:

- History of MRI imaging
- The key developments that lead to the MRI
- How magnets and radio waves can be used to create images of the body



# What is Magnetic Resonance Imaging?

- Magnetic resonance is when tiny particles inside things, wiggle in response to a big, powerful magnet.
- Scientists use this magnetic resonance to study the magnetic properties and behavior of atoms
- It helps scientists understand the shapes and structures of molecules and chemicals, like solving a puzzle.
- **Magnetic resonance imaging (MRI)** uses these wiggles to create pictures inside your body, helping doctors see your bones and organs without surgery.



# Pioneers MRI

Lauterbur and Mansfield developed the key scientific advancements that made MRI possible. Their groundbreaking work was honored with the Nobel Prize in Physiology or Medicine in 2003



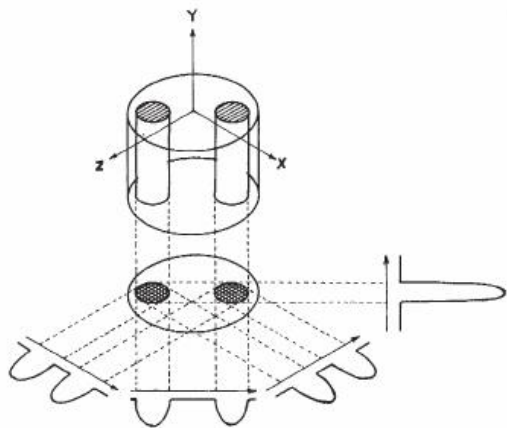
**SIR PETER MANSFIELD**



**PAUL LAUTERBUR**

# Creating 2D images

Lauterbur discovered that by using something called "gradients" in a magnetic field, he could take lots of little pictures from different angles and then combine them to create a two-dimensional picture of what's inside something, like your body.



**Fig. 1** Relationship between a three-dimensional object, its two-dimensional projection along the Y-axis, and four one-dimensional projections at  $45^\circ$  intervals in the XZ-plane. The arrows indicate the gradient directions.



**Fig. 2** Proton nuclear magnetic resonance zeugmatogram of the object described in the text, using four relative orientations of object and gradients as diagrammed in Fig. 1.



**PAUL LAUTERBUR**

*Fun Fact:*

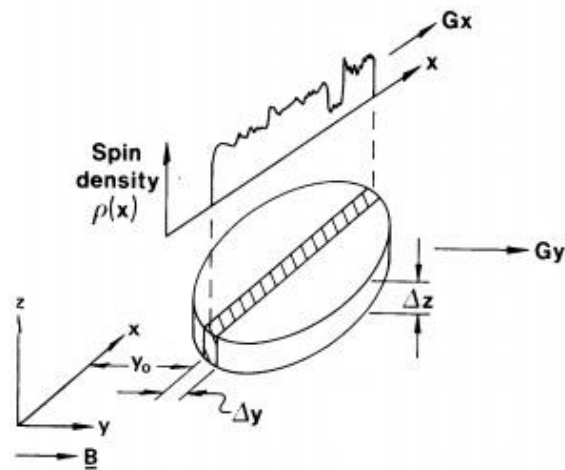
*The first living thing the Lauterbur imaged using the NMR technique was a tiny Clam 🐚*

Lauterbur, P. C. (1973). Image Formation by Induced Local Interactions: Examples Employing Nuclear Magnetic Resonance. *Nature*, 242(5394), 190-191. doi:10.1038/242190a0



# Computing the Images

Mansfield showed that by using math you could analyze the signals from these “gradients” in the magnetic field to develop useful medical imaging techniques. He further refined these techniques to create images of the human body



Line-Scan Technique developed by Mansfield and Maudsley

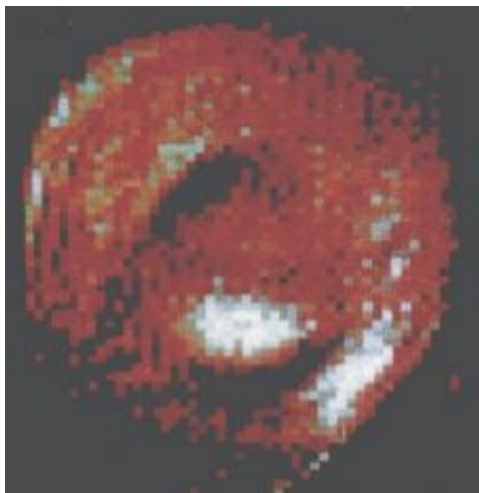


Image of human finger from Mansfield and Maudsley (1977)



SIR PETER MANSFIELD

**Cool Fact:**

*In 1977 Mansfield and Maudsley produced the first image of a human body part: the Finger 🙌*

# How do MRI machines work?

Let's investigate four essential components in of MR imaging

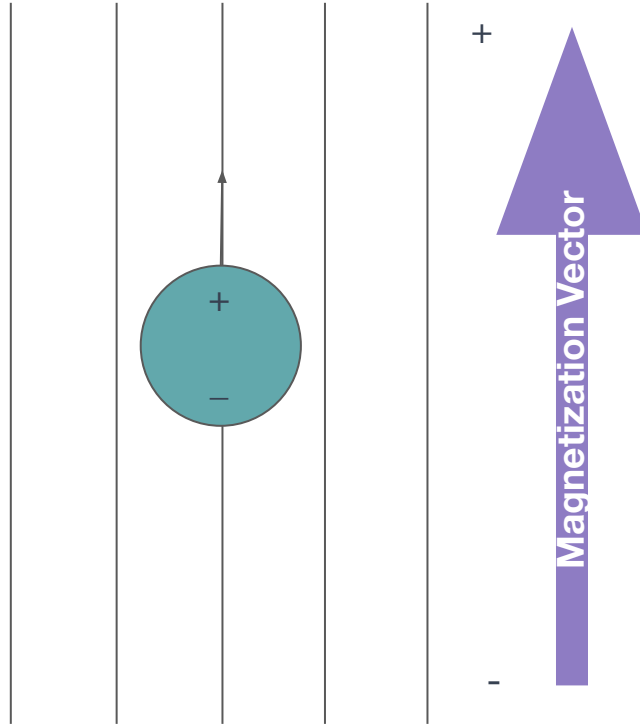
**Strong  
Magnetic Fields**

**NMR**

**Radiofrequency**

**Relaxation**

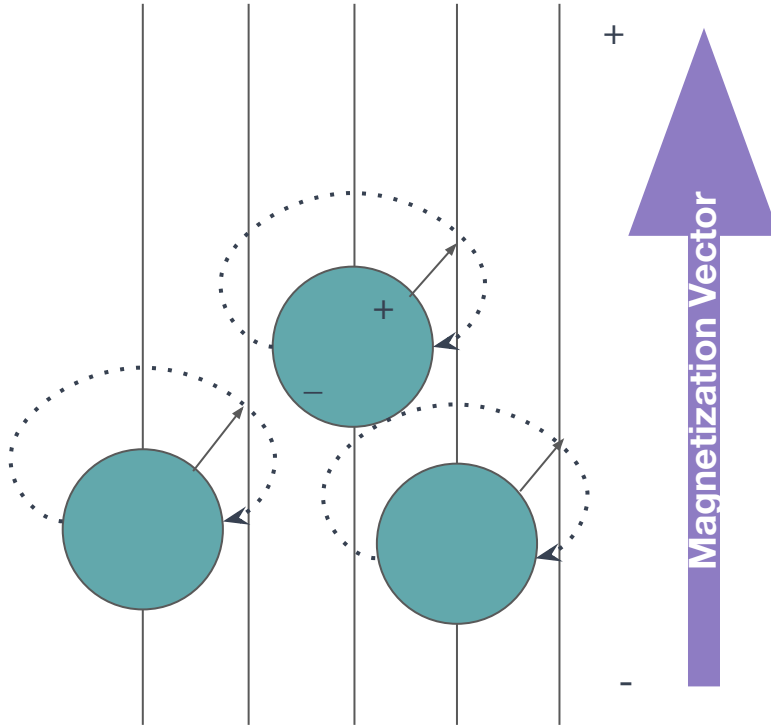
# Strong Magnetic Fields



- Hydrogen Nuclei are protons that are abundant in your body.
- The MRI machine generates a strong magnetic field which aligns the protons in your body to follow the direction of the magnetic field.

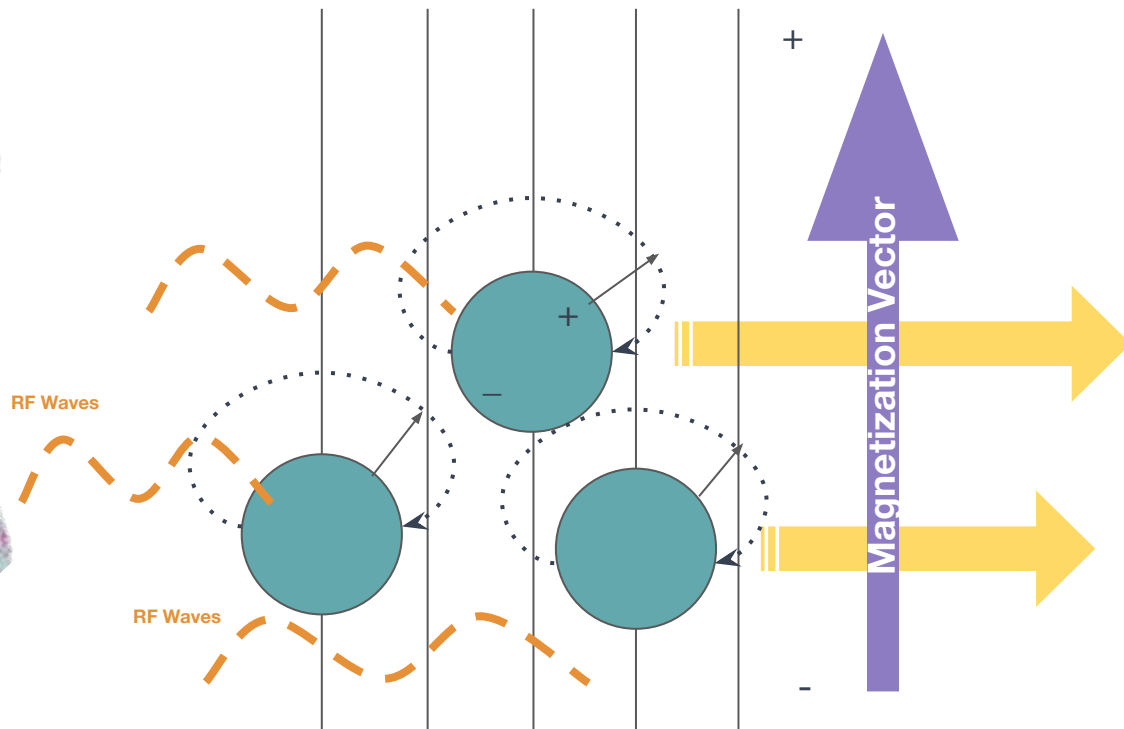


# Nuclear Magnetic Resonance



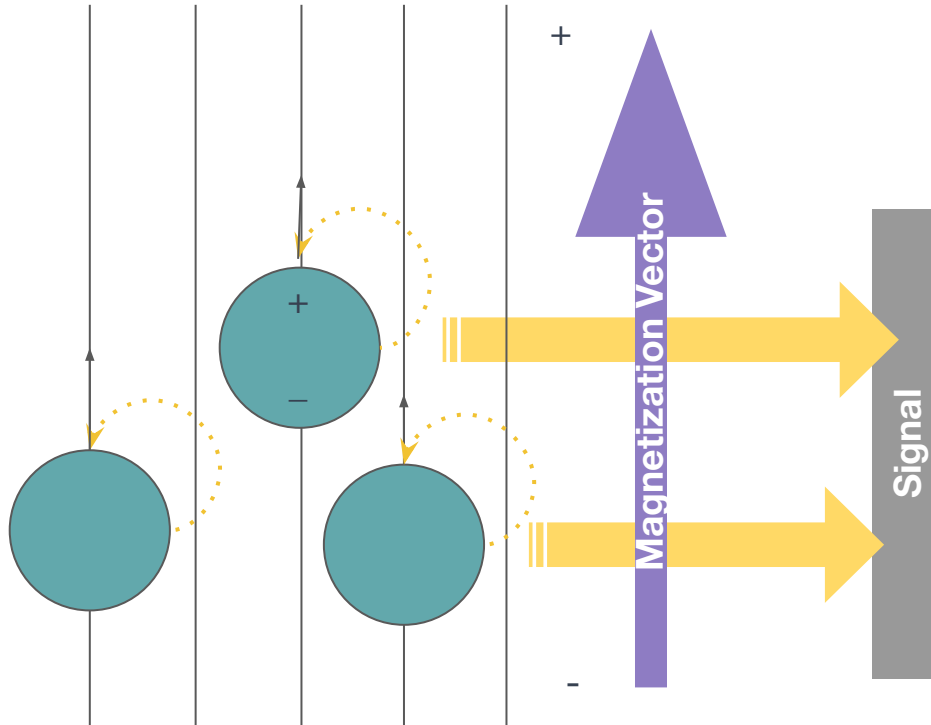
- Once the hydrogen nuclei are all aligned in a magnetic field. We can measure changes in their spin and alignment in the magnetic field.
- This process is called NMR

# Radiofrequency (RF) Waves



- We can send radio waves that push on the hydrogen nuclei and cause them to spin in a unique way
- As these nuclei stop spinning they send out their own signals that tell us about the way they were spinning

# Relaxation



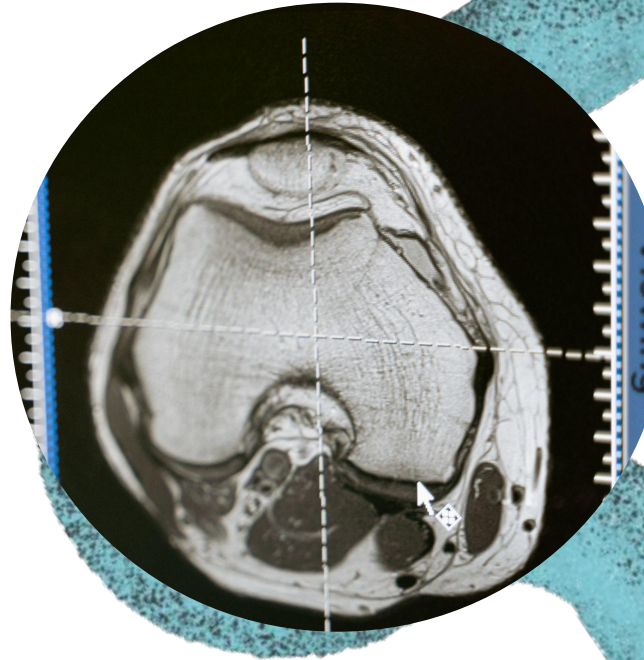
- When the hydrogen nuclei return to the original magnetic field we say that they are “relaxing”
- As nuclei relax, they release energy, and the energy is captured as a signal.
- We can use this signal to create images

# Lesson Summary

Magnetic Resonance Imaging (MRI) is a method for imaging the body that uses magnets and radio waves to see into the body and visualize soft tissues, nerves, and even blood flow.

In **this lesson** you learned about how the MRI process works to create images of the body.

In the **next lesson** you will learn more about the components of an MRI machine, and how MRIs are used in medicine.



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