International Journal of Recent Advances in Multidisciplinary Topics
Volume 2, Issue 6, June 2021
https://www.ijramt.com | ISSN (Online): 2582-7839

Refractive Index of 0.4 Molar Paramagnetic FeCl3 Solution in Absence and in Presence of Non Uniform Magnetic field

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***Abstract*: Using hollow glass prism, Spectrometer and monochromatic Sodium source as a light source refractive index of 0.4 Molar FeCl3 solution was obtained in absence and in presence of non-uniform magnetic field at room temperature. It was found that refractive index of 0.4 molar paramagnetic FeCl3 solution is lesser in presence of non-uniform magnetic field than in absence of magnetic field. When non uniform magnetic field is applied across FeCl3 solution its refractive index decreases due to torque and magnetic force acting on magnetic dipole of the solution. Such torque and force causes paramagnetic matter to move from area of weaker to stronger magnetic field to create non uniform density in medium. Using Fermat principle it was concluded that refractive index of medium in presence of non-uniform magnetic field decreases**

***Keywords*: FeCl3, Non-uniform magnetic field, Paramagnets, Refractive index.**

1. Introduction

Refractive index of 0.4 molar paramagnetic FeCl3 solution was obtained in absence and in presence of non-uniform magnetic field produced by bar magnet having magnetic field 1500 gauss at its surface. Principle of Shuster's method and prism formula was used to calculate refractive index of medium [4] [5]. When prism filled with paramagnetic FeCl3 solution was placed in non-uniform magnetic field the magnetic dipole experienced torque and magnetic force [1]. Due to this force paramagnetic matter moved from area of lower magnetic field to area of higher magnetic field [2]. This resulted in formation of non-uniform density in medium. This caused some area in the medium in presence of non-uniform magnetic field to have density rarer than density of medium that would have been in absence of magnetic field. According to Fermat principle the path of light in the medium was the path which required lowest time to travel [3]. Thus the path having lowest density was chosen by light which followed increase in the velocity of light [6] in the medium when placed between the bar magnets. This might be the reason for decrease in refractive index of 0.4 molar paramagnetic FeCl3 solution [7].

2. Experiment

Figure (1) Experimental setup to determine refractive index of 0.4 molar FeCl3 solution in presence of non-uniform magnetic field 0.4 Molar concentration solution of Paramagnetic FeCl3 solution was prepared at room temperature. Telescope, collimator and prism table of spectrometer were aligned horizontally using spirit level. Cross wire was adjusted on fine slit illuminated by monochromatic Sodium light source. Prism filled with paramagnetic solution was placed on prism table with its base parallel to collimator and telescope. In absence of magnetic field angle of minimum deviation was obtained using Shuster's method [4]. To reduce error the procedure was repeated for five time. Substituting angle of prism A=60° in prism formula

$$\mu = \frac{\sin\{[A+\int m]/2\}}{\sin[A/2]} \quad [5]$$

Reduces to equation $\mu = 2*\sin[(60+\int m)/2]$…….. (1)

Where μ is the refractive index of desired medium. By using Equation (1) refractive index of 0.4 molar FeCl3 solution in absence of magnetic field was calculated. To determine refractive index of medium in presence of non-uniform magnetic field two bar magnets were arranged on both the side of prism table as shown in figure (1). By help of gauss meter magnetic field at surface of bar magnet was 1500 gauss and was observed to be 50 gauss above the centre of prism table. Prism filled with 0.4 molar FeCl3 solution was placed between two magnets on the prism table. Refractive index was calculated by working with same procedure used to compute refractive index in absence of magnetic field. Observation table to calculate refractive index of 0.4 Molar paramagnetic FeCl3 solution in absence and in presence of non-uniform magnetic field are given below.

3. Result and Discussion

Refractive index of 0.4 molar paramagnetic FeCl3 solution obtained in absence of magnetic field was 1.3831. Whereas Refractive index of same solution in presence of non-uniform magnetic field was 1.3803. Refractive index of the solution in presence of non-uniform magnetic field was lesser than in absence of magnetic field due to torque and magnetic force exerted on magnetic dipole [1] causing to formation of non

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Table 1
Paramagnetic FeCl3 solution in absence of magnetic field

S.no	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	194°40’	14°32’	167°02’	346°54’	27°38’	27°38’	27°38’
2	181°10’	1°07’	153°35’	333°24’	27°35’	27°43’	27°41’
3	168°14’	348°03’	140°36’	320°23’	27°38’	27°40’	27°39’
4	154°57’	334°44’	127°43’	307°27’	27°14’	27°17’	27°15’30”
5	139°17’	319°31’	292°13’	27°16’	27°16’	27°18’	27°17’

∫m= 27°30’06”

μ = 2*sin{[A+∫m]/2} = 1.3831

Table 2
Paramagnetic FeCl3 solution in presence of magnetic field

S.no	∫m position		Direct reading		difference		mean
	A’	B’	A	B	A’-A	B’-B	∫m
1	126°33’	306°18’	99°20’	279°03’	27°13’	27°15’	27°14’
2	89°42’	269°30’	62°25’	242°10’	27°17’	27°20’	27°18’30”
3	66°56’	246°47’	39°33’	219°35’	27°23	27°12’	27°17’30”
4	47°58’	227°57’	20°36’	200°40’	27°22’	27°17’	27°19’30”
5	34°0’	214°07’	6°44’	186°52’	27°16	27°15’	27°15’30”

∫m= 27°17’0”

μ = 2*sin{[A+∫m]/2}

μ = 1.3803

uniform density in the solution. With the help of Fermat principle [3] and relation between refractive index of the medium and velocity of light in the medium (μ = c/v) [7] it was concluded that refractive index of paramagnetic solution decreases if placed in non-uniform magnetic field.

4. Conclusion

It was concluded that refractive index of 0.4 molar paramagnetic FeCl3 solution is lesser in presence of non-uniform magnetic field than in absence of magnetic field. When non uniform magnetic field is applied across FeCl3 solution its refractive index decreased due to the magnetic force acting on paramagnetic dipole to form non uniform density in the medium [1].

5. Future Scope

This conclusion can be verified for different paramagnetic solution at different concentration and at different temperature. This experiment can also be repeated using strong magnets. If possible then refractive index of paramagnetic solution can be determined in uniform magnetic field.

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