

Difference Between ESR NMR and MRI

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Key Difference – ESR NMR vs MRI

Spectroscopy is a quantification technique used to analyze organic compounds and to elucidate their structure and characterize the compound based on its properties. It studies how radiation is dispersed on striking a surface and interacts with matter. The type of radiation used in the spectroscopic technique may differ from visible light to electromagnetic radiation. The matter on which spectroscopic analysis is performed can also differ. Depending upon the type of matter with which radiation interacts, there can be two main techniques – ESR and NMR. **Electron Spin Resonance spectroscopy (ESR) identifies electron spin rates in a molecule and Nuclear Magnetic Resonance spectroscopy (NMR) uses the principle of nuclear scattering upon exposure to radiation. Magnetic Resonance Imaging (MRI) is a form of NMR and an imaging technique used to determine the structures and shapes of organs and cells using the intensity of the radiation emission.** This is the key difference between ESR, NMR and MRI.

What is ESR?

Electron Spin Resonance (ESR) Spectroscopy is primarily based on the scattering of microwave radiation upon exposure to an unpaired electron in a strong magnetic field. Thus, organs or cells that contain unpaired, highly reactive electrons such as free radicals can be detected using this methodology. Therefore, this technique provides useful and structural information of molecules and can be used as an analysis method to deduce structural information of molecules, crystals, ligands in electron transport and chemical reaction processes.



Figure 01: ESR Spectrometer

In ESR, when the molecule is subjected to a magnetic field, the energy of the molecule will split into various energy levels and once the unpaired electron present in the molecule absorbs the energy of the radiation, the electron begins to spin, and these spinning electrons weakly interact with each other. The absorption signals are measured to elucidate the behavior of these electrons.

What is NMR?

Nuclear Magnetic Resonance (NMR) Spectroscopy is one of the most widely used techniques in biochemistry and radiobiology. In this process, charged nuclei are the target material of a molecule and its excitation upon exposure to radiation is measured in a magnetic field. The frequency of the absorbed radiation generates a spectrum and the quantification and the structural analysis of the particular molecule or the organ can be performed. Radiation used in most NMR detection is gamma radiation since it is a high energy non-ionizing radiation. The spinning of the nuclei in the magnetic field results in two spin states: positive spin and the negative spin. The positive spin generates a magnetic field opposite to the external magnetic field whereas the negative spin generates a magnetic field in the direction of the external magnetic field. The energy gap corresponding to this will absorb external radiation and result in a spectrum.

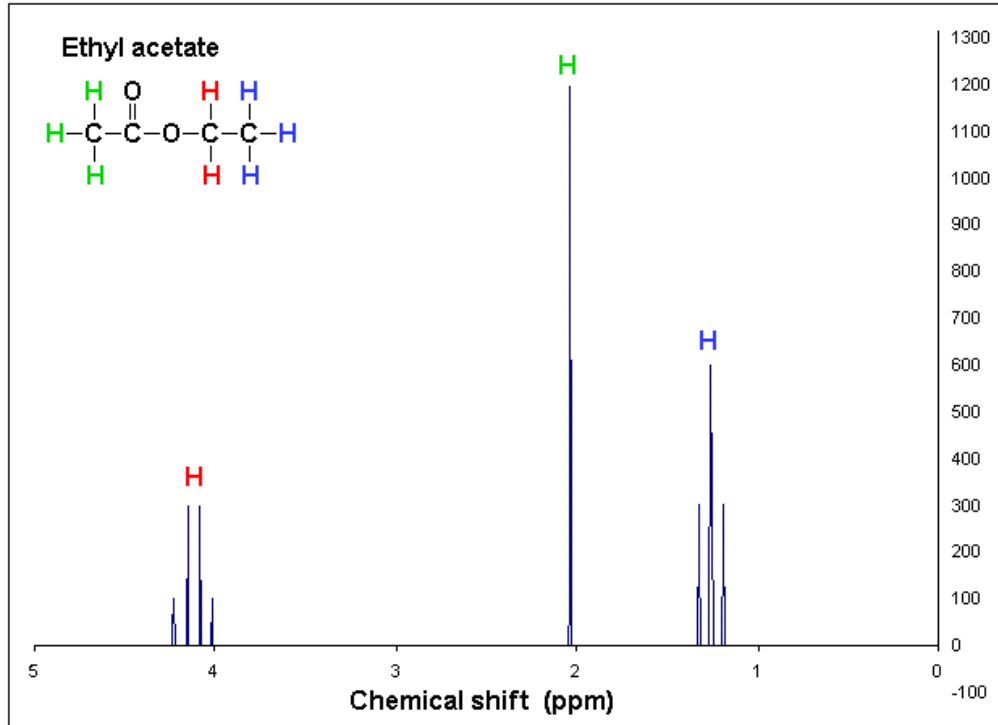


Figure 02: NMR Spectrum

What is MRI?

Magnetic Resonance Imaging (MRI) is a form of NMR, where the intensity of the radiation absorbed is used to generate images of organs and cellular structures. This is a non-invasive technique and does not use any harmful radiation for detection. In order to obtain an MRI, the patient is kept inside a magnetic chamber and is treated prior with intra-venous contrast agents in order to obtain the image clearly.



Figure 03: MRI

What are the similarities between ESR NMR and MRI?

- ESR, NMR and MRI use a magnetic field.
- In all three techniques, the scattering of matter is done by radiation; visible light or electromagnetic radiation.
- All are non-invasive techniques.
- All three techniques are based on the excitation of matter in a magnetic field.
- These techniques are used in diagnostics and structural analysis of organs and cells.

What is the difference between ESR NMR and MRI?

ESR NMR vs MRI	
Definition	
ESR	Electron Spin Resonance (ESR) Spectroscopy is the technique which uses spinning of an unpaired electron that is in resonance and generates a spectrum based on the absorption of radiation.
NMR	Nuclear Magnetic Resonance (NMR) Spectroscopy is the resonance that occurs when a charged nucleus is placed in a magnetic field and

	is 'swept' by a radio frequency that causes the nuclei to 'flip'. This frequency is measured to form a spectrum.
MRI	Magnetic Resonance Imaging (MRI) is an application of NMR, where the intensity of the radiation is used to capture images of organs in the body.
Type of Radiation	
ESR	ESR mostly uses microwaves.
NMR	NMR uses radio waves.
MRI	MRI uses electromagnetic radiation such as gamma rays.
Type of Matter Targeted	
EST	EST targets unpaired electrons, free radicals.
NMR	NMR targets charged nuclei.
MRI	MRI targets charged nuclei.
Output Generated	
EST	ESR generates an absorption spectrum.
NMR	NMR also generates an absorption spectrum.
MRI	MRI produces images of organs, cells.

Summary – ESR NMR vs MRI

Spectroscopic techniques are widely used in the biochemical analysis of molecules, compounds, cells and organs, especially in detecting novel cells and malignant cells in the body and thereby characterizing their physical properties. Thus, the three techniques; ESR, NMR and MRI are of great importance as they are non-invasive spectroscopic techniques used for qualitative and quantitative interpretation on biomolecules. The main difference between ESR NMR and MRI is the type of radiation they use and the type of matter they target.

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