INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Suchit Kumar Jena
Roll Number	:	186121027
Programme of Study	:	Ph.D.

Thesis Title: Geometrical Frustration in Jahn-Teller Active Spinel Pyrochlores

Name of Thesis Supervisor(s)	:	Prof. Subhash Thota
Thesis Submitted to the Department/ Center	:	Physics
Date of completion of Thesis Viva-Voce Exam	:	19-05-2023
Key words for description of Thesis Work	:	Spin-liquid, Spin-glass, magnetic frustration, Jahn-Teller effect, Spinel-Pyrochlore

SHORT ABSTRACT

Geometrical frustration (GF) in magnetic materials has attracted researchers of current era owing to their unusual physical properties, in which the origin of frustration is two-fold. The first and foremost requirement is the peculiar arrangement of the crystal lattice, while the second most important requirement is the nature of the magnetic ions occupying the specific lattice sites. Such GF phenomena is inherent in the specific lattice having corner-shared tetrahedral geometry, commonly known as the 'Pyrochlore lattice', where the fragile magnetic ground state leads to novel physical phenomena such as: Reentrant spin-glass state, Quantum spin-liquid/ice nature, Bipolar exchange-bias, and giant magneto-caloric-effect. In this context, spinel oxides (AB_2O_4) are considered to be the well-known systems which are prone to exhibit unusual magnetic properties because of their special features like competing exchange interactions (J_{AB}, J_{AA} and J_{BB}) and the topology of *B* sublattice. However, in the spinel-Pyrochlores only the *B* sublattice formulates a pyrochlore arrangement whereas *A* forms a diamond lattice. Therefore, tuning the magnetic interaction on the *B* site have shown much higher degrees of magnetic frustration. The GF phenomena in the spinel-Pyrochlore $ZnFe_2O_4$ (ZFO) was first predicted by Anderson in 1956, which was then experimentally unveiled to exhibit magnitude of frustration index $f = |\Theta_{CW}|/T_N$ as high as 12 (where the antiferromagnetic Néel temperature $T_N \simeq$ 10 K). In this research work, we attempt to lift the GF in cubic ZFO by compelling it to stabilize in the lower crystal structural symmetry (tetragonal) with incorporation of the Jahn-Teller (JT) active spin–1 Mn^{3+} on *B* site and additional dilution effect from another JT active spin–1/2 Cu^{2+}. Here the divalent Cu is capable of occupying both *A* and *B* sites and is expected to alter the exchange coupling significantly. The role of weakly magnetic Ru^{3+} substitution on the magnetic exchange interactions of ZFO has also been investigated. A systematic comparison of the change in magnetic ordering with the substitution of Ru^{3+} and Cu^{2+} are thoroughly studied in terms of the associated exchange interactions (J) along with the magnetic Field-Temperature (H–T) phase diagrams. Alongside, this work aims to probe the variations occurring in J_{AA}, J_{AB} and J_{BB} with increasing the Cu content in ZFO. Such Cu substitution in ZFO introduces complexity in the cationic distribution which leads to very high ferrimagnetic (FiM) ordering T_{FiM} ~ 743 K in the tetragonal $CuFe_2O_4$. Further, a comprehensive study of the magnetic and dielectric properties of the investigated systems are discussed considering their importance in the field of microwave and spintronic devices.