A magnetic resonance summary (Updating)

Yefan Tian∗

Department of Physics and Astronomy, Texas A&M University, College Station, TX 77840, USA

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A summary of magnetic resonance (MR).

I. INTRODUCTION

Magnetic resonance is a phenomenon that affects a Magnetic dipole when placed in a uniform static magnetic field. Its energy is split into a finite number of energy levels, depending on the value of quantum number of angular momentum. This is similar to energy quantization for atoms, say $e^-$ in H atom; in this case the atom, in interaction to an external electric field, transitions between different energy levels by absorbing or emitting photons. Similarly if a magnetic dipole is perturbed with electromagnetic field of proper frequency ($E/h$), it can transit between its energy eigenstates, but as the separation between energy eigenvalues is small, the frequency of the photon will be the microwave or radio frequency range. If the dipole is tickled with a field of another frequency, it is unlikely to transition. This phenomenon is similar to what occurs when a system is acted on by a periodic force of frequency equal to its natural frequency.

II. MAGNETIC RESONANCE CLASSIFICATION

Magnetic Resonance can be classified into several different categories: Nuclear Magnetic Resonance (NMR), Electron Paramagnetic Resonance (EPR) and Ferromagnetic Resonance (FMR).

A. Nuclear Magnetic Resonance (NMR)

NMR is a physical phenomenon in which nuclei in a strong static magnetic field are perturbed by a weak oscillating magnetic field (in the near field and therefore not involving electromagnetic waves) and respond by producing an electromagnetic signal with a frequency characteristic of the magnetic field at the nucleus.

Solid-state NMR (ssNMR) spectroscopy is a kind of nuclear magnetic resonance (NMR) spectroscopy, characterized by the presence of anisotropic (directionally dependent) interactions.

1. Solid-state NMR (ssNMR)

2. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, magnetic field gradients, and radio waves to generate images of the organs in the body. MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT or CAT scans and PET scans. Magnetic resonance imaging is a medical application of NMR. NMR can also be used for imaging in other NMR applications such as NMR spectroscopy.

B. Electron Paramagnetic Resonance (EPR)

EPR spectroscopy is a method for studying materials with unpaired electrons. The basic concepts of EPR are analogous to those of NMR, but it is electron spins that are excited instead of the spins of atomic nuclei. EPR spectroscopy is particularly useful for studying metal complexes or organic radicals.

C. Ferromagnetic Resonance (FMR)

FMR is a spectroscopic technique to probe the magnetization of ferromagnetic materials. It is a standard tool for probing spin waves and spin dynamics. FMR is very broadly similar to EPR, and also somewhat similar to NMR, except that FMR probes the sample magnetization resulting from the magnetic moments of dipolar-coupled but unpaired electrons, while NMR probes the magnetic moment of atomic nuclei that are screened by the atomic or molecular orbitals surrounding such nuclei of non-zero nuclear spin.

∗ http://people.physics.tamu.edu/yftian/