

# Introduction to Nuclear Magnetic Resonance Spectroscopy

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# 1.1. Introduction to Magnetic Resonance

- Magnetic resonance (MR) is a phenomenon of resonant energy absorption by a system of nuclei (and electrons).
- Nuclear magnetic resonance (NMR) results from the intrinsic magnetic moment of the nuclei of some atoms. Magnetic moments of electrons are exploited in electron spin resonance.
- Magnetic resonance (MR) generally involves placing a sample in a strong magnetic field (to generate polarisation at a fixed resonant frequency) and detecting signals produced following application of pulsed radio-frequency electromagnetic fields (RF pulses).
- MR is a very powerful method for studying the structure of materials: used in physics, chemistry, biology, medicine etc.

## 1.2. Applications of NMR

- NMR spectroscopy is used for chemical analysis and for molecular structure determination

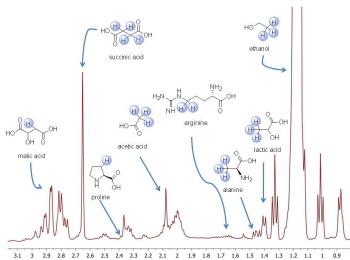


Fig.1:  $^1\text{H}$  NMR spectrum of a sample of Spanish wine (<http://www.unirioja.es/gsoe/NMR.htm>)

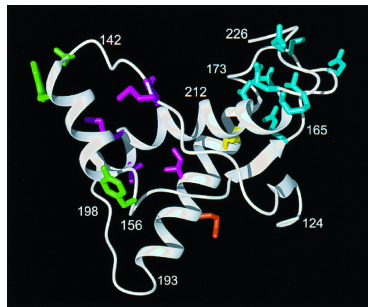


Fig.2: NMR-derived structure of a prion <http://www.pnas.org/content/94/14/7281.full>

## 1.2. Applications of NMR

- NMR relaxometry can be used to monitor molecular environment

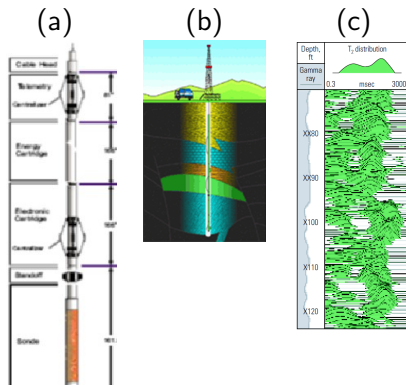


Fig.3: (a) NMR-logging probe, (b) Schematic positioning of the probe in a well, (c) T<sub>2</sub>-relaxation profile along the bore. Sources: 1) Allen et al. Oilfield review, Autumn 2000; 2) Coates, Xiao NMR Logging Principles and Applications, Halliburton

## 1.2. Applications of NMR

- NMR forms the basis for magnetic resonance imaging (MRI)

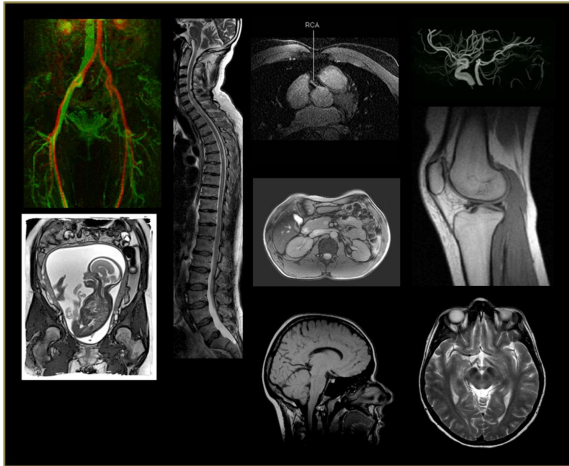


Fig.4: Example magnetic resonance images of blood vessel (in legs), fetus in utero, spine, heart, abdomen, head, blood vessels (in brain), knee, brain (courtesy of Prof. Richard Bowtell)