Achieving Room Temperature Superconductivity in Ferrites

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Abstract

This proposal describes the arrangement based on the Einstein de-Haas experiment. An externally applied magnetic field magnetized the ferrite core by giving microwave power frequency to the coil around the ferrite core. Ferromagnetic resonance is achieved due to the effect of the interaction of spin precession magnetic moments due to Zeeman splitting on the macroscopic magnetization of the material. The core attains negative permeability at ferromagnetic resonance. Due to negative permeability, the ferrite counteracts the magnetizationdue to the applied DC electric field given to one end of the ferrite core. In certain scenarios, negative permeability can lead to the expulsion of the magnetic field resulting in B equal to zero inside the material. This induced phenomenon is somewhat analogous to the Meissner effect observed in superconductors. In the case of negative permeability, the negative magnetic response effectively shields the material's interior from external magnetic fields. The curl of the magnetic field is zero resulting in a net force equal to zero on the moving charge carriers.

Introduction:

An intriguing scientific phenomenon that is yet poorly understood is magnetism. Magnetic materials are used in many important technologies, from high-performance magnets in large-scale power generation, energy storage, and transmission motors and generators to magnetic information technologies on the nanoscale, which include storage, logic, and sensor devices utilizing the spintronics concept. The magnetic properties of matter continue to pique scientific curiosity and imagination. The electron's spin is the basic component of magnetism, and the diversity of ferromagnetic, ferrimagnetic, and antiferromagnetic materials, as well as paramagnetic and diamagnetic materials, results from the different couplings of nearby electron spins in a material.

The characteristics, behavior, and utility of magnetic materials are influenced by microscopic spin configurations resulting from competing interactions inside the material. Exogenous magnetic, electric, and light fields, as well as light itself, can affect or modify magnetization itself. This opens the door to the development of ultrasmall, ultrafast, and low-power microelectronic systems in the future. The forthcoming Internet-of-Things (IoT) era will be greatly impacted by such accomplishments in terms of technology, economy, the environment, and society[1].

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Basic Theory of Ferromagnetic Materials:

Ferromagnetic materials contains permanent atomic magnetic dipoles that are spontaneously oriented parallel to one another even in the absence of an external field.It is challenging to comprehend the phenomenon of ferromagnetism because of the magnetic repulsion between two dipoles placed side by side with their moments in the same direction. It is known that huge clusters of atoms spontaneously align within ferromagnetic materials. There is a new kind of interaction involved, a quantum mechanical effect called the exchange interaction. Here is a very simple explanation of how electrons in ferromagnetic materials are aligned via the exchange interaction.

The magnetic moment connected to an electron's spin in an outer atomic shell—more precisely, the third d shell—is what gives iron its magnetic properties. We call these electrons magnetization electrons. Two electrons cannot have the same attributes according to the Pauli exclusion principle; for instance, two electrons cannot be in the same place with the same spin direction.It is against the Pauli exclusion principle for two electrons to possess the same characteristics; for instance, they cannot be at the same place and have opposite spin directions. For spins pointing in the same direction, this exclusion can be thought of as a "repulsive" mechanism; its action is the opposite of what is needed to align the electrons that cause the magnetization in the iron domains. On the other hand, the interaction between the magnetization electrons and other electrons with opposite spin, mainly in the fourth atomic shell, at close range, is attractive. These s-shell electrons affect and align the magnetization electrons of many iron atoms due to the attraction force of their opposing spins[2].

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Ferromagnetic resonance:

Ferromagnetic resonance (or FMR) arises due to the coincidence of the precession frequency of the total magnetic moment of a ferromagnet particle with the frequency of external microwave radiation[3]. The applied field creates a Zeeman splitting in the energy levels at the microscopical level, and the magnetic dipole transitions between these split levels are excited by the microwave. The material's orientation and the strength of the applied magnetic field determine the precession frequency[4].The negative permeability appears when the ferromagnetic resonance (FMR) of the ferrite taking place[5].

Einstein de-Haas Experiment:

The proposed experimental arrangement for achieving room temperature superconductivity is the Einstein de-Haas experiment.This arrangement is ideal for FMR studies especially the magnetoelectric coupling between the microwave magnetic field and DC electric fields[6].This can be achieved in the proposed arrangement by applying microwave power frequency to the coil around the ferrite core combined with DC electric field applied at one end of the ferrite core or high DC current fed to one end of the ferrite core.

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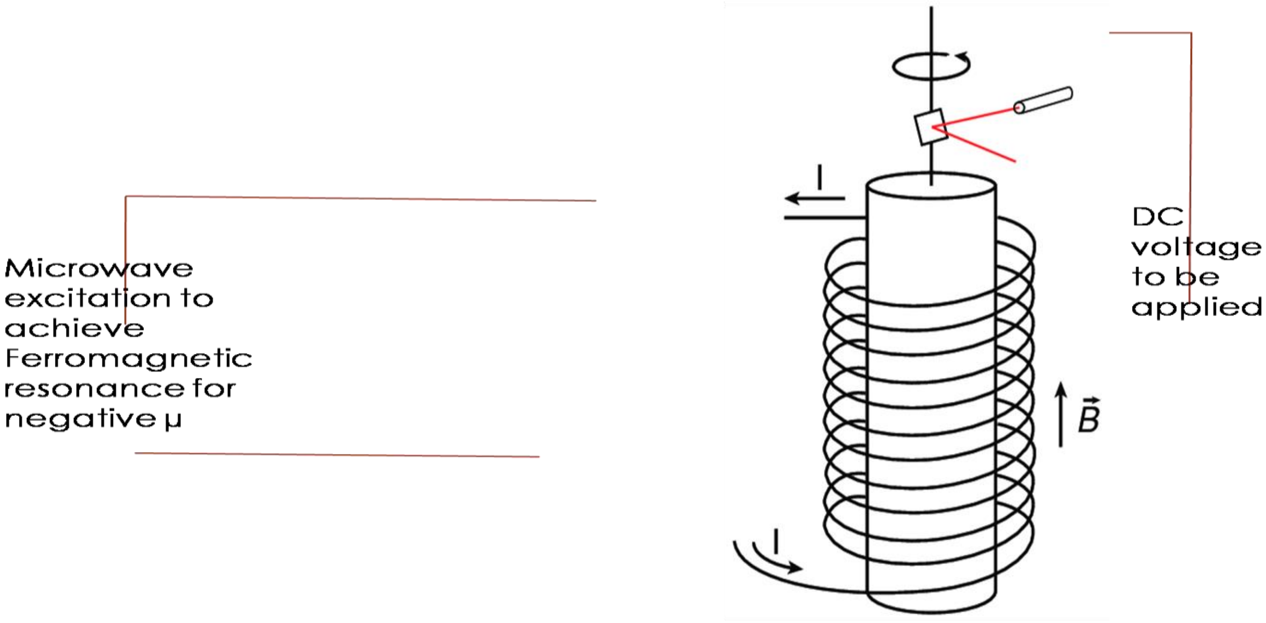

Fig 1 : Proposed Experimental Arrangement

When the ferromagnetic resonance is achieved, the permeability of the ferrite core becomes negative and if there is externally induced magnetic field due to the DC current then the ferrite core will oppose this field.The magnetization due to DC current is in one direction and the magnetization of the material as a result of it will result in the opposite direction, resulting in,

B=0 ,inside the material.

This phenomenon is somewhat analogous to the Meissner effect observed in superconductors, where magnetic fields are expelled from the interior of the material. In the case of negative permeability, the negative magnetic response effectively shields the interior of the material from external magnetic fields

Curl equation of B=0 -----→no net force on the moving charge carriers

Radius of curvature of the moving charge carrier in a finite magnetic field,r=mv/qB ---→B=0

r=∞ , which is a straight line. The ferrite core will remain stationary and there will be no rotation.

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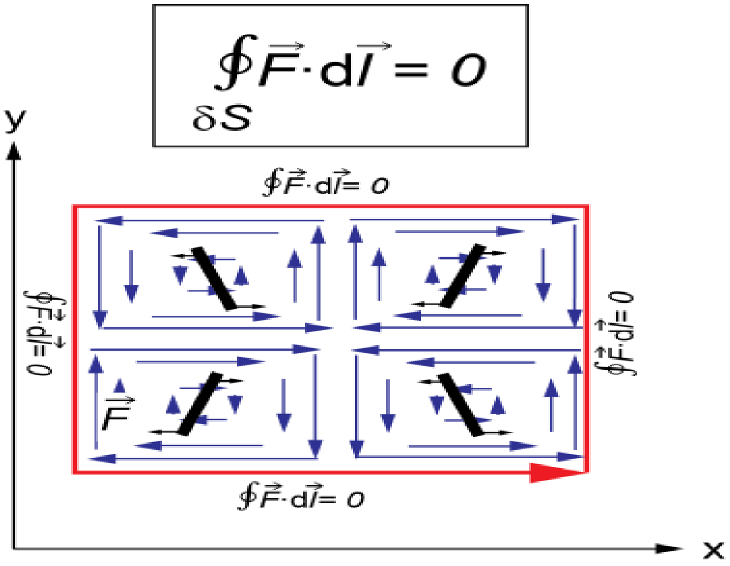

- Normally, the curl of magnetic field exists but in this case , the curl of magnetic field is zero.(μ= a negative quantity)

$$\nabla XB=0$$

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Conclusion:

The application of room temperature superconductors are MRIs with a larger field of view, quicker computers, lossless power transmission and distribution, incredibly powerful and torque-dense electric motors and generators with efficiency levels beyond 99.2–99.5%, etc. Fusion power plants and maglev transportation, among many other applications involving magnetic suspension, would also become commonplace. The world would drastically alter if we could simply create RT superconductors at a moderate cost and with a sizable current carrying capacity.

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