Magnetic Resonance Imaging

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Magnetic Resonance Imaging is one of the more modern techniques for non invasive medical imaging. In 1973 the first image using the modern technique was published. MRI is the common name used in the medical world, however in the research side of things is known as a NMR (Nuclear Magnetic Resonance).

All the atoms in your body spin or precess on an axis, however they do not do this in a uniform direction. Hydrogen, making up most of the human body (as it is found in water) and has a high magnetic moment due to its signal proton nucleus. Inside the bore of the MRI where the patient is inserted the magnetic field runs straight down the centre of the bore. The strong field causes the hydrogen atoms to align themselves with the field. Radio frequency pulses, specific to hydrogen, are sent to the area of the body that is to be examined. The protons in that area absorb the energy from the RF pulses, which alters their alignment from the magnetic field. The oscillating between the excited state and alignment, give the resonance part of its name. The rate at which the protons switch back and forth from alignment is determined by the strength of the magnetic field and tissue being imaged, this frequency is known as the Larmour Frequency. The gradient magnets create a lesser field than that of the main magnet. The gradient magnets are turned off and on very quickly and alter the main magnetic field allowing the MRI to focus on certain areas (allowing for 3D models to be made). As the protons return to alignment they release the extra energy from the RF pulse. The energy is picked up and converted into an image.

Although the process is the same, there are three different types of main magnets used in practical MRIs today. In addition to the main magnet this is also usually three magnets referred to as gradient magnets.

Resistive Magnets are magnets that have coiled wire wrapped around them. Electricity is then sent through the wire to produce a stronger magnetic field. Name comes from the large amount of resistance that comes from the massage for electivity though the wire (up to ca 50Kilowatts). They are cheaper to produce than a Superconducting magnet but, become more expensive to operate over 0.3 Tesla.

A permanent magnet is a magnet with its magnetic that is always at full field strength. They are very heavy and bulky, they also tend to be the weaker side of about ~0.4-0.5 Tesla. They are very cheap to operate on the positive side.

Superconducting magnets are the most commonly used form of MRI. The magnet works on the same concept as the resistive magnet only surrounding the wire is a cryogen (commonly liquid helium @ -452.4°F). The extreme cold helps drastically reduce the resistance in the coiled wire making it cheaper to operate. Superconducting magnets can have field from 0.5 Tesla to 2 Tesla.

Gradient Magnet – low strength magnetic field of about 180 to 270 Gauss (18 – 27 mT), usually found it a set of three in an MRI. Aid altering main magnetic field to get 3D location information.

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