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Relation between Matter Density, Atomic number, Magnetic field and resonance Frequency on the basis of Non Equilibrium Statistical Law and Zeeman Effect

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Abstract: *Identification of elements is very important in mineral exploration. The change of conductivity with frequency shows resonance values for different matter. At these values the conductivity is minimum, this resonance frequency is shown experimentally to be related to the matter density and atomic number beside the magnetic field. These emprical relations can be explained theoretically on the basis of new statistical laws derived from plasma equations beside Zeeman Effect law.*
Key Words: *matter density, resonance, frequency, equilibrium statistical, Zeeman Effect.*

I. Introduction

The behavior of atoms in a solid material can be explained by using statistical physics. This explanation is related to the fact. That solid consist of a large number of atoms and molecules. The electrons and atoms of a solid can also be explained by using the laws of quantum mechanics. According to Maxwell distribution the density of photons is proportional to the exited atoms or electrons density. [1, 2]

Assume that the spectrum is formed due to the emission of free electrons surrounding the positive ion of solids. In this case the potential is negative and attractive.

The atomic spectra are used in mineral exploration. It is also used in identification of the elemental content of solids, liquids, plants, tissues and bloods. [3, 4]

These elemental contents are useful in understanding the behavior of earth curst, plants, living organisms as well as environmental pollution.

These wide applications of atomic spectrometer show the importance of this technique. However, the spectrometers are expensive and needs complex procedures to analyze results [5,6, 7]. Thus there is a need for simple spectral technique. One of the promising ones is the electrical method.

This electrical method was used by some researchers to find energy bands for semiconductors. [8, 9]

Unfortunately this method cannot identify minerals and conductors. Motivated by this new technique an experimental work was done to see how this electrical method can identify conductors by observing and determining the variation of conductivity with the frequency of current induced on it.

Section (2) is devoted for this experimental work. Section (3) is concerned with the results obtained.

The theoretical interpretation is in section (4), while sections (5) and (6) are the discussion and conclusion respectively.

II. Experimental Relation of Matter density and Magnetic Field with Resonance Frequency

In this experiment a transmitter coil emits electromagnetic waves.

These electromagnetic waves are allowed to incident on certain materials. The re emitted electromagnetic waves are receipted by a receiver.

(2-1) Apparatus:

- 10 Resistors (10kΩ, 2.2GΩ, 39kΩ),12 Capacitors (0.1μF, 0.01μF, 220μF), 6 Transistors (NPN)., 2 Coils (400,500, 600, 700, 1000 turns) , Wire connection, Speaker, Cathode Ray Oscillator, Board connection, Battery (9V), Signal generator.

(2-2) Samples:

A piece of metal (Cu, Al, Fe, Au, Ag, Sn)

(2-3) Method:

The transmitter coil current is varied by using signal generator. The emitted photons are allowed to incident on the sample. The sample absorps photons and re emit them. The metal detector design is the circuit which connected as shown in fig (3.1). The signals appearing at oscilloscope were taken before mounting the sample, and after photon emission. The frequency and the corresponding conductivity of sample are recorded and determined from signal generator, current, voltage, the length and cross sectional area of samples. The current and voltage gives resistance, which allows conductivity determination from the dimensions of the sample.

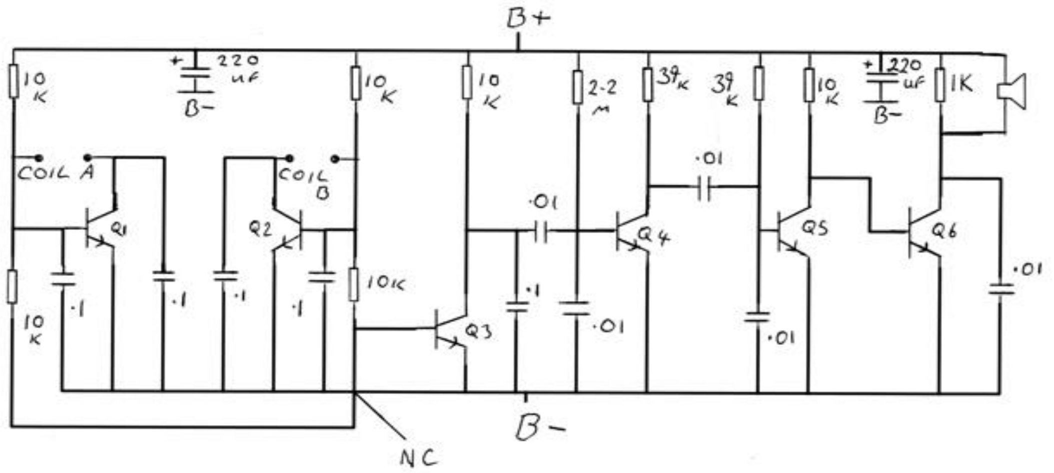

Fig (3-1)

(2-4) Tables and Results:

Table (2-4-1) Relation between frequency (f) and magnetic field in different voltages

Frequency (Hz)	magnetic field(μT) In 400mV	magnetic field(μT) In 200mV	magnetic field(μT) In 180mV
55.25746	194.53	96.73	90.94
47.48594	136.2	68.06	63.66
40.49329	116.7	58.33	54.6
35.4219	97.3	48.6	45
26.8109	77.8	38.9	36.4

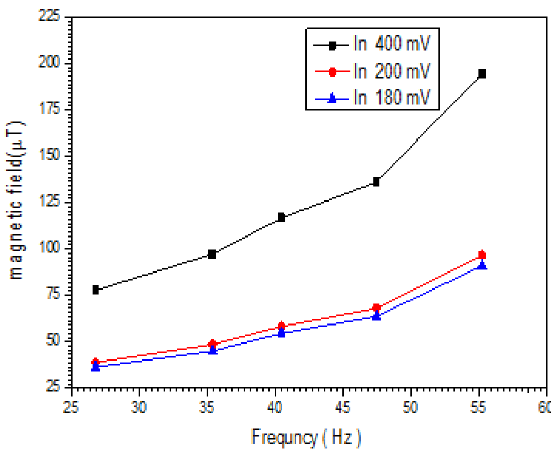

Fig (2-4-1-1) Relation between frequency (f) and magnetic field in different voltages

Table (2-4-2) Relation between frequency (f), Electron Affinity, Atomic number, and Density

elements	Frequency (Hz)	Electron Affinity(KJ/mole)	Atomic number(g/mole)	Density(kg/m3)
Al	56	44.2	13	2700
Fe	29	16	26	7870
Sn	34	116	50	7300
Ag	50	112	47	8900
Au	24	223	79	19300
Cu	27	118	29	8960

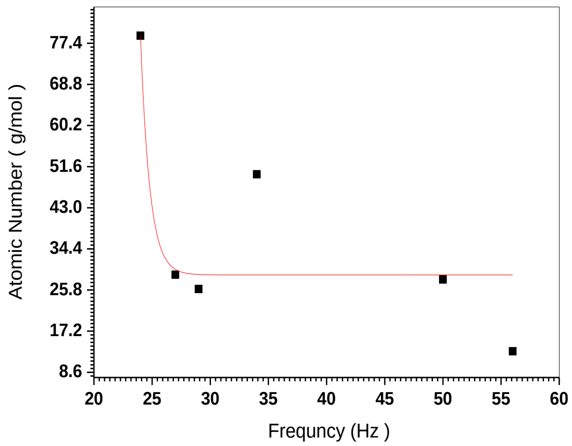

Fig (2-4-2-1) Relation between frequency and Atomic Number

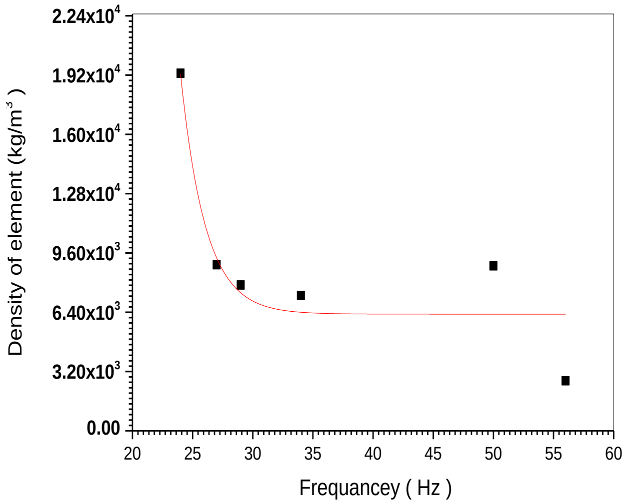

Fig (2-4-2-2) Relation between frequency and Density

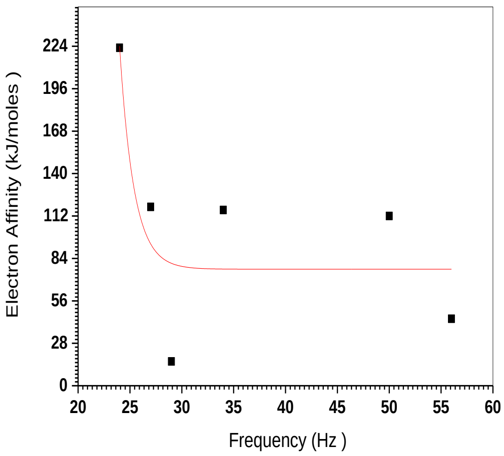

Fig (2-4-2-3) Relation between frequency and electron affinity

III. Zeeman effect and Statistical Theoretical Model

The Zeeman effect is the name given to the splitting of the energy levels of an atom when it is placed in an externally applied magnetic field. The occurs because of the interaction of the magnetic moment μ of the atom with magnetic field **B** slightly shifts the energy of the atomic levels by an amount

$$\Delta E = -\mu B \qquad (3\text{-}1)$$

This energy shift depends on the relative orientation of the magnetic moment and the magnetic field.
Nuclear magnetic resonance (NMR) and electron spin resonance (ESR) both depend on the Zeeman splitting of a single energy level within the atom.

The first order perturbation theory gives a corresponding energy shift by:

$$\Delta E = \mu_B g_s M_J H \qquad (3\text{-}2)$$

Where

M_J : is orbital angular momentum

g_s : is g-factors (Lande)

In the optical Zeeman effect atoms are excited to level above the ground state by, collisions with electrons in an electrical discharge .when they return to the ground state ,they emit by extra energy as a visible photon whose energy corresponds to the difference in energy between the excited and ground state.

According to Maxwell distribution the density of particles is given by

$$n = n_o e^{\frac{E}{\overline{E}}} \qquad (3\text{-}3)$$

Where $\overline{E}$ Stands for the uniform energy.

Assuming the oscillating frequency is uniform, then $\overline{E} = hf$

Therefore equation (4-3) becomes

$$n = n_o e^{\frac{-E}{hf}} \qquad (3\text{-}4)$$

It is quite natural to assume that the density of photons is proportional to the exited atoms or electrons density i.e.

$$n_p = C_0 n = C_0 n_o e^{\frac{-E}{hf}} \qquad (3\text{-}5)$$

By neglecting kinetic term, when the potential is very high in this case

$$E = -V_0 \qquad (3\text{-}6)$$

Therefore equation becomes (3.2)

$$n_p = C_0 n_o e^{\frac{V_0}{hf}} \qquad (3\text{-}7)$$

$$\frac{V_0}{h} \sim \frac{10^{-5}}{r_0}$$

For $r_0 \sim 10^{-5} m \ \frac{V_0}{h} \sim 1$ (3-8)

The light intensity of emitted photons is given by

$$I = Cn_p = CC_0 n_o e^{\frac{-V_0}{hf}} = I_0 e^{\frac{V_0}{hf}} \qquad (3\text{-}9)$$

By a suitable choice of (3-8) and using (3-9) parameters one can choose

$$I = I_0 e^{\frac{1}{f}}$$

$$I_0 = 10 \qquad (3\text{-}10)$$

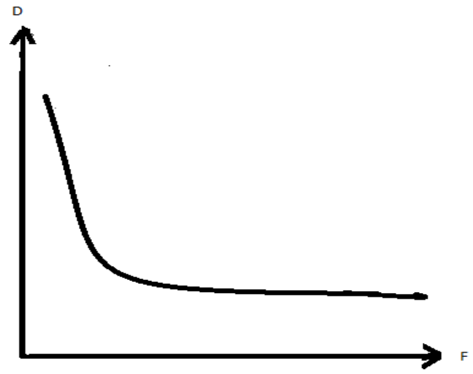

Fig (2-4-2-4) Relation between frequency and Density

IV. Discussion

The emprical relation between applied magnetic field and resonance frequency resembles the theoretical one which shows exponential decay in fig (2-4-1-1).This confirms the readability of work done.

The emprical relation between resonance frequency on one hand with matter density, atomic number and electron affinity on the other hand which shows exponential decay as in figs (2-4-2-1), (2-4-2-2) and (2-4-2-3) can be explained also on the basis of the statistical equation for non-equilibrium state as which shows relation between density and frequency theoretically Fig (2-4-2-4).

The relation for atomic number Z is related to the fact that the number of free electrons n_f is proportional to the atomic number Z where

$$n_f \propto Z - n_b$$

Where

n_b are the number of bounded electrons.

V. Conclusion

The emprical relation between resonance frequency of radiation and magnetic field obeys Zeeman effect relation. The statistical distribution law based on plasma equation for non-equilibrium systems can describe the relation between matter density and atomic number on one hand and the resonance natural frequency of matter on the other hand.

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