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(I) An Introduction to MRI: How to make pictures with magnetic moments

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Magnetic resonance imaging (MRI) is a non-invasive diagnostic tool that uses magnetic fields and radio waves to create detailed images of the body's internal structures. This lecture introduces MRI and explains the physical principles behind the formation of images from signals derived from the magnetic moments of 1H nuclei.

The lecture will discuss the fundamental concepts of MRI, including nuclear magnetic resonance (NMR). NMR is the underlying physical phenomenon that allows MRI to work and involves the interaction of magnetic fields with the atomic nuclei in the body's tissues.

Next, the lecture explains how strong magnetic fields are used in MRI. A magnetic field aligns the magnetic moments of the atomic nuclei in the body's tissues, which can then be excited with radio frequency (RF) fields. The excited nuclei then emit RF signals that are picked up by the MRI's detectors, known as radio frequency coils. Linear gradients in the magnetic field are used to spatially encode the detected RF signals so that images can be formed using the Fourier Transform.

Different sources of contrast in images will be introduced, including T1, T2, and proton density. Examples of how each of these highlights different properties of the body's tissues will be presented.

Safety considerations for MRI will be briefly discussed. Finally, some applications of MRI in medicine will be presented, including its use in cancer, neurological disorders, and musculoskeletal injuries.

Overall, this lecture briefly introduces the physics involved in MRI image generation. It is intended for anyone interested in learning more about this important diagnostic tool.

Keyword-1

magnetic resonance imaging

Keyword-2

nuclear magnetic resonance

Keyword-3

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