

# NUCLEAR MAGNETIC RESONANCE APPLICATIONS

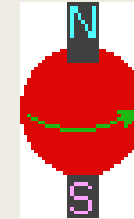
Presentation by Robert J Pulatie



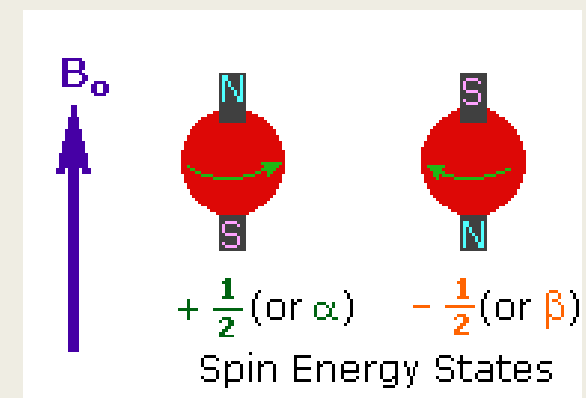
# Outline

- Nuclear Magnetic Resonance Spectroscopy
  - *Proton NMR Spectroscopy*
- Magnetic Resonance Imaging
  - *How MRI works*
  - *What Components Are Used for MRI?*
  - *What is MRI Used For?*
  - *MRI safety*
- Conclusion

# Nuclear Magnetic Resonance Spectroscopy (NMR)



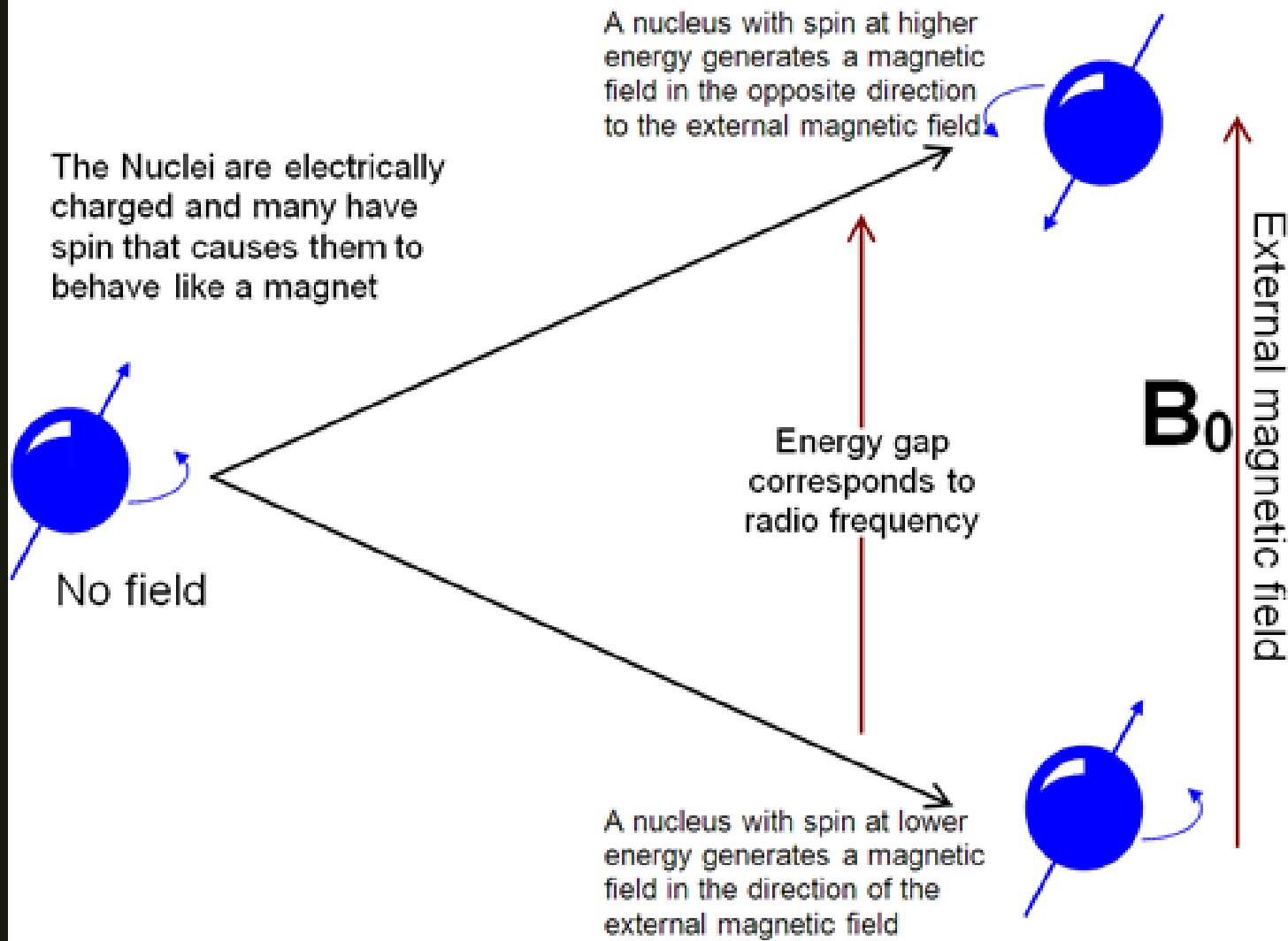
- A spinning charge generates a magnetic field.
  - *The resulting spin-magnet has a magnetic moment ( $\mu$ ) proportional to the spin.*
- In a magnetic field, two spin states exist for a proton,  $+1/2$  and  $-1/2$ .
  - *The lower energy  $+1/2$  spin state is aligned with the external field, but the higher energy  $-1/2$  state is opposed to the external field.*



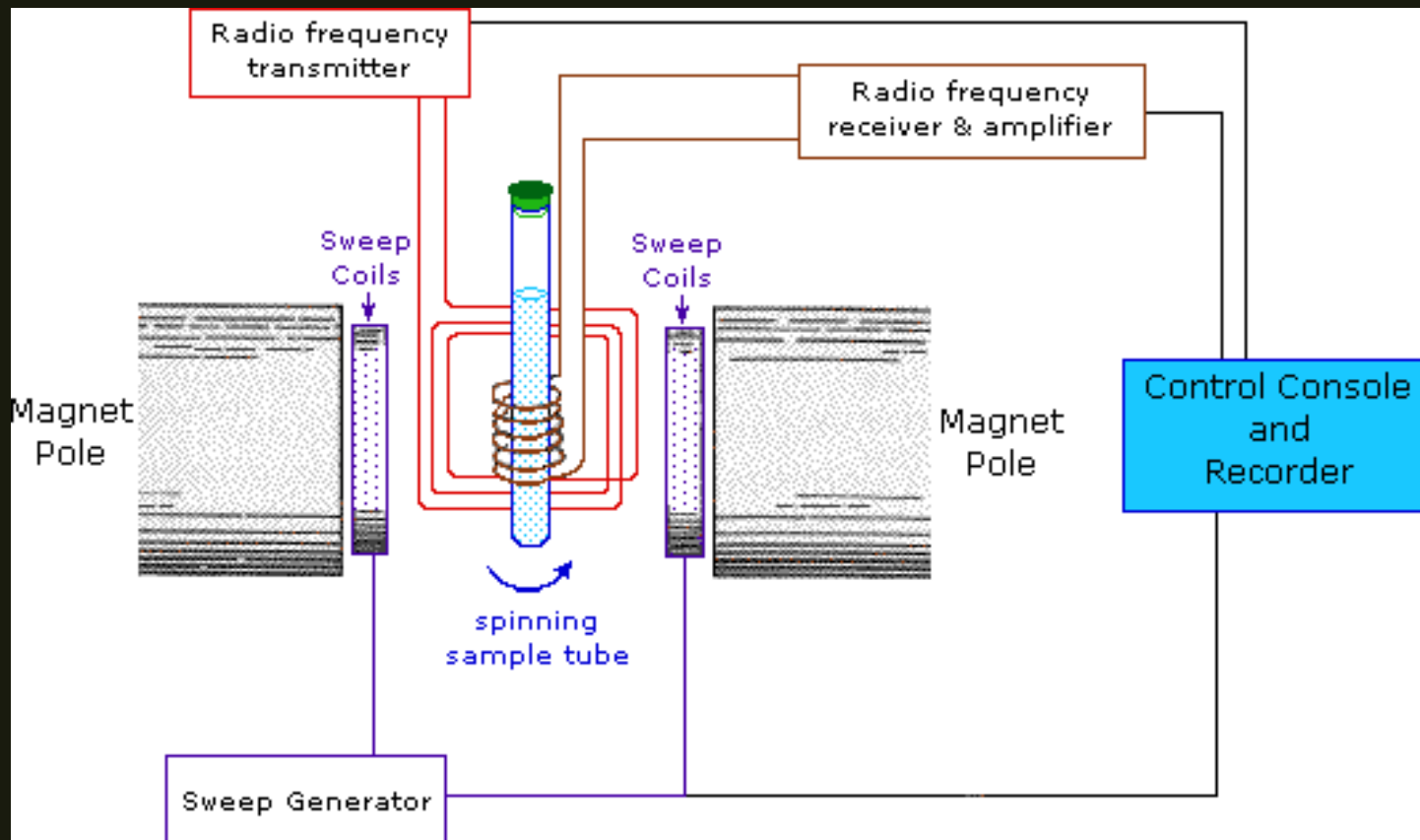
# Nuclear Magnetic Resonance Spectroscopy (NMR)

- The difference in energy between the two spin states is dependent on the external magnetic field strength.
- Strong magnetic fields in the range of 1 to 20 Tesla are necessary for NMR spectroscopy.
  - *Earth's magnetic field is approximately  $10^{-4}$  T at ground level.*
- The small energy difference ( $\Delta E$ ) is usually given as a frequency in units of MHz ranging from 20 to 900 MHz.
- For spin  $\frac{1}{2}$  nuclei, the energy difference between the two spin states at a given magnetic field strength will be proportional to their magnetic moments.

## The case of the spin- $\frac{1}{2}$ nucleus



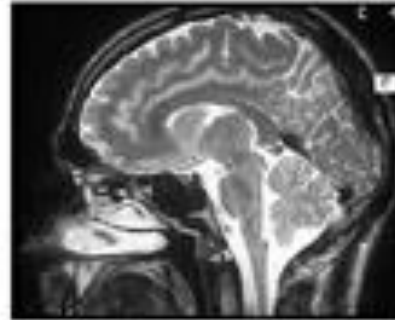
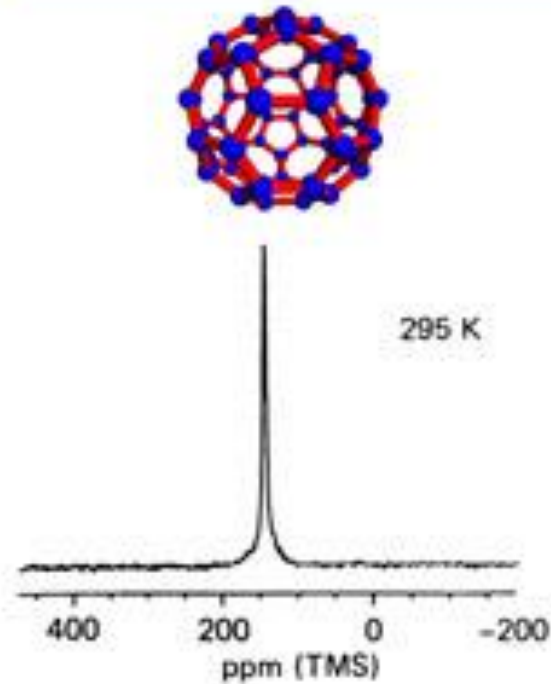
WHAT  
DOES ALL  
THIS  
MEAN?



# PROTON NMR SPECTROSCOPY

The simplest method to obtain the spectrum of the proton is known as the continuous wave (CW) method.

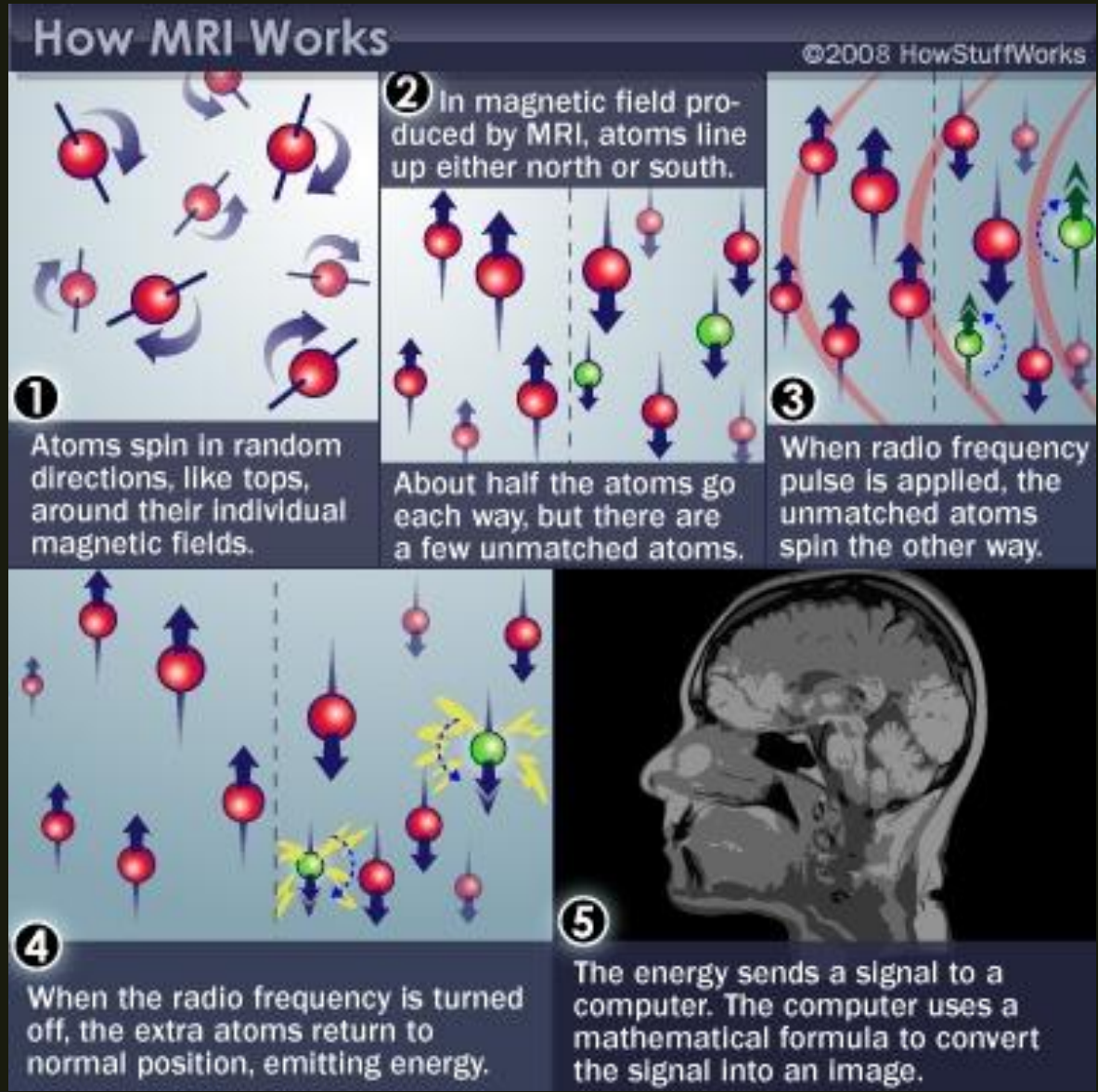
# NMR and MRI



## Magnetic Resonance Imaging

- MRI uses Nuclear Magnetic Resonance to get an image of the inside of the body.
  - *Typically concentrated on one nucleus like hydrogen.*





# HOW MRI WORKS



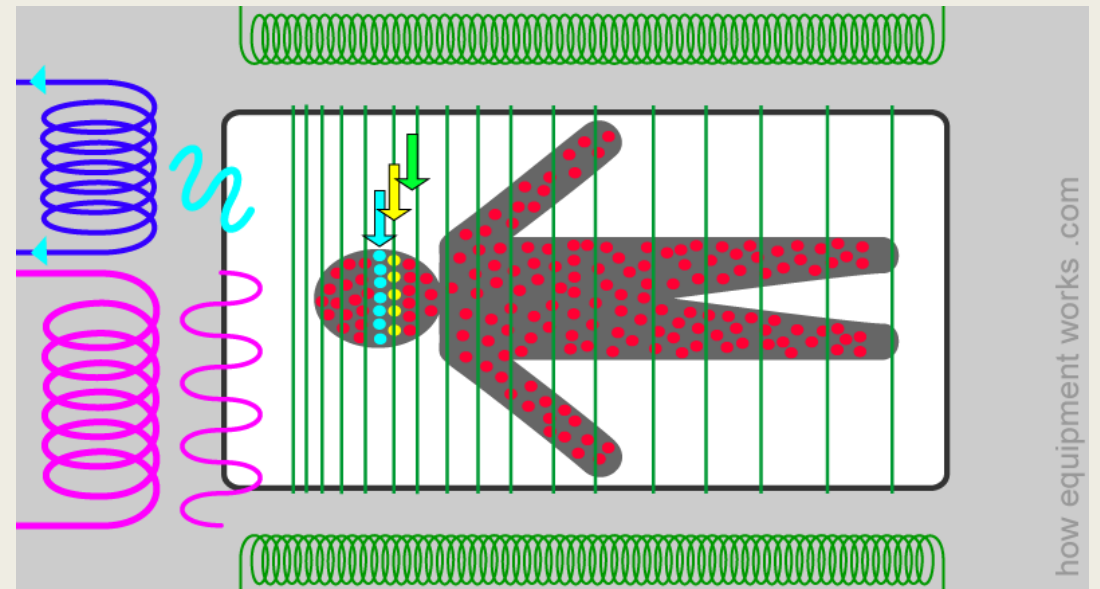
# What Components Are Used for MRI?

## ■ Magnetic Fields

- *Human body is 60% water (water molecules are polar).*
- *The protons of the molecules align in the same direction.*

## ■ Radio Transmitter & Receiver

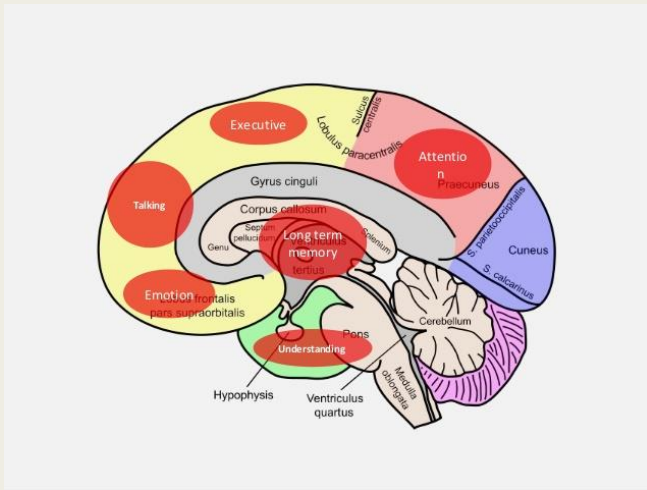
- *Short bursts of radio waves knock the protons out of alignment.*
- *After the burst of radio waves, the protons realign with the magnetic field.*
- *Based on the time it takes and energy released, tissues are differentiable.*



# What is MRI Used For?

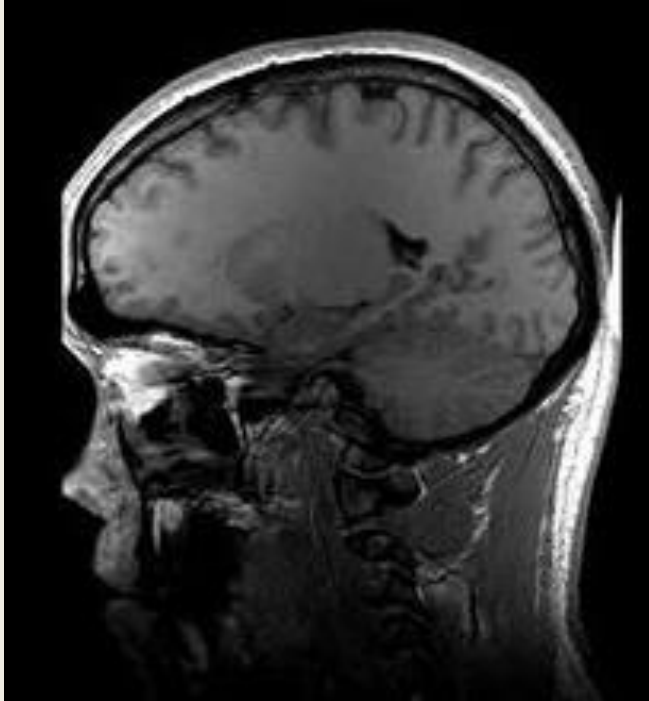
## Functional MRI

- Measures brain activity by detecting changes in blood flow.
- Relies on use of blood-oxygen-level dependent (BOLD) contrast.



# What is MRI Used For?

## Diffusion-weighted MRI



- Maps diffusion process of molecules (primarily water) in tissues.
- Commonly used for mapping white matter of the brain.



## What is MRI Used For?

Magnetic Resonance Angiography  
Magnetic Resonance Venography

- Primarily image blood vessels.
- MRA uses a contrast material like gadolinium.
- MRV uses intravenous contrast dye.



# MRI Safety Pros

- No Ionizing Radiation
  - *No damage to cells.*
  - *No risk of cancer.*
  - *No radiation burns.*
- Non-Invasive Procedure
  - *No surgery.*
  - *Contrast dyes are not necessary.*
- Magnets
  - *No known harmful effects.*



# MRI Safety Cons

- Loud Noises
  - *Headphones are given to the patient due to the really loud tapping noises.*
- Strong Magnets
  - *People with metallic implants, such as a pacemaker, cannot get an MRI scan.*
  - *All metal objects must be removed from the patient before the scan.*



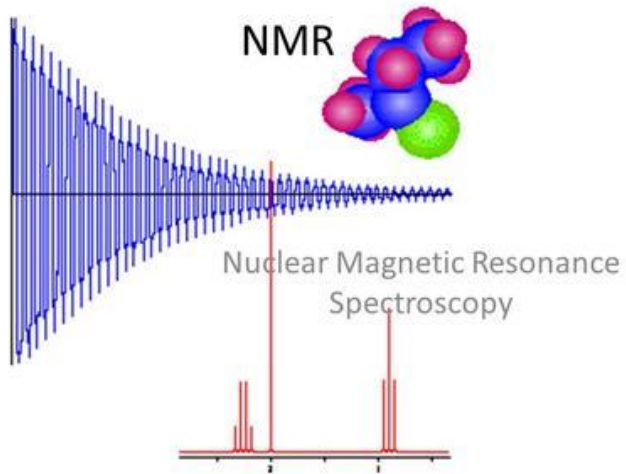


# MRI- magnetic resonance imaging



# Conclusion

- Magnetic resonance imaging (MRI) uses nuclear magnetic resonance (NMR) by utilizing powerful magnets and radio waves to create detailed pictures of the inside your body.



# Sources

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# Image Sources

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