Introduction to MRI

MRT Program

What is MRI?

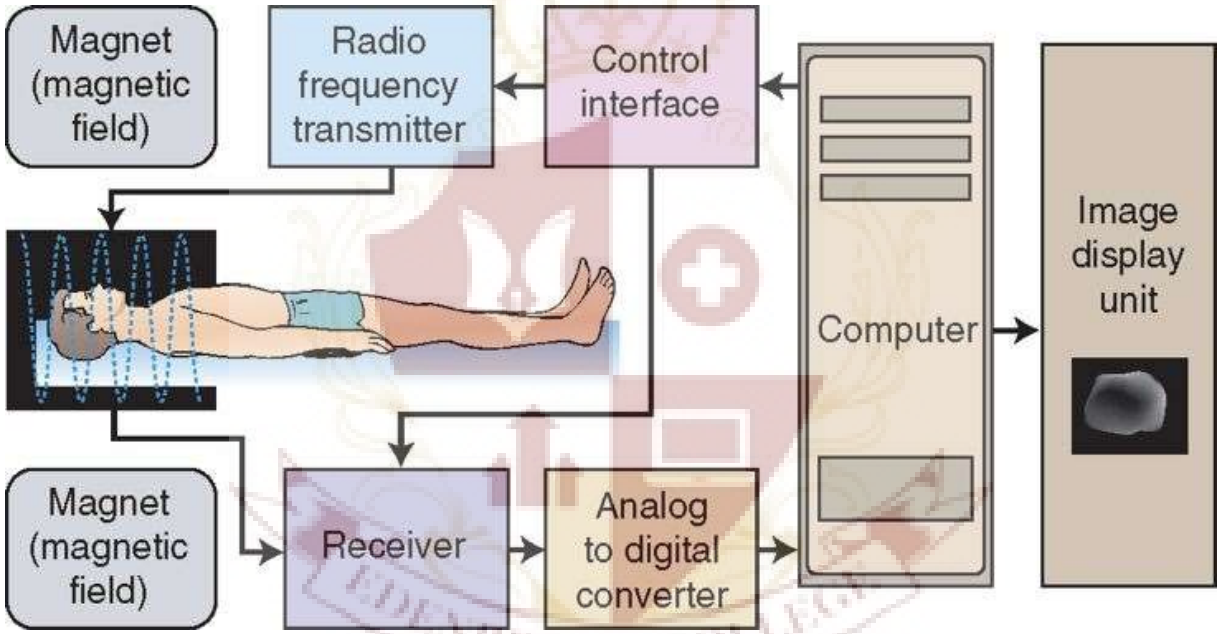


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Why use MRI?

- X-ray does not provide much image contrast for soft tissue structures.
- MRI provides superior contrast resolution.
  - Better than CT
- Multiplanar imaging:
  - Any anatomical plane can be reconstructed because a large data set is collected during a single imaging sequence.
- No ionizing radiation:
  - Stimulates the body to produce a radiofrequency signal.
  - Uses electromagnetic radiation and magnetic fields.

Process and Components



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The Magnet

Earths magnetic field is 0.00005 T

Field strength is 0.1–3 Tesla (T)

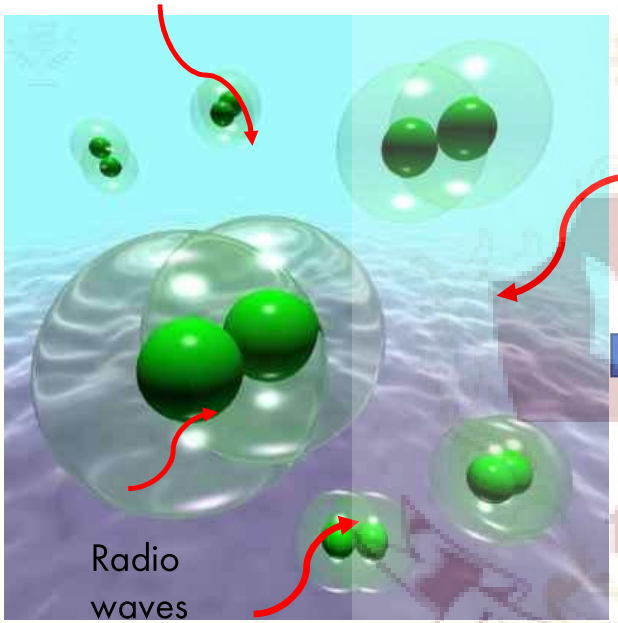


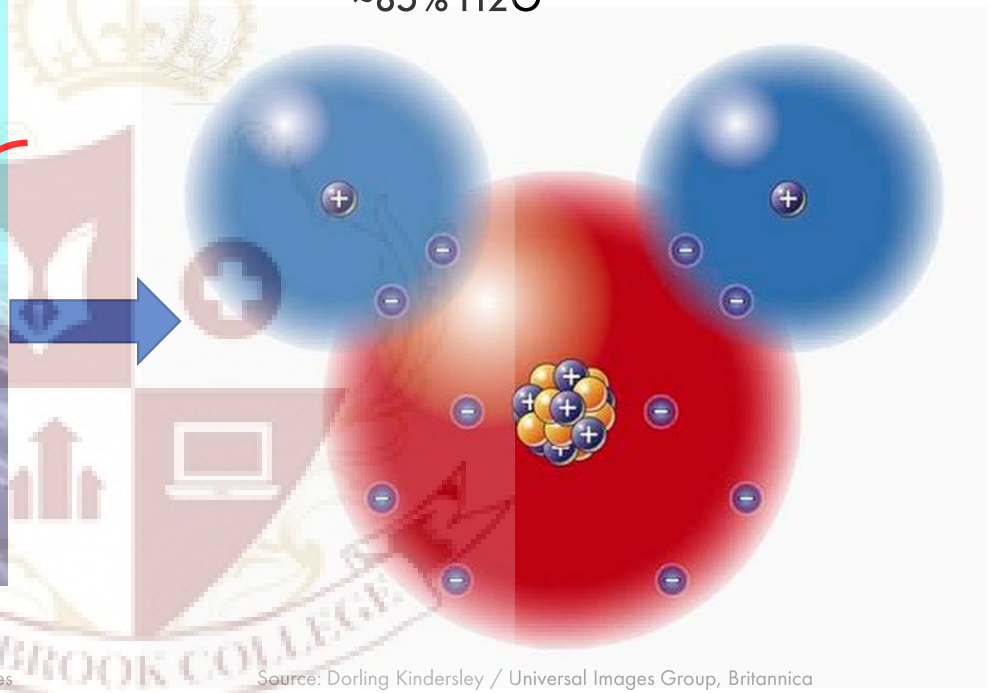
Courtesy Philips Medical Systems.

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Basic Principles of MRI

The body is made up of ~85% H_2O





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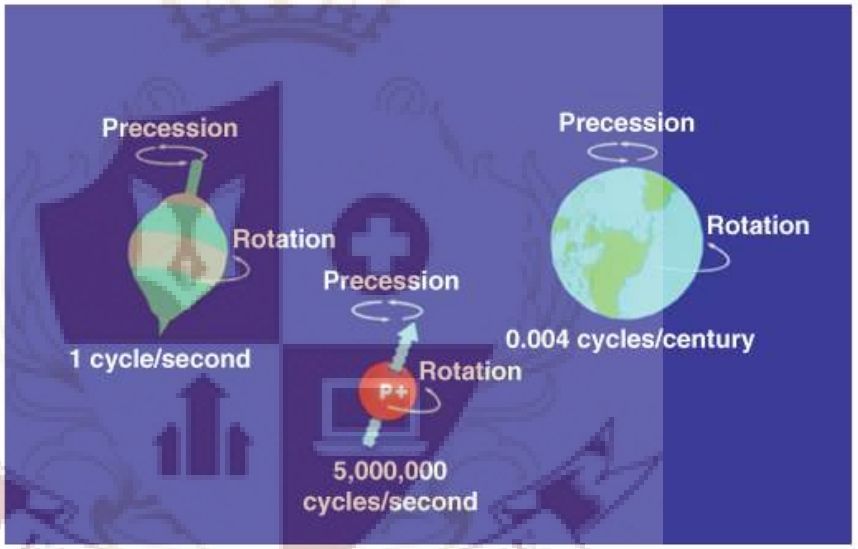
Interaction of Nuclei

- In x-ray we deal with the electrons that surround the nuclei.
- In MRI we are dealing with the nuclei alone.
- When a patient is in a static magnetic field, proton dipoles align with the magnetic field.
- The way the nuclei react is how we obtain our images.

Precession

Occurs when a spinning object is acted on by an outside force.

The wobble motion is called **precession.**

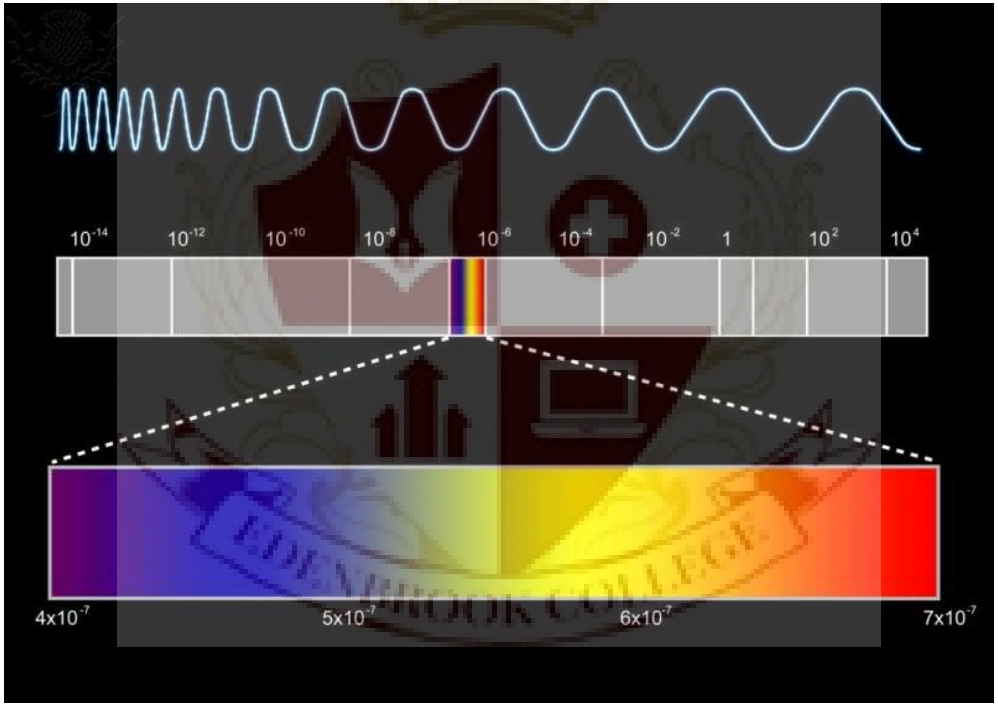


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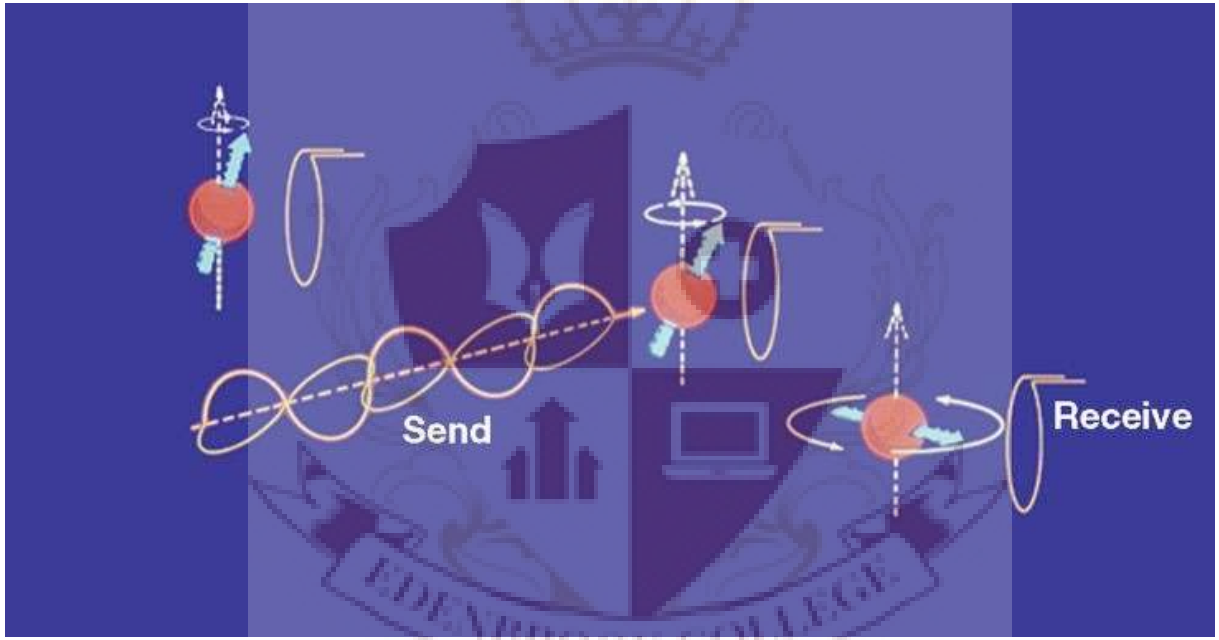
Radio Signal

Once the static magnetic field is applied we can further influence the nuclei by introducing another force, the radio wave.



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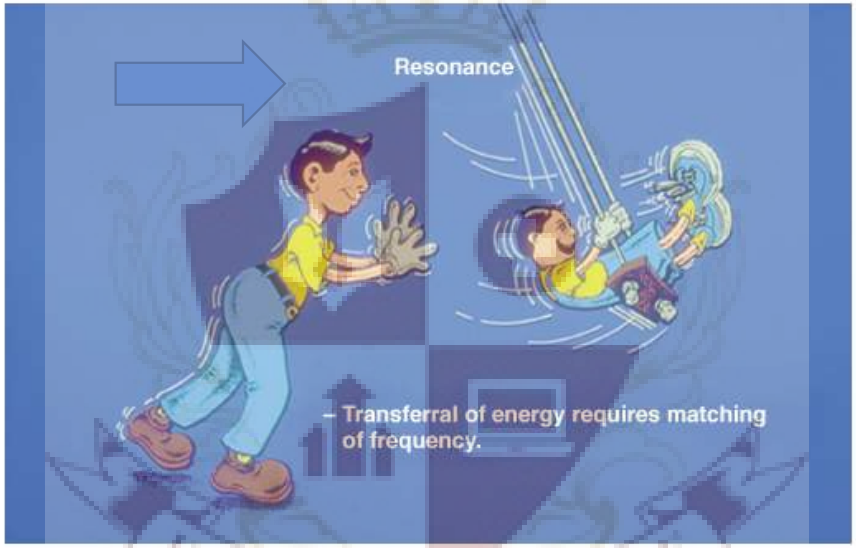
Radio Waves and Precession



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Resonance

Because of their wavelength, radio waves are in resonance with the precessing nuclei.



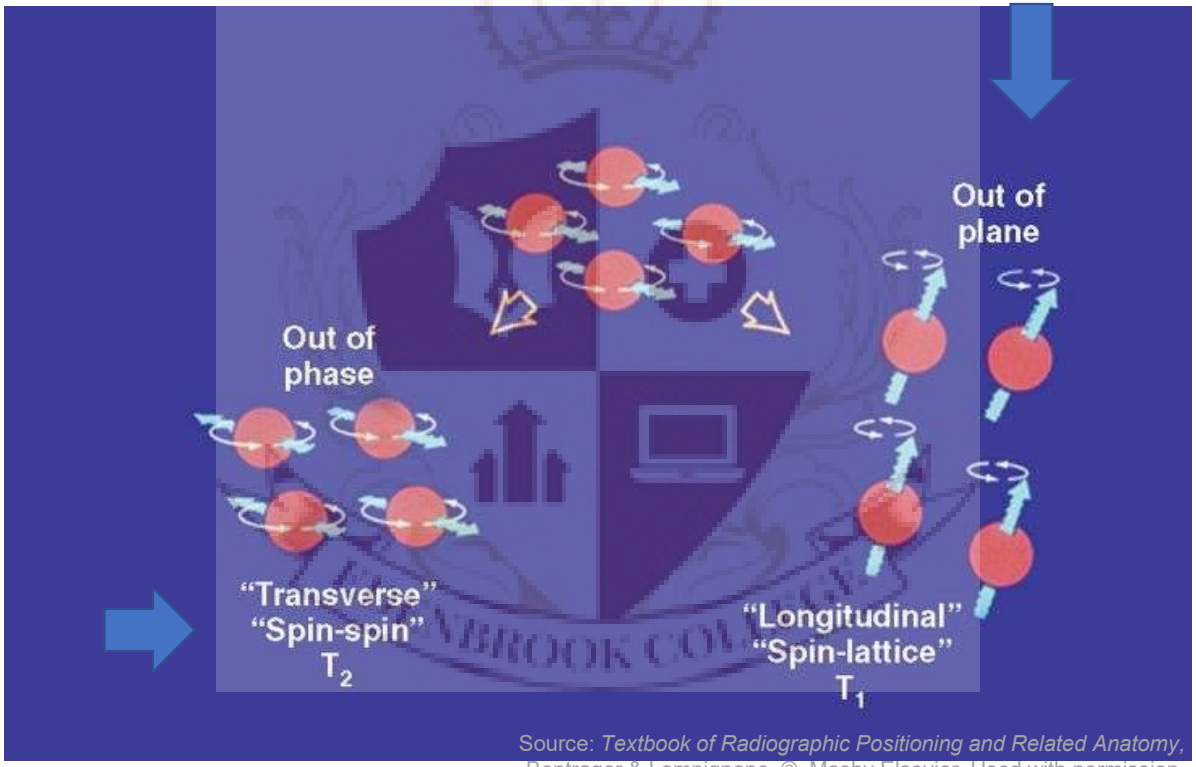
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Relaxation

T1 – when excited nuclei change from a horizontal orientation to a more vertical one.

T2 – when excited nuclei start to spin out of phase.



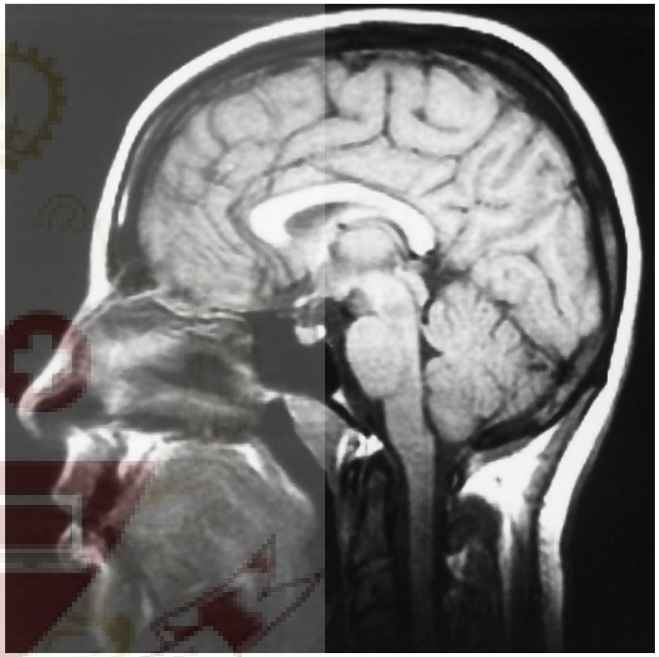
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Process Summary

- Brightness of each point on the image is determined by the signal strength received by antenna.
- The main factors that determine the brightness of each point on the image are T1, T2 and spin density.
- Differences between those factors produce differences in brightness on the image.

Visualization

- High density tissue does not show as image contrast.
  - Hydrogen nuclei tightly bound when tissue density is high.
- Soft tissues show very well, more response from nuclei.



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Clinical Application

- Projectiles
  - Oxygen tanks, wheelchairs, IV pumps and patient-monitoring equipment is not allowed in the room.
  - Could become lethal because the magnetic force is so great.



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Contraindications

1. Absolute Contraindications
   - Pacemakers
   - Ferromagnetic aneurysm clips
   - Metal fragments in eye (this is why we do orbital x-ray first)
   - Cochlear implants
   - Internal drug-infusion pumps
   - Neurostimulators
   - Bone growth stimulators
   - Ferromagnetic gastrointestinal surgical clips
2. Contraindication
   - Pregnancy – this is often considered a contraindication in the first trimester and needs to be approved by a radiologist before the patient can be scanned.

Safety Considerations

- Electrical interference with implants
  - Possible damage to electrical components of pacemakers
- Torquing of some metallic objects (surgical clips)
- Local heating of tissues and metallic objects
  - Due to tissue heating we try not to scan pregnant women because of risk of harmful increases of fetal temperatures
- Electrical interference with normal functions of nerve cells and muscle fibers

Advantages of MRI over CT

- Superior soft tissue contrast resolution.
- Excellent multiplanar imaging capabilities.
- No ionizing radiation.
- Better than CT at identifying small changes in tissue water content.
- Preferred for imaging posterior fossa and brain stem because of limited bone artifact.

Advantages of CT over MRI

- Cases where small calcifications are crucial to identify.
  - MRI typically insensitive to small calcifications
- Cranium fractures:
  - CT and x-ray combined is preferred
- Better for trauma/critical patients:
  - Faster exam time
  - More tolerant of patient motion
  - Ability to show acute blood and fractures
  - Able to monitor patient easier
  - No concerns about materials of the support equipment