Lesson 1 (A): MRI introduction
Magnetic dipole moment

Aims

- Learning the following topics:
- Photography and radiography
- Steps of an MRI examination
- External magnetic field
- Radiofrequency (RF) pulse
- Magnetic dipole moment

Photography

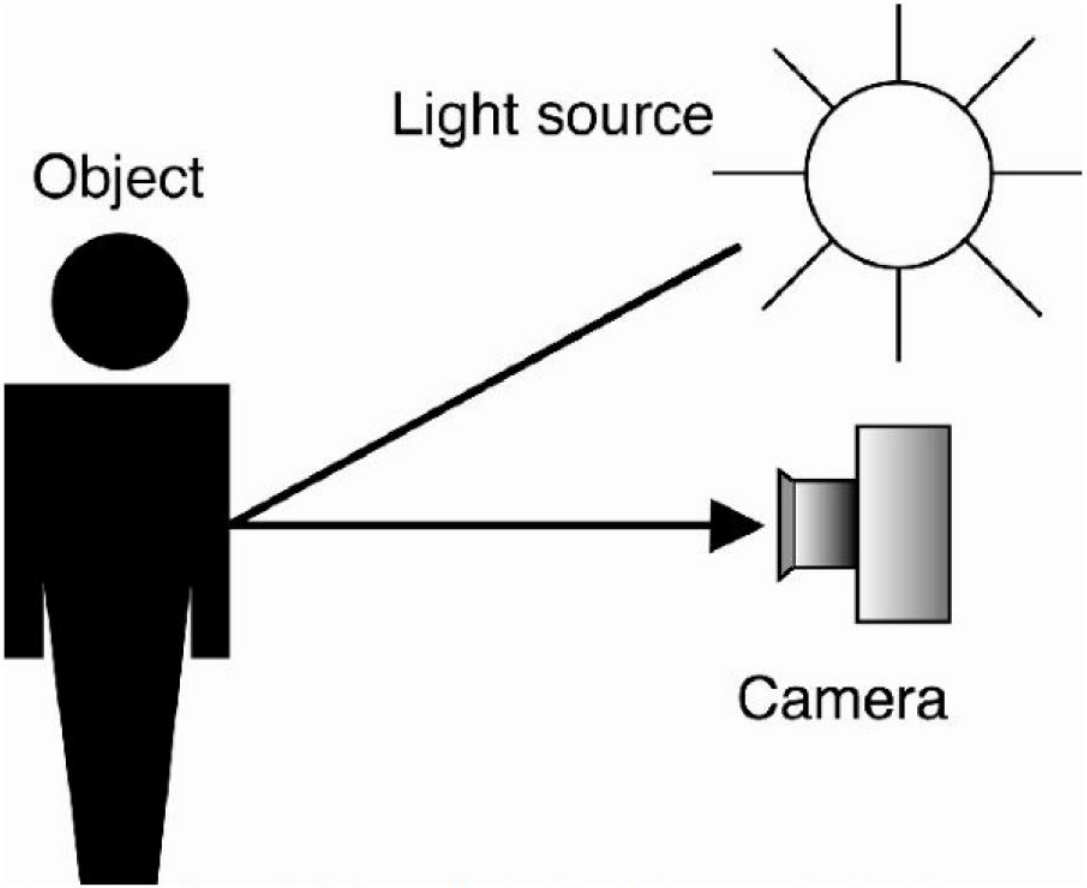
- 

Figure 2-9 In photography, light is reflected off the object and is received by a photographic plate in a camera.

Radiography

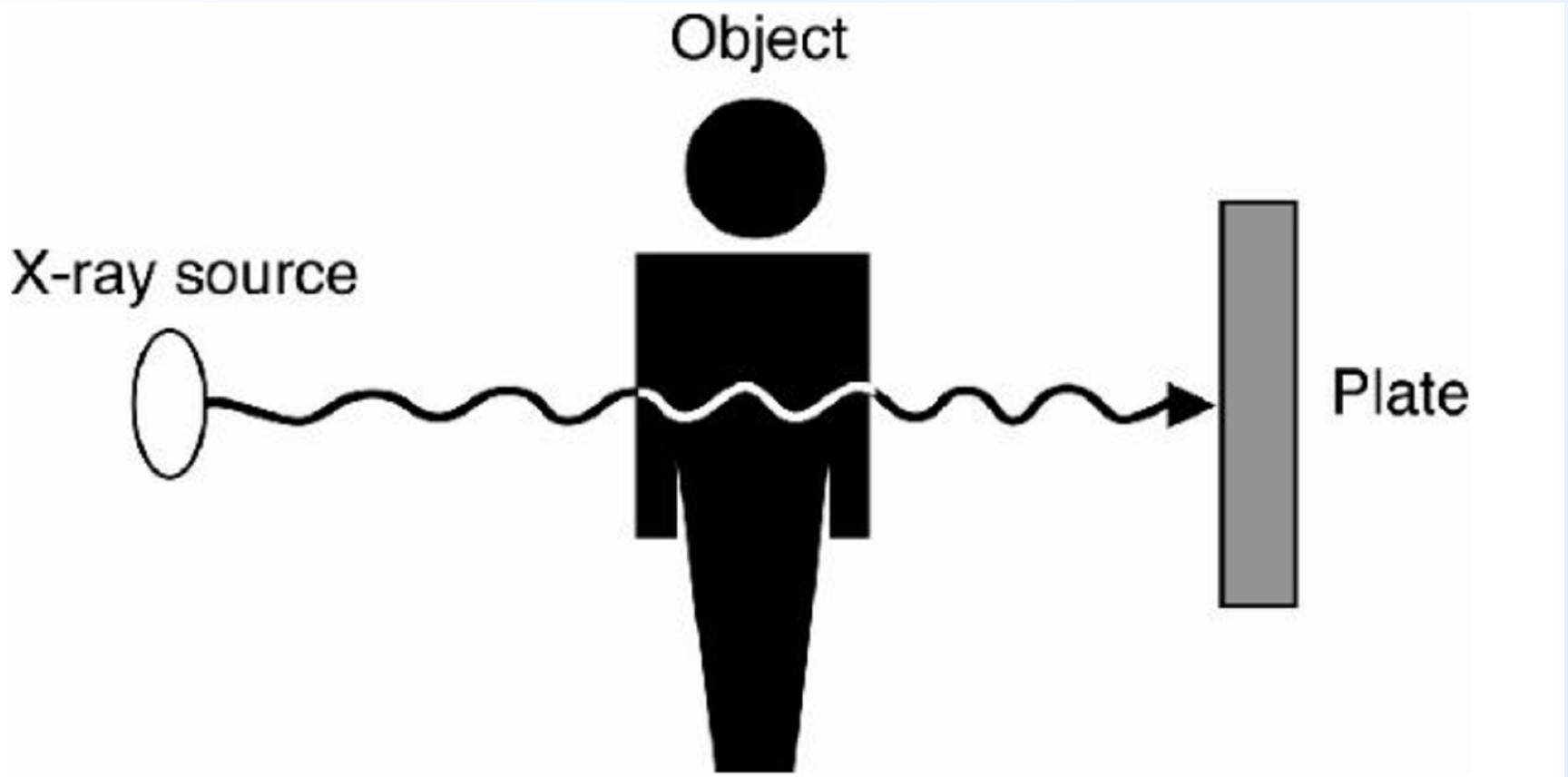


Figure 2-10 In X-ray, radiation penetrates the object and reaches a photographic plate behind the object.

Steps of an MRI examination

- The patient is placed in a magnet
- A radio frequency (RF) wave is sent
- The radiofrequency wave is turned off
- The patient emits a signal which is received and used for reconstruction of the image

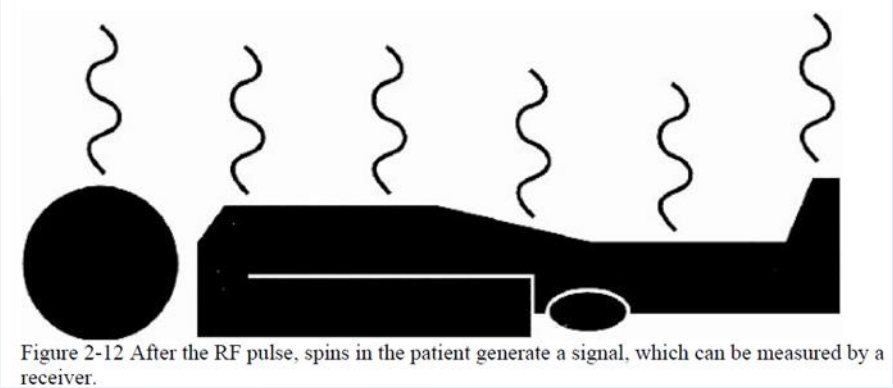


Figure 2-12 After the RF pulse, spins in the patient generate a signal, which can be measured by a receiver.

B0 Field

- The external magnetic field is denoted B0.
- In MRI, B0 is on the order of Tesla (T).
- 1 Tesla = 10,000 Gauss
- The earth's magnetic field, in comparison, is only about 0.5 Gauss (30,000 times weaker than a 1.5 T scanner!)

Radiofrequency (RF) pulse

- Many types of electromagnetic waves exist throughout the electromagnetic spectrum:
- X-rays, visible light, microwaves, radiofrequencies, …
- The frequencies used in MRI fall in the RF range. They are called RF pulses.

Electromagnetic waves

- Electromagnetic waves have two components:
- an electric component (E)
- a magnetic component (H or B).
- Which component is important in MRI?
- The magnetic component
- The electric component?

Spinning charged particle and magnetic field

- Text

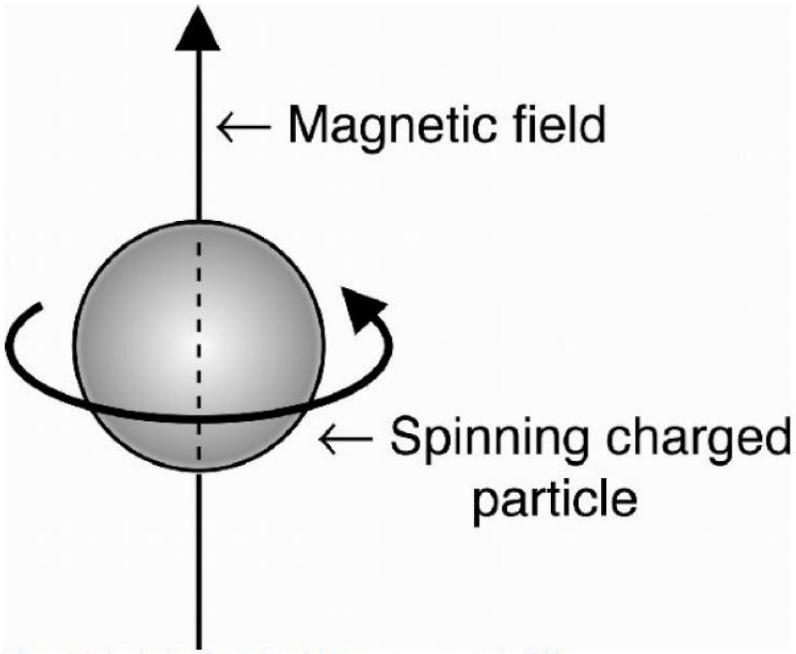
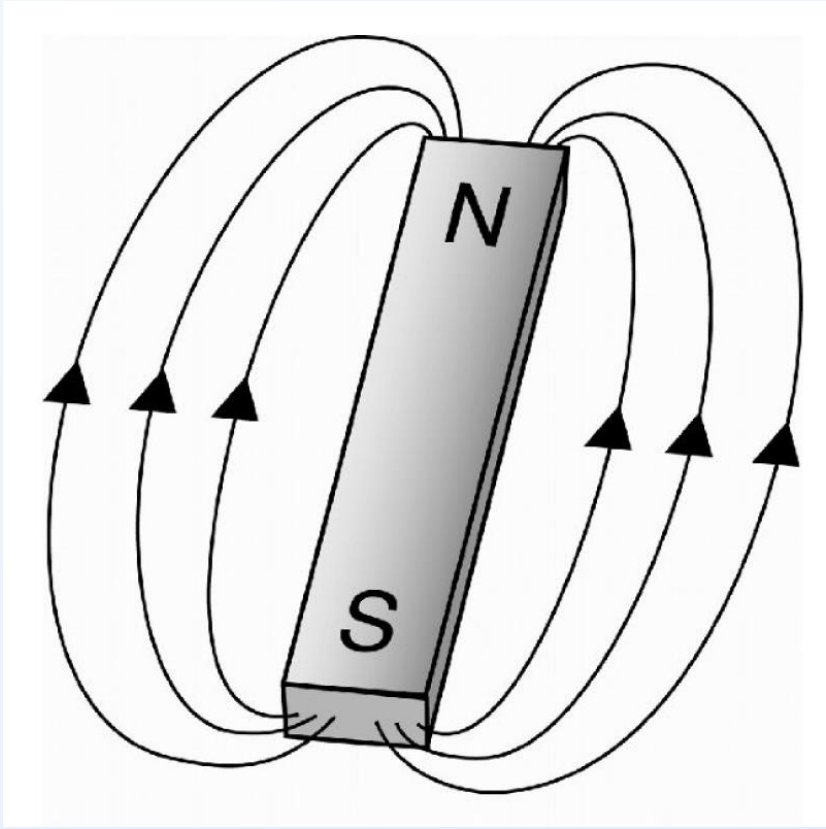


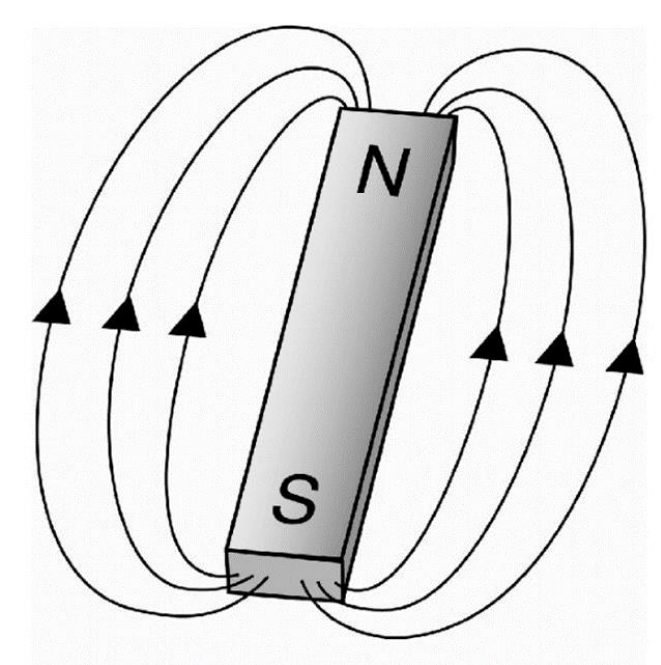
Figure 2-3 A spinning charged particle generates a magnetic field.



Magnetic dipole moment (MDM)

- Each one of the magnetic fields is called a magnetic dipole moment (MDM) and is denoted by the symbol μ.

- Is there MDM in all nucleus?



Paired and unpaired protons

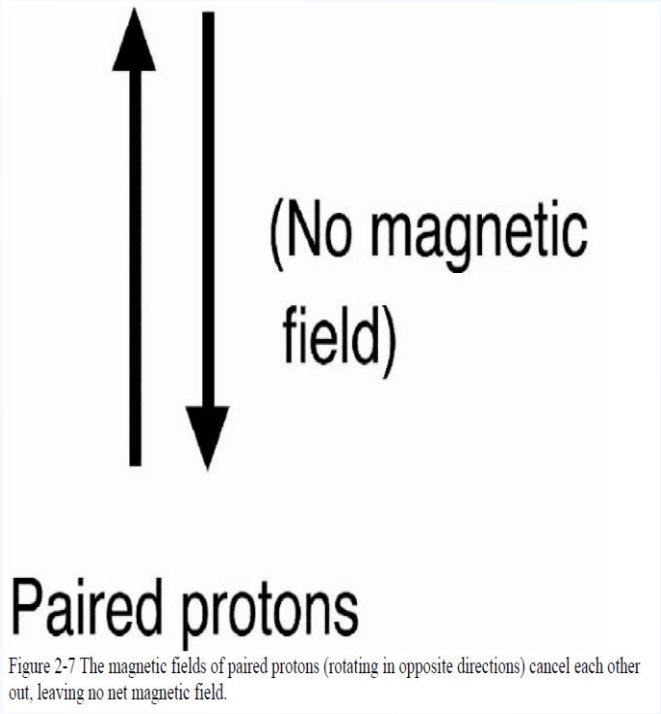
- 

Figure 2-7 The magnetic fields of paired protons (rotating in opposite directions) cancel each other out, leaving no net magnetic field.

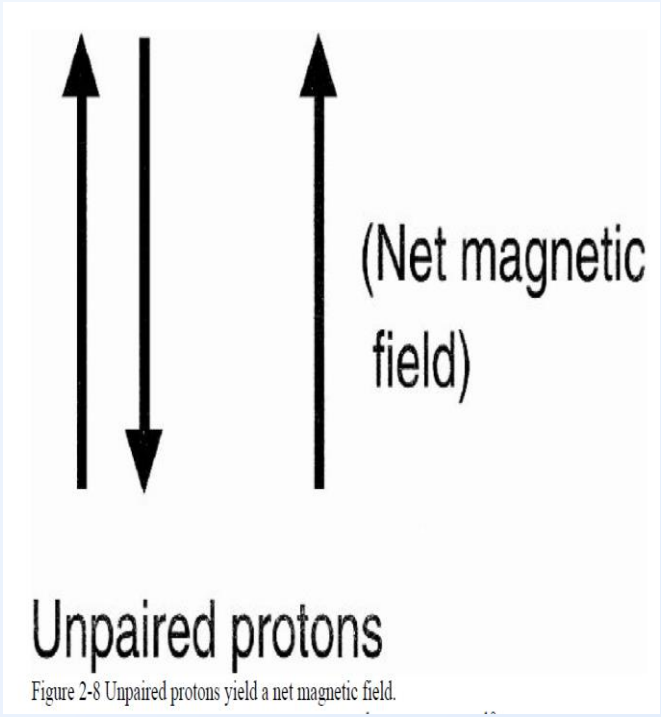


Figure 2-8 Unpaired protons yield a net magnetic field.

MDM

- In the absence of any external magnetic field (B0), the axes of the magnetic dipole moments are arranged in a random way. →
- They all cancel each other out →
- The net magnetic field will be zero.

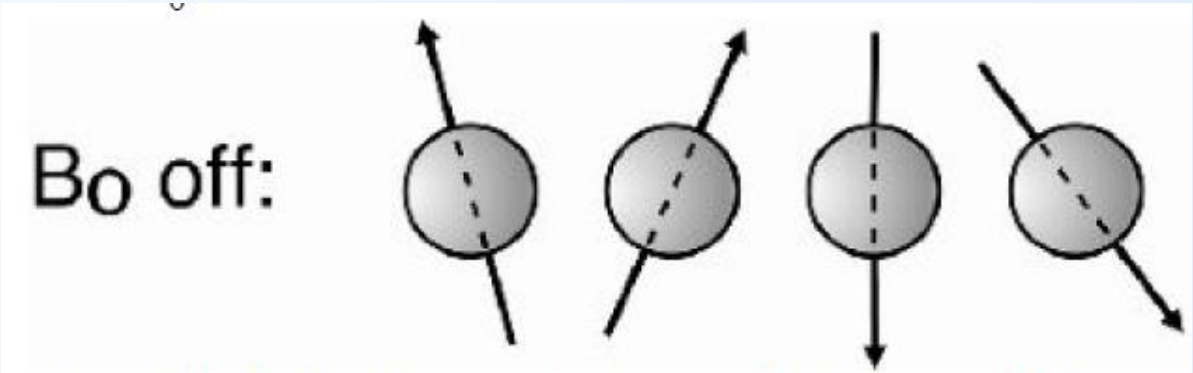


Figure 2-13 In the absence of an external magnetic field B_0, net

Summary

- Steps of an MRI examination
- External magnetic field
- Radiofrequency (RF) pulse
- Magnetic dipole moment

Reference

- Hashemi, RH and Brandy, WG. MRI the Basics, Second Edition