References:

[1] R. . Pathria, "Pathria, R K - Statistical Mechanics.pdf." Oxford, 2001.

[2] F. Reif, "Fundamentals of statistical and thermal physics (PDFDrive).pdf." McGraw-Hill, Boston, 1965.

[3] R. M. White, *Quantum Theory of Magnetism: Magnetic Properties of Materials*, vol. 32. 2007.

[4] S. Blundell, "Magnetism in Condensed Matter," *Magn. Condens. Matter (Oxford Univ. Press. Oxford)*, 2001, [Online]. Available: S. Blundell, Magnetism in Condensed Matter (Oxford%0AUniversity Press, Oxford, 2001).

[5] P. W. Anderson, "The concept of frustration in SGes," *J. Less-Common Met.*, vol. 62, no. C, pp. 291–294, 1978, doi: 10.1016/0022-5088(78)90040-1.

[6] G. R. Haripriya *et al.*, "Spin reorientation and disordered rare earth magnetism in Ho 2 FeCoO 6," *J. Phys. Condens. Matter*, vol. 29, no. 47, p. 475804, Nov. 2017, doi: 10.1088/1361-648X/aa919e.

[7] N. S. Rogado, J. Li, A. W. Sleight, and M. A. Subramanian, "Magnetocapacitance and magnetoresistance near room temperature in a ferromagnetic semiconductor: La2NiMnO6," *Adv. Mater.*, vol. 17, no. 18, pp. 2225–2227, 2005, doi: 10.1002/adma.200500737.

[8] J. Blasco *et al.*, "Magnetoelectric and structural properties of Y2CoMn O6: The role of antisite defects," *Phys. Rev. B*, vol. 93, no. 21, pp. 1–12, 2016, doi: 10.1103/PhysRevB.93.214401.

[9] D. Choudhury *et al.*, "Near-room-temperature colossal magnetodielectricity and multiglass properties in partially disordered La 2NiMnO 6," *Phys. Rev. Lett.*, vol. 108, no. 12, pp. 1–5, 2012, doi: 10.1103/PhysRevLett.108.127201.

[10] H. S. Nair, D. Swain, N. Hariharan, S. Adiga, C. Narayana, and S. Elzabeth, "Griffiths phase-like behavior and spin-phonon coupling in double perovskite Tb 2NiMnO 6," *J. Appl. Phys.*, vol. 110, no. 12, 2011, doi: 10.1063/1.3671674.

[11] T. Chakraborty, H. S. Nair, H. Nhalil, K. Ramesh Kumar, A. M. Strydom, and S. Elizabeth, "Disordered ferromagnetism in Ho 2 NiMnO 6 double perovskite," *J. Phys. Condens. Matter*, vol. 29, no. 2, 2017, doi: 10.1088/0953-8984/29/2/025804.

[12] J. Wang *et al.*, "Epitaxial BiFeO3 multiferroic thin film heterostructures," *Science (80-.).*, vol. 299, no. 5613, pp. 1719–1722, 2003, doi: 10.1126/science.1080615.

[13] S. Sharma, T. Basu, A. Shahee, K. Singh, N. P. Lalla, and E. V. Sampathkumaran, "Multiglass properties and magnetoelectric coupling in the uniaxial anisotropic spin-cluster-glass Fe2O5," *Phys. Rev. B*, vol. 90, no. 14, p. 144426, Oct. 2014, doi: 10.1103/PhysRevB.90.144426.

[14] T. Saha-Dasgupta, "Double perovskites with 3d and 4d/5d transition metals: Compounds with promises," *Mater. Res. Express*, vol. 7, no. 1, 2019, doi: 10.1088/2053-1591/ab6293.

[15] J. B. Goodenough, "Theory of the role of covalence in the perovskite-type manganites

[La,M(II)]MnO3," *Phys. Rev.*, vol. 100, no. 2, pp. 564–573, 1955, doi: 10.1103/PhysRev.100.564.

[16] R. I. Dass and J. B. Goodenough, " Multiple magnetic phases of La2CoMnO6−δ (0<~δ<~0.05) ," *Phys. Rev. B*, vol. 67, no. 1, pp. 1–9, 2003, doi: 10.1103/physrevb.67.014401.

[17] K. D. Truong, J. Laverdière, M. P. Singh, S. Jandl, and P. Fournier, "Impact of Co Mn cation ordering on phonon anomalies in La2 CoMn O6 double perovskites: Raman spectroscopy," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 76, no. 13, pp. 1–4, 2007, doi: 10.1103/PhysRevB.76.132413.

[18] A. Pal *et al.*, "B-site disorder driven multiple-magnetic phases: Griffiths phase, re-entrant cluster glass, and exchange bias in Pr $_2$ CoFeO $_6$," *Appl. Phys. Lett.*, vol. 114, no. 25, p. 252403, Jun. 2019, doi: 10.1063/1.5094905.

[19] S. Sachdev, "Quantum Phase Transitions," *Encycl. Math. Phys. Five-Volume Set*, no. 1, pp. 289–295, 2004, doi: 10.1016/B0-12-512666-2/00132-2.

[20] A. P. Ramirez, "Strongly geometrically frustrated magnets," *Annu. Rev. Mater. Sci.*, vol. 24, no. 1, pp. 453–480, 1994, doi: 10.1146/annurev.matsci.24.1.453.

[21] T. Haseda and A. R. Miedema, "Specific heat of Cu(NH3)4SO4.H2O below 1°K," *Physica*, vol. 27, no. 12, pp. 1102–1112, 1961, doi: 10.1016/0031-8914(61)90051-9.

[22] R. B. Flippen and S. A. Friedberg, "Low-temperature magnetic susceptibilities of some hydrated formates of Cu++ and Mn++," *J. Chem. Phys.*, vol. 38, no. 11, pp. 2652–2657, 1963, doi: 10.1063/1.1733567.

[23] G. R. Wagner and S. A. Friedberg, "Linear chain antiferromagnetism in Mn(HCOO)2 · 2H2O," *Phys. Lett.*, vol. 9, no. 1, pp. 11–13, Mar. 1964, doi: 10.1016/0031-9163(64)90194-5.

[24] D. Hone, C. Scherer, and F. Borsa, "Proton spin-lattice relaxation in TMMC [(CH3)4 NMnCl3]," *Phys. Rev. B*, vol. 9, no. 3, pp. 965–974, 1974, doi: 10.1103/PhysRevB.9.965.

[25] N. Motoyama, H. Eisaki, and S. Uchida, "Magnetic susceptibility of ideal spin 1/2 heisenberg antiferromagnetic chain systems, Sr2CuO3 and SrCuO2," *Phys. Rev. Lett.*, vol. 76, no. 17, pp. 3212–3215, 1996, doi: 10.1103/PhysRevLett.76.3212.

[26] D. Bitko, T. F. Rosenbaum, and G. Aeppli, "Quantum critical behavior for a model magnet," *Phys. Rev. Lett.*, vol. 77, no. 5, pp. 940–943, 1996, doi: 10.1103/PhysRevLett.77.940.

[27] R. Coldea *et al.*, "Quantum criticality in an ising chain: Experimental evidence for emergent e8 symmetry," *Science (80-.).*, vol. 327, no. 5962, pp. 177–180, 2010, doi: 10.1126/science.1180085.

[28] O. Breunig, M. Garst, A. Klümper, J. Rohrkamp, M. M. Turnbull, and T. Lorenz, "Quantum criticality in the spin-1/2 Heisenberg chain system copper pyrazine dinitrate," *Sci. Adv.*, vol. 3, no. 12, pp. 1–7, 2017, doi: 10.1126/sciadv.aao3773.

[29] I. A. Zaliznyak, C. Broholm, M. Kibune, M. Nohara, and H. Takagi, "Anisotropic spin freezing in the S=1/2 zigzag chain compound SrCuO2," *Phys. Rev. Lett.*, vol. 83, no. 25, pp. 5370–5373, 1999, doi: 10.1103/PhysRevLett.83.5370.

[30] A. Auerbach, *413941.pdf*. Springer, New York, 2012).

[31] E. Lieb, T. Schultz, and D. Mattis, "Two soluble models of an antiferromagnetic chain," *Ann. Phys. (N. Y).*, vol. 16, no. 3, pp. 407–466, 1961, doi: 10.1016/0003-4916(61)90115-4.

[32] J. P. Keating and F. Mezzadri, "Entanglement in quantum spin chains, symmetry classes of random matrices, and conformal field theory," *Phys. Rev. Lett.*, vol. 94, no. 5, pp. 1–4, 2005, doi: 10.1103/PhysRevLett.94.050501.

[33] R. Bursill, G. A. Gehring, D. J. J. Farnell, J. B. Parkinson, T. Xiang, and C. Zeng, "Numerical and approximate analytical results for the frustrated spin- 1/2 quantum spin chain," *J. Phys. Condens. Matter*, vol. 7, no. 45, pp. 8605–8618, 1995, doi: 10.1088/0953-8984/7/45/016.

[34] K. Wierschem and P. Sengupta, "Characterizing the Haldane phase in quasi-one-dimensional spin-1 Heisenberg antiferromagnets," *Mod. Phys. Lett. B*, vol. 28, no. 32, pp. 1–21, 2014, doi: 10.1142/S0217984914300178.

[35] R. Jafari and A. Langari, "Phase diagram of the one-dimensional S= 1 2 XXZ model with ferromagnetic nearest-neighbor and antiferromagnetic next-nearest-neighbor interactions," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 76, no. 1, pp. 1–7, 2007, doi: 10.1103/PhysRevB.76.014412.

[36] T. Hirano, H. Katsura, and Y. Hatsugai, "Topological classification of gapped spin chains: Quantized Berry phase as a local order parameter," *Phys. Rev. B*, vol. 77, no. 9, pp. 1–5, 2008, doi: 10.1103/physrevb.77.094431.

[37] F. Pollmann, E. Berg, A. M. Turner, and M. Oshikawa, "Symmetry protection of topological phases in one-dimensional quantum spin systems," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 85, no. 7, pp. 1–9, 2012, doi: 10.1103/PhysRevB.85.075125.

[38] F. D. M. Haldane, "Nonlinear field theory of large-spin Heisenberg antiferromagnets: Semiclassically quantized solitons of the one-dimensional easy-axis Néel state," *Phys. Rev. Lett.*, vol. 50, no. 15, pp. 1153–1156, 1983, doi: 10.1103/PhysRevLett.50.1153.

[39] F. D. M. Haldane, "Nobel lecture: Topological quantum matter," *Rev. Mod. Phys.*, vol. 89, no. 4, pp. 1–10, 2017, doi: 10.1103/RevModPhys.89.040502.

[40] N. D. Mermin and H. Wagner, "Absence of ferromagnetism or antiferromagnetism in one- or two-dimensional isotropic Heisenberg models," *Phys. Rev. Lett.*, vol. 17, no. 22, pp. 1133–1136, 1966, doi: 10.1103/PhysRevLett.17.1133.

[41] C. Yasuda *et al.*, "Néel temperature of quasi-low-dimensional Heisenberg antiferromagnets," *Phys. Rev. Lett.*, vol. 94, no. 21, pp. 5–8, 2005, doi: 10.1103/PhysRevLett.94.217201.

[42] H. J. Schulz, "Dynamics of coupled quantum spin chains," *Phys. Rev. Lett.*, vol. 77, no. 13, pp. 2790–2793, 1996, doi: 10.1103/PhysRevLett.77.2790.

[43] J. E. Greedan, "Geometrically frustrated magnetic materials," *J. Mater. Chem.*, vol. 11, no. 1, pp. 37–53, 2001, doi: 10.1039/b003682j.

[44] K. M. Kojima *et al.*, "Reduction of ordered moment and néel temperature of quasi-one-dimensional antiferromagnets Sr2CuO3 and Ca2CuO3," *Phys. Rev. Lett.*, vol. 78,

no. 9, pp. 1787–1790, 1997, doi: 10.1103/PhysRevLett.78.1787.

[45] T. Lancaster *et al.*, "Magnetic order in the quasi-one-dimensional spin- 12 molecular chain compound copper pyrazine dinitrate," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 2, pp. 1–4, 2006, doi: 10.1103/PhysRevB.73.020410.

[46] S. Furukawa, M. Sato, and S. Onoda, "Chiral order and electromagnetic dynamics in one-dimensional multiferroic cuprates," *Phys. Rev. Lett.*, vol. 105, no. 25, pp. 1–4, 2010, doi: 10.1103/PhysRevLett.105.257205.

[47] M. Hase, I. Terasaki, and K. Uchinokura, "Observation of the spin-Peierls transition in linear Cu2+ (spin-1/2) chains in an inorganic compound CuGeO3," *Phys. Rev. Lett.*, vol. 70, no. 23, pp. 3651–3654, 1993, doi: 10.1103/PhysRevLett.70.3651.

[48] S. L. Drechsler *et al.*, "Frustrated cuprate route from antiferromagnetic to ferromagnetic spin-12 heisenberg chains: Li2ZrCuO4 as a missing link near the quantum critical point," *Phys. Rev. Lett.*, vol. 98, no. 7, pp. 1–4, 2007, doi: 10.1103/PhysRevLett.98.077202.

[49] A. W. Garrett, S. E. Nagler, D. A. Tennant, B. C. Sales, and T. Barnes, "Magnetic excitations in the S=1/2 alternating chain compound (VO)_2P_2O_7," *Phys. Rev. Lett.*, vol. 79, no. 4, pp. 745–748, 1997, doi: 10.1103/PhysRevLett.79.745.

[50] N. H. Nam, T. N. Thuy, V. B. Hong, and T. N. Duc, "Origin of the forbidden phonons in Raman scattering spectra of uranium-doped Ca2CuO3, a spin 1/2 chain system," *J. Raman Spectrosc.*, vol. 40, no. 2, pp. 170–175, 2009, doi: 10.1002/jrs.2100.

[51] Z. He, T. Kyômen, and M. Itoh, "BaCu2V2O8: Quasi-one-dimensional alternating chain compound with a large spin gap," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 69, no. 22, pp. 1–4, 2004, doi: 10.1103/PhysRevB.69.220407.

[52] Z. He, Y. Ueda, and M. Itoh, "Synthesis, structure and magnetic properties of new vanadate PbCo2V2O8," *J. Solid State Chem.*, vol. 180, no. 5, pp. 1770–1774, May 2007, doi: 10.1016/j.jssc.2007.03.026.

[53] D. Dender, D. Davidović, D. H. Reich, C. Broholm, and K. Lefmann, "Magnetic properties of a quasi-one-dimensional S=1/2 antiferromagnet: Copper benzoate," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 53, no. 5, pp. 2583–2589, 1996, doi: 10.1103/PhysRevB.53.2583.

[54] C. Kittel, "Indirect Exchange Interactions in Metals," *Solid State Phys. - Adv. Res. Appl.*, vol. 22, no. C, pp. 1–26, 1969, doi: 10.1016/S0081-1947(08)60030-2.

[55] E. C. P. D. D. G. J. S. Miller, "Molecular Magnetism: From Molecular Assemblies to the Devices," *Dordr. Springer Netherlands,* vol. NATO ASI s, 1996.

[56] J. B. Neaton, C. Ederer, U. V. Waghmare, N. A. Spaldin, and K. M. Rabe, "First-principles study of spontaneous polarization in multiferroic BiFeO 3," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 71, no. 1, pp. 1–8, 2005, doi: 10.1103/PhysRevB.71.014113.

[57] P. W. Anderson, "Antiferromagnetism. Theory of Suyerexchange," *Phys. Rev.*, vol. 79, no. 2, pp. 350–356, 1950.

[58] J. Kanamori, "Superexchange interaction and symmetry properties of electron orbitals," *J. Phys. Chem. Solids*, vol. 10, no. 2–3, pp. 87–98, 1959, doi: 10.1016/0022-

3697(59)90061-7.

[59] H. A. Kramers, “L’INTERACTION ENTRE LES ATOMES MAGNF~TO- GENES DANS UN CRISTAL PARAMAGNETIQUE par H. A. K R A M E R S,” *Physica*, p. 182, 1934.

[60] A. Millis, “Orbital ordering and superexchange in manganite oxides,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 55, no. 10, pp. 6405–6408, 1997, doi: 10.1103/PhysRevB.55.6405.

[61] C. Kittel, “Symposium on exchange-introduction,” *Rev. Mod. Phys.*, vol. 25, no. 1, p. 191, 1953, doi: 10.1103/RevModPhys.25.191.

[62] P. W. Anderson, “Considerations on Double Exchange,” *Phys. Rev.*, vol. 320, no. 1937, 1955.

[63] J. Dho, W. S. Kim, and N. H. Hur, “Reentrant Spin Glass Behavior in Cr-Doped Perovskite Manganite,” *Phys. Rev. Lett.*, vol. 89, no. 2, p. 027202, Jun. 2002, doi: 10.1103/PhysRevLett.89.027202.

[64] I. A. Campbell and L. Bernardi, “Frustration, randomness, and the spin-glass transition,” *Phys. Rev. B*, vol. 52, no. 14, pp. 9819–9823, 1995.

[65] R. Nath *et al.*, “Strong frustration due to competing ferromagnetic and antiferromagnetic interactions : Magnetic properties of M (VO) 2 (PO 4) 2 (M = Ca and Sr),” vol. 2, pp. 1–13, 2008, doi: 10.1103/PhysRevB.78.024418.

[66] K. Jonason, P. Nordblad, E. Vincent, J. Hammann, and J. Bouchaud, “Memory interference effects in spin glasses,” *Eur. Phys. J. B*, vol. 105, pp. 99–105, 2000.

[67] E. P. Wohlfarth, “THE THEORY OF THE VOGEL—FULCHER LAW OF SPIN GLASSES S. SHTRIKMAN a and E.P. WOHLFARTH,” vol. 85, no. 8, pp. 467–470, 1981.

[68] T. Mori and H. Mamiya, “Dynamical properties of a crystalline rare-earth boron cluster spin-glass system,” pp. 3–7, 2003, doi: 10.1103/PhysRevB.68.214422.

[69] R. Kohlrausch., “Theorie des elektrischen Rückstandes in der Leidener Flasche,” *Annalen_der_Physik_und_Chemie*, vol. 91, pp. 179–213, 1854, doi: 10.1002/andp.18541670203.

[70] Y GRAHAM WILLIAMS AND DAVID C. WATT, “Non-Symmetrical Dielectric Relaxation Behaviour Arising from a Simple Empirical Decay Function,” no. 1, pp. 80–85, 1969.

[71] S. Ghara, B. G. Jeon, K. Yoo, K. H. Kim, and A. Sundaresan, “Reentrant spin-glass state and magnetodielectric effect in the spiral magnet BiMnFe2 O6,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 90, no. 2, pp. 1–7, 2014, doi: 10.1103/PhysRevB.90.024413.

[72] A. Ito, H. Aruga, and E. Torikai, “Time-Dependent Phenomena in a Short-Range Ising Spin-Glass , Feo . sMno . sTiOa,” vol. 57, no. July, pp. 483–486, 1986.

[73] R. B. Griffiths, “Nonanalytic Behavior Above the Critical Point in a Random Ising Ferromagnet,” *Phys. Rev. Lett.*, vol. 23, no. 1, pp. 17–19, Jul. 1969, doi: 10.1103/PhysRevLett.23.17.

[74] A. J. Bray and M. A. Moore, "On the eigenvalue spectrum of the susceptibility matrix for random spin systems," *J. Phys. C Solid State Phys.*, vol. 15, no. 23, pp. L765–L771, Aug. 1982, doi: 10.1088/0022-3719/15/23/008.

[75] M. B. Salamon, P. Lin, and S. H. Chun, "Colossal magnetoresistance is a Griffiths singularity," *Phys. Rev. Lett.*, vol. 88, no. 19, pp. 1972031–1972034, 2002, doi: 10.1103/PhysRevLett.88.197203.

[76] W. H. Meiklejohn and C. P. Bean, "New Magnetic Anisotropy," *Phys. Rev.*, vol. 102, no. 5, pp. 1413–1414, Jun. 1956, doi: 10.1103/PhysRev.102.1413.

[77] A. Punnoose, H. Magnone, and M. S. Seehra, "Bulk to nanoscale magnetism and exchange bias in CuO nanoparticles," vol. 64, pp. 1–8, 2001, doi: 10.1103/PhysRevB.64.174420.

[78] Y. B. Yang *et al.*, "Structure and exchange bias of Ni50Mn37Sn13 ribbons Structure and exchange bias of Ni 50 Mn 37 Sn 13 ribbons," vol. 916, no. 2012, pp. 2010–2013, 2015, doi: 10.1063/1.3672244.

[79] W. Yuan, T. Su, Q. Song, W. Xing, Y. Chen, and T. Wang, "Crystal Structure Manipulation of the Exchange Bias in an Antiferromagnetic Film," *Nat. Publ. Gr.*, no. June, pp. 1–8, 2016, doi: 10.1038/srep28397.

[80] S. K. S. Patel, J. H. Lee, M. K. Kim, B. Bhoi, and S. K. Kim, "Single-crystalline Gd-doped BiFeO3 nanowires:: R 3 c -to- Pn 21 a phase transition and enhancement in high-coercivity ferromagnetism," *J. Mater. Chem. C*, vol. 6, no. 3, pp. 526–534, 2018, doi: 10.1039/c7tc05362b.

[81] L. Wee, R. L. Stamps, L. Malkinski, Z. Celinski, and D. Skrzypek, "Thermal training of exchange bias in epitaxial Fe/KNiF3," *Phys. Rev. B*, vol. 69, no. 13, p. 134425, Apr. 2004, doi: 10.1103/PhysRevB.69.134425.

[82] C. Jin *et al.*, "Exchange bias in flexible freestanding La0.7Sr0.3MnO3/BiFeO3membranes," *Appl. Phys. Lett.*, vol. 117, no. 25, pp. 0–6, 2020, doi: 10.1063/5.0032693.

[83] F. Tian *et al.*, "Giant spontaneous exchange bias triggered by crossover of superspin glass in Sb-doped Ni 50 Mn 38 Ga 12 Heusler alloys," *Nat. Publ. Gr.*, no. July, pp. 1–8, 2016, doi: 10.1038/srep30801.

[84] C. Zobel *et al.*, "Evidence for a low-spin to intermediate-spin state transition in LaCoO3," *Phys. Rev. B*, vol. 66, no. 2, p. 020402, Jun. 2002, doi: 10.1103/PhysRevB.66.020402.

[85] M. W. Haverkort *et al.*, "Spin State Transition in LaCoO3 studied Using Soft X-ray Absorption Spectroscopy and Magnetic Circular Dichroism," *Phys. Rev. Lett.*, vol. 97, no. 17, p. 176405, Oct. 2006, doi: 10.1103/PhysRevLett.97.176405.

[86] Z. Hu *et al.*, "Different look at the spin state of Co3+ ions in a CoO 5 pyramidal coordination," *Phys. Rev. Lett.*, vol. 92, no. 20, pp. 3–6, 2004, doi: 10.1103/PhysRevLett.92.207402.

[87] H. Wu and T. Burnus, "Spin and orbital states in La1.5 Sr0.5 CoO 4 studied by electronic structure calculations," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 80, no. 8, pp. 3–6, 2009, doi: 10.1103/PhysRevB.80.081105.

[88] J. B. Goodenough, “Theory of the Role of Covalence in the Perovskite-Type Manganites [La,M(II)]MnO3,” *Phys. Rev.*, vol. 100, no. 2, pp. 564–573, Oct. 1955, doi: 10.1103/PhysRev.100.564.

[89] J. C. W. and R. L. White, “Study of magnetic interactions in HoFeO3,” vol. 10, no. 11, 1974.

[90] D. Meier *et al.*, “Mutual induction of magnetic 3 d and 4 f order in multiferroic hexagonal ErMnO 3,” vol. 184415, pp. 1–8, 2012, doi: 10.1103/PhysRevB.86.184415.

[91] J. Hemberger, S. Lobina, N. Tristan, A. A. Mukhin, A. M. Balbashov, and A. Loidl, “Complex interplay of 3 d and 4 f magnetism in La 1 − x Gd x MnO 3,” vol. 024414, pp. 1–8, 2004, doi: 10.1103/PhysRevB.70.024414.

[92] F. Shuai-shuai and Q. Hao-xue, “Spectral properties of endohedrally confined helium atom * Spectral properties of endohedrally confined helium atom ∗,” 2015, doi: 10.1088/1674-1056/24/8/083101.

[93] Cao Ze-Xian, “Intermediate sp-hybridization for chemical bonds in nonplanar covalent molecules of carbon Intermediate ?? -hybridization for chemical bonds in nonplanar covalent molecules of carbon,” 2014, doi: 10.1088/1674-1056/23/6/063102.

[94] Y. Guo, R. Yu, R. Zhang, X. Zhang, and K. Tao, “Calculation of Magnetic Properties and Analysis of Valence Electronic Structures of,” vol. 5647, no. 97, pp. 9–16, 1998.

[95] C. Lin, G. Yin, and Y. Zhao, “Calculation of the cohesive energy of solids with the use of valence electron structure parameters,” *Comput. Mater. Sci.*, vol. 101, pp. 168–174, 2015, doi: 10.1016/j.commatsci.2015.01.026.

[96] P. G. KLEMENS, “Anhaimonic Decay of Optical Phonons,” vol. 659, 1966.

[97] E. Granado *et al.*, “Magnetic ordering effects in the Raman spectra of La1-xMn1-xO3,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 60, no. 17, pp. 11879–11882, 1999, doi: 10.1103/physrevb.60.11879.

[98] A. Pal *et al.*, “Interplay of lattice, spin, and dipolar properties in CoTeMoO6: Emergence of Griffiths-like phase, metamagnetic transition, and magnetodielectric effect,” *Phys. Rev. B*, vol. 105, no. 2, p. 024420, Jan. 2022, doi: 10.1103/PhysRevB.105.024420.

[99] M. A. Prosnikov, A. N. Smirnov, V. Y. Davydov, Y. Araki, T. Arima, and R. V. Pisarev, “Lattice and magnetic dynamics in the polar, chiral, and incommensurate antiferromagnet Ni2InSbO6,” *Phys. Rev. B*, vol. 100, no. 14, p. 144417, Oct. 2019, doi: 10.1103/PhysRevB.100.144417.

[100] W. Baltensperger, J.S. Helman, “Influence of magnetic order in insulators on the optical phonon frequency,” *Helv. Phys. Act*, vol. 68, no. 11, p. 48, 1968.

[101] J A Mydosh, “Spin glasses: an experimental introduction. London: Taylor & Francis.,” in *Spin glasses: an experimental introduction*, London: Taylor and Francis, 1993, pp. 64–76.

[102] K. Binder and A. P. Young, “Spin glasses: Experimental facts, theoretical concepts, and open questions,” *Rev. Mod. Phys.*, vol. 58, no. 4, pp. 801–976, Oct. 1986, doi: 10.1103/RevModPhys.58.801.

[103] C. Djurberg, P. Svedlindh, and P. Nordblad, “Dynamics of an interacting particle system: Evidence of critical slowing down,” *Phys. Rev. Lett.*, vol. 79, no. 25, pp. 5154–5157, 1997, doi: 10.1103/PhysRevLett.79.5154.

[104] M. D. Mukadam, S. M. Yusuf, P. Sharma, S. K. Kulshreshtha, and G. K. Dey, “Dynamics of spin clusters in amorphous Fe2O3,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 72, no. 17, pp. 1–7, 2005, doi: 10.1103/PhysRevB.72.174408.

[105] J. Krishna Murthy and A. Venimadhav, “Giant zero field cooled spontaneous exchange bias effect in phase separated La 1.5 Sr 0.5 CoMnO 6,” *Appl. Phys. Lett.*, vol. 103, no. 25, p. 252410, Dec. 2013, doi: 10.1063/1.4855135.

[106] L. Shlyk, S. Strobel, B. Farmer, L. E. De Long, and R. Niewa, “Coexistence of ferromagnetism and unconventional spin-glass freezing in the site-disordered kagome ferrite SrS n2 F e4 O11,” *Phys. Rev. B*, vol. 97, no. 5, pp. 1–11, 2018, doi: 10.1103/PhysRevB.97.054426.

[107] A. K. Pramanik and A. Banerjee, “Finite-size effect on evolution of Griffiths phase in manganite nanoparticles,” *J. Phys. Condens. Matter*, vol. 28, no. 35, 2016, doi: 10.1088/0953-8984/28/35/35LT02.

[108] A. K. Pramanik and A. Banerjee, “Griffiths phase and its evolution with Mn-site disorder in the half-doped manganite Pr 0.5 Sr 0.5 Mn 1-y Ga y O 3 (y=0.0, 0.025, and 0.05),” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 81, no. 2, pp. 1–5, 2010, doi: 10.1103/PhysRevB.81.024431.

[109] C. Magen *et al.*, “Observation of a Griffiths-like Phase in the Magnetocaloric Compound Tb5Si2Ge2,” *Phys. Rev. Lett.*, vol. 96, no. 16, p. 167201, Apr. 2006, doi: 10.1103/PhysRevLett.96.167201.

[110] A. K. Singh, P. Balasubramanian, A. Singh, M. K. Gupta, and R. Chandra, “Structural transformation, Griffiths phase and metal-insulator transition in polycrystalline Nd 2−x Sr x NiMnO 6 (x = 0, 0.2, 0.4, 0.5 and 1) compound,” *J. Phys. Condens. Matter*, vol. 30, no. 35, p. 355401, Sep. 2018, doi: 10.1088/1361-648X/aad573.

[111] A. Karmakar, S. Majumdar, S. Kundu, T. K. Nath, and S. Giri, “A Griffiths-like phase in antiferromagnetic R0.5Eu 0.5MnO3 (R = Pr, Nd, Sm),” *J. Phys. Condens. Matter*, vol. 25, no. 6, p. 066006, 2013, doi: 10.1088/0953-8984/25/6/066006.

[112] M. Ali, P. Adie, C. H. Marrows, D. Greig, B. J. Hickey, and R. L. Stamps, “Exchange bias using a spin glass,” *Nat. Mater.*, vol. 6, no. 1, pp. 70–75, Jan. 2007, doi: 10.1038/nmat1809.

[113] B. M. Wang *et al.*, “Large Exchange Bias after Zero-Field Cooling from an Unmagnetized State,” *Phys. Rev. Lett.*, vol. 106, no. 7, p. 077203, Feb. 2011, doi: 10.1103/PhysRevLett.106.077203.

[114] S. Giri, M. Patra, and S. Majumdar, “Exchange bias effect in alloys and compounds,” *J. Phys. Condens. Matter*, vol. 23, no. 7, p. 073201, Feb. 2011, doi: 10.1088/0953-8984/23/7/073201.

[115] S. Kumar, G. Giovannetti, J. Van Den Brink, and S. Picozzi, “Theoretical prediction of multiferroicity in double perovskite Y 2NiMnO6,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 82, no. 13, pp. 1–6, 2010, doi: 10.1103/PhysRevB.82.134429.

[116] S. L. Wang *et al.*, “Structural, magnetic and electrical transport properties of double

perovskite Tb 2 MnCoO 6," *J. Mater. Res.*, vol. 31, no. 8, pp. 1038–1045, Apr. 2016, doi: 10.1557/jmr.2016.112.

[117] J. Y. Moon *et al.*, "Anisotropic magnetic properties and giant rotating magnetocaloric effect in double-perovskite Tb2CoMnO6," *Phys. Rev. B*, vol. 98, no. 17, p. 174424, Nov. 2018, doi: 10.1103/PhysRevB.98.174424.

[118] T. Aoyama, K. Yamauchi, A. Iyama, S. Picozzi, K. Shimizu, and T. Kimura, "Giant spin-driven ferroelectric polarization in TbMnO3 under high pressure," *Nat. Commun.*, vol. 5, no. May, pp. 1–7, 2014, doi: 10.1038/ncomms5927.

[119] M. Kenzelmann *et al.*, "Magnetic Inversion Symmetry Breaking and Ferroelectricity in TbMnO3," *Phys. Rev. Lett.*, vol. 95, no. 8, p. 087206, 2005, doi: 10.1103/PhysRevLett.95.087206.

[120] N. Aliouane, D. N. Argyriou, J. Strempfer, I. Zegkinoglou, S. Landsgesell, and M. V. Zimmermann, "Field-induced linear magnetoelastic coupling in multiferroic TbMnO3," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 2, pp. 2–5, 2006, doi: 10.1103/PhysRevB.73.020102.

[121] A. Pal *et al.*, "Investigation of multi-mode spin–phonon coupling and local B-site disorder in Pr 2 CoFeO 6 by Raman spectroscopy and correlation with its electronic structure by XPS and XAS studies," *J. Phys. Condens. Matter*, vol. 31, no. 27, p. 275802, Jul. 2019, doi: 10.1088/1361-648X/ab144f.

[122] M. P. Singh, K. D. Truong, S. Jandl, and P. Fournier, "Magnetic properties and phonon behavior of Pr2 NiMnO6 thin films," *Appl. Phys. Lett.*, vol. 98, no. 16, pp. 10–13, 2011, doi: 10.1063/1.3575564.

[123] K. D. Truong, M. P. Singh, S. Jandl, and P. Fournier, "Investigation of phonon behavior in Pr2NiMnO6 by micro-Raman spectroscopy," *J. Phys. Condens. Matter*, vol. 23, no. 5, 2011, doi: 10.1088/0953-8984/23/5/052202.

[124] W. Liu, L. Shi, S. Zhou, J. Zhao, Y. Li, and Y. Guo, "Griffiths phase, spin-phonon coupling, and exchange bias effect in double perovskite Pr2CoMnO6," *J. Appl. Phys.*, vol. 116, no. 19, pp. 2012–2017, 2014, doi: 10.1063/1.4902078.

[125] A. Pal *et al.*, "B-site spin-state and anti-site disorder driven multiple-magnetic phases: Griffiths phase, re-entrant cluster glass and exchange bias in double perovskite Pr$_2$CoFeO$_6$.," *arXiv Mater. Sci.*, doi: arXiv:1810.09788v1.

[126] F. D. M. Haldane, "Continuum dynamics of the 1-D Heisenberg antiferromagnet: Identification with the O(3) nonlinear sigma model," *Phys. Lett. A*, vol. 93, no. 9, pp. 464–468, 1983, doi: 10.1016/0375-9601(83)90631-X.

[127] S. K. Satija, J. D. Axe, G. Shirane, H. Yoshizawa, and K. Hirakawa, "Neutron scattering study of spin waves in one-dimensional antiferromagnet KCuF3," *Phys. Rev. B*, vol. 21, no. 5, pp. 2001–2007, 1980, doi: 10.1103/PhysRevB.21.2001.

[128] A. Zheludev *et al.*, "Magnetic excitations in coupled Haldane spin chains near the quantum critical point," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 62, no. 13, pp. 8921–8930, 2000, doi: 10.1103/PhysRevB.62.8921.

[129] A. K. Bera, B. Lake, A. T. M. N. Islam, B. Klemke, E. Faulhaber, and J. M. Law, "Field-induced magnetic ordering and single-ion anisotropy in the quasi-one-dimensional Haldane chain compound SrNi2V2O 8: A single-crystal investigation,"

Phys. Rev. B - Condens. Matter Mater. Phys., vol. 87, no. 22, pp. 1–10, 2013, doi: 10.1103/PhysRevB.87.224423.

[130] T. Sakai and M. Takahashi, "Effect of the Haldane gap on quasi-one-dimensional systems," *Phys. Rev. B*, vol. 42, no. 7, pp. 4537–4543, 1990, doi: 10.1103/PhysRevB.42.4537.

[131] A. K. Bera, B. Lake, W. D. Stein, and S. Zander, "Magnetic correlations of the quasi-one-dimensional half-integer spin-chain antiferromagnets SrM2V2O8 (M = Co, Mn)," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 89, no. 9, pp. 1–13, 2014, doi: 10.1103/PhysRevB.89.094402.

[132] P. Lejay, E. Canevet, S. K. Srivastava, B. Grenier, M. Klanjsek, and C. Berthier, "Crystal growth and magnetic property of MCo2V2O 8 (M=Sr and Ba)," *J. Cryst. Growth*, vol. 317, no. 1, pp. 128–131, 2011, doi: 10.1016/j.jcrysgro.2011.01.016.

[133] E. S. Klyushina *et al.*, "Investigation of the spin-1 honeycomb antiferromagnet BaNi2V2O8 with easy-plane anisotropy," *Phys. Rev. B*, vol. 96, no. 21, pp. 1–14, 2017, doi: 10.1103/PhysRevB.96.214428.

[134] A. K. Bera and S. M. Yusuf, "Quantum phase transition from a spin-liquid state to a spin-glass state in the quasi-one-dimensional spin-1 system Sr 1-xCa xNi 2V 2O 8," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 86, no. 2, pp. 1–9, 2012, doi: 10.1103/PhysRevB.86.024408.

[135] K. Ghoshray, B. Pahari, B. Bandyopadhyay, R. Sarkar, and A. Ghoshray, "V51 NMR study of the quasi-one-dimensional alternating chain compound BaCu2V2O8," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 71, no. 21, pp. 1–7, 2005, doi: 10.1103/PhysRevB.71.214401.

[136] Y. Uchiyama *et al.*, "Spin-vacancy-induced long-range order in a new haldane-gap antiferromagnet," *Phys. Rev. Lett.*, vol. 83, no. 3, pp. 632–635, 1999, doi: 10.1103/PhysRevLett.83.632.

[137] V. Kurnosov *et al.*, "Phonon excitations in the quasi-one-dimensional Haldane phase of SrNi2V2O8," *Low Temp. Phys.*, vol. 43, no. 12, pp. 1405–1414, 2017, doi: 10.1063/1.5012793.

[138] S. K. Niesen, O. Heyer, T. Lorenz, and M. Valldor, "Antiferromagnetic heisenberg S=5/2 spin chain compound SrMn 2V2O8," *J. Magn. Magn. Mater.*, vol. 323, no. 21, pp. 2575–2578, 2011, doi: 10.1016/j.jmmm.2011.05.056.

[139] Z. He, T. Taniyama, T. Kyômen, and M. Itoh, "Field-induced order-disorder transition in the quasi-one-dimensional anisotropic antiferromagnet BaCo2V2O8," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 72, no. 17, pp. 3–6, 2005, doi: 10.1103/PhysRevB.72.172403.

[140] Y. Cui *et al.*, "Quantum Criticality of the Ising-like Screw Chain Antiferromagnet SrCo2 V2 O8 in a Transverse Magnetic Field," *Phys. Rev. Lett.*, vol. 123, no. 6, pp. 2–7, 2019, doi: 10.1103/PhysRevLett.123.067203.

[141] Z. He, T. Taniyama, and M. Itoh, "Antiferromagnetic-paramagnetic transitions in longitudinal and transverse magnetic fields in a Sr Co2 V2 O8 crystal," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 21, pp. 6–9, 2006, doi: 10.1103/PhysRevB.73.212406.

[142] Z. He and Y. Ueda, "Quantum phase transition in quasi-one-dimensional spin-1 system SrNi 2V2O8 induced by cation substitution," *J. Phys. Soc. Japan*, vol. 77, no. 1, pp. 1–4, 2008, doi: 10.1143/JPSJ.77.013703.

[143] B. Pahari, K. Ghoshray, R. Sarkar, B. Bandyopadhyay, and A. Ghoshray, "NMR study of V51 in quasi-one-dimensional integer spin chain compound Sr Ni2 V2 O8," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 1, pp. 5–8, 2006, doi: 10.1103/PhysRevB.73.012407.

[144] Z. He, Y. Ueda, and M. Itoh, "Magnetic properties of the quasi-one-dimensional system BaMn2V 2O8," *Solid State Commun.*, vol. 141, no. 1, pp. 22–24, 2007, doi: 10.1016/j.ssc.2006.09.043.

[145] W. Rontgen, "Diffraction of X-rays," pp. 1–33, 1895.

[146] "National Facility for Neutron Beam Research [NFNBR]," [Online]. Available: http://14.139.62.172/mumbai/nfnbr-book-R.pdf.

[147] "No Title," [Online]. Available: https://oxfordre.com/physics/doc/10.1093/acrefore/9780190871994.001.0001/acrefore-9780190871994-e-32-graphic-003-full.gif.

[148] "No Title," [Online]. Available: https://adreasnow.com/Undergrad/Notes/Sem 6. Advanced Analytical/Surface Analytical Tech/10b/#xps-schematic.

[149] "No Title," [Online]. Available: https://en.wikipedia.org/wiki/Raman_spectroscopy.

[150] J. Kowalska and S. Debeer, "The role of X-ray spectroscopy in understanding the geometric and electronic structure of nitrogenase Biochimica et Biophysica Acta The role of X-ray spectroscopy in understanding the geometric and electronic structure of nitrogenase ☆," *BBA - Mol. Cell Res.*, no. March, 2015, doi: 10.1016/j.bbamcr.2014.11.027.

[151] G. Van Der Laan and A. I. Figueroa, "X-ray magnetic circular dichroism — A versatile tool to study magnetism," *Coord. Chem. Rev.*, vol. 277–278, pp. 95–129, 2014, doi: 10.1016/j.ccr.2014.03.018.

[152] M. Fiebig, T. Lottermoser, D. Fröhlich, A. V. Goltsev, and R. V. Pisarev, "Observation of coupled magnetic and electric domains," *Nature*, vol. 419, no. 6909, pp. 818–820, Oct. 2002, doi: 10.1038/nature01077.

[153] Y. Kitagawa, Y. Hiraoka, T. Honda, T. Ishikura, H. Nakamura, and T. Kimura, "Low-field magnetoelectric effect at room temperature," *Nat. Mater.*, vol. 9, no. 10, pp. 797–802, Oct. 2010, doi: 10.1038/nmat2826.

[154] S.-W. Cheong and M. Mostovoy, "Multiferroics: a magnetic twist for ferroelectricity," *Nat. Mater.*, vol. 6, no. 1, pp. 13–20, Jan. 2007, doi: 10.1038/nmat1804.

[155] J. Wang, "Epitaxial BiFeO3 Multiferroic Thin Film Heterostructures," *Science (80-.).*, vol. 299, no. 5613, pp. 1719–1722, Mar. 2003, doi: 10.1126/science.1080615.

[156] S. H. Baek *et al.*, "Ferroelastic switching for nanoscale non-volatile magnetoelectric devices," *Nat. Mater.*, vol. 9, no. 4, pp. 309–314, Apr. 2010, doi: 10.1038/nmat2703.

[157] K.-I. Kobayashi, T. Kimura, H. Sawada, K. Terakura, and Y. Tokura, "Room-temperature magnetoresistance in an oxide material with an ordered double-perovskite

structure," *Nature*, vol. 395, no. 6703, pp. 677–680, Oct. 1998, doi: 10.1038/27167.

[158] A. K. Singh, R. Hembrom, A. Sisodia, A. K. Pal, and Asmita, "Effect of iron and zinc on flowering and postharvest life in gladiolus (Gladiolus spp.)," *Indian J. Agric. Sci.*, vol. 86, no. 10, 2016.

[159] M. P. Singh, K. D. Truong, S. Jandl, and P. Fournier, "Long-range Ni/Mn structural order in epitaxial double perovskite La2 NiMnO6 thin films," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 79, no. 22, pp. 1–6, 2009, doi: 10.1103/PhysRevB.79.224421.

[160] H. Guo, J. Burgess, S. Street, A. Gupta, T. G. Calvarese, and M. A. Subramanian, "Growth of epitaxial thin films of the ordered double perovskite La 2NiMnO 6 on different substrates," *Appl. Phys. Lett.*, vol. 89, no. 2, 2006, doi: 10.1063/1.2221894.

[161] R. B. Macedo Filho, A. Pedro Ayala, and C. William de Araujo Paschoal, "Spin-phonon coupling in Y 2 NiMnO 6 double perovskite probed by Raman spectroscopy," *Appl. Phys. Lett.*, vol. 102, no. 19, p. 192902, May 2013, doi: 10.1063/1.4804988.

[162] J. Krishna Murthy, K. D. Chandrasekhar, H. C. Wu, H. D. Yang, J. Y. Lin, and A. Venimadhav, "Antisite disorder driven spontaneous exchange bias effect in La 2-x Sr x CoMnO 6 ($0 \leq x \leq 1$)," *J. Phys. Condens. Matter*, vol. 28, no. 8, 2016, doi: 10.1088/0953-8984/28/8/086003.

[163] R. Yadav and S. Elizabeth, "Magnetic frustration and dielectric relaxation in insulating Nd 2 NiMnO 6 double perovskites," *J. Appl. Phys.*, vol. 117, no. 5, p. 053902, Feb. 2015, doi: 10.1063/1.4906989.

[164] Y. Q. Lin and X. M. Chen, "Dielectric relaxation and polaronic conduction in double perovskite La2MgMnO6," *Appl. Phys. Lett.*, vol. 96, no. 14, p. 142902, Apr. 2010, doi: 10.1063/1.3377906.

[165] M. P. Singh *et al.*, "Absence of long-range NiMn ordering in ferromagnetic La2 NiMn O6 thin films," *Appl. Phys. Lett.*, vol. 91, no. 1, pp. 89–92, 2007, doi: 10.1063/1.2753715.

[166] R. Mandal *et al.*, "Magneto-dielectric effect in relaxor superparaelectric Tb2CoMn O6 film," *Phys. Rev. B*, vol. 101, no. 9, 2020, doi: 10.1103/PhysRevB.101.094426.

[167] A. Muñoz, J. A. Alonso, M. T. Casais, M. J. Martínez-Lope, and M. T. Fernández-Díaz, "Crystal and magnetic structure of the complex oxides Sr2MnMoO6, Sr2MnWO6 and Ca2MnWO6: A neutron diffraction study," *J. Phys. Condens. Matter*, vol. 14, no. 38, pp. 8817–8830, 2002, doi: 10.1088/0953-8984/14/38/306.

[168] A. J. Barón-González, C. Frontera, J. L. García-Mũoz, B. Rivas-Murias, and J. Blasco, "Effect of cation disorder on structural, magnetic and dielectric properties of La2MnCoO6 double perovskite," *J. Phys. Condens. Matter*, vol. 23, no. 49, 2011, doi: 10.1088/0953-8984/23/49/496003.

[169] K. Manna, A. K. Bera, M. Jain, S. Elizabeth, S. M. Yusuf, and P. S. A. Kumar, "Structural-modulation-driven spin canting and reentrant glassy magnetic phase in ferromagnetic L u2MnNi O6," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 91, no. 22, pp. 1–7, 2015, doi: 10.1103/PhysRevB.91.224420.

[170] J. Blasco *et al.*, "Evidence of large magneto-dielectric effect coupled to a metamagnetic transition in Yb2CoMnO6," *Appl. Phys. Lett.*, vol. 107, no. 1, 2015, doi:

10.1063/1.4926403.

[171] A. P. Sazonov, I. O. Troyanchuk, D. P. Kozlenko, A. M. Balagurov, and V. V Sikolenko, “Magnetic ordering in the Nd 2 CoMnO 6 þ d perovskite system,” vol. 302, pp. 443–447, 2006, doi: 10.1016/j.jmmm.2005.10.004.

[172] G. D. Dwivedi *et al.*, “Structural, magnetic, magneto-transport properties, and electronic structure study of charge-ordered (La 0.4 Pr 0.6) 0.65 Ca 0.35 MnO 3,” *J. Alloys Compd.*, vol. 699, pp. 31–37, 2017, doi: 10.1016/j.jallcom.2016.12.282.

[173] G. D. Dwivedi *et al.*, “Electronic structure study of wide band gap magnetic semiconductor (La 0.6 Pr 0.4) 0.65 Ca 0.35 MnO 3 nanocrystals in paramagnetic and ferromagnetic phases,” *Appl. Phys. Lett.*, vol. 108, no. 17, p. 172402, Apr. 2016, doi: 10.1063/1.4947466.

[174] E. Beyreuther, S. Grafström, L. M. Eng, C. Thiele, and K. Dörr, “XPS investigation of Mn valence in lanthanum manganite thin films under variation of oxygen content,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 15, pp. 1–9, 2006, doi: 10.1103/PhysRevB.73.155425.

[175] Y. Bai *et al.*, “A-Site-Doping Enhanced B-Site Ordering and Correlated Magnetic Property in La2-xBixCoMnO6,” *J. Phys. Chem. C*, 2012.

[176] C. A. F. Vaz, D. Prabhakaran, E. I. Altman, and V. E. Henrich, “Experimental study of the interfacial cobalt oxide in Co3O4-Al2,” *Phys. Rev. B*, vol. 80, no. 15, p. 155457, Oct. 2009, doi: 10.1103/PhysRevB.80.155457.

[177] P. A. Joy, P. S. Anil Kumar, and S. K. Date, “The relationship between field-cooled and zero-field-cooled susceptibilities of some ordered magnetic systems,” *J. Phys. Condens. Matter*, vol. 10, no. 48, pp. 11049–11054, 1998, doi: 10.1088/0953-8984/10/48/024.

[178] M. Viswanathan and P. S. A. Kumar, “Observation of reentrant spin glass behavior in LaCo0.5Ni 0.5 O3,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 80, no. 1, pp. 3–6, 2009, doi: 10.1103/PhysRevB.80.012410.

[179] D. N. H. Nam *et al.*, “D. N. H. Nam,” vol. 59, no. 6, pp. 4189–4194, 1999.

[180] F. Li and J. Fang, “Glassy-ferromagnetic behavior in Eu 0.5Sr 0.5CoO 3,” *J. Magn. Magn. Mater.*, vol. 324, no. 17, pp. 2664–2668, 2012, doi: 10.1016/j.jmmm.2012.03.046.

[181] N. Terada, D. D. Khalyavin, P. Manuel, T. Osakabe, A. Kikkawa, and H. Kitazawa, “Magnetic ordering in pressure-induced phases with giant spin-driven ferroelectricity in multiferroic TbMnO3,” *Phys. Rev. B*, vol. 93, no. 8, pp. 1–5, 2016, doi: 10.1103/PhysRevB.93.081104.

[182] J. K. Murthy and A. Venimadhav, “4f-3d exchange coupling induced exchange bias and field induced Hopkinson peak effects in Gd2CoMnO6,” *J. Alloys Compd.*, vol. 719, pp. 341–346, 2017, doi: 10.1016/j.jallcom.2017.05.203.

[183] B. Salamon and H. Chun, “Griffiths singularities and magnetoresistive manganites,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 68, no. 1, pp. 1–8, 2003, doi: 10.1103/PhysRevB.68.014411.

[184] Y. Imry and S. Ma, “Random-Field Instability of the Ordered State of Continuous

Symmetry," *Phys. Rev. Lett.*, vol. 35, no. 21, pp. 1399–1401, Nov. 1975, doi: 10.1103/PhysRevLett.35.1399.

[185] K. K. Shukla, R. Singh, A. Kumar, A. K. Ghosh, and S. Chatterjee, "Griffith-like phase in Crednerite CuMnO 2," *Mater. Res. Bull.*, vol. 91, pp. 135–139, 2017, doi: 10.1016/j.materresbull.2017.03.054.

[186] J. Deisenhofer *et al.*, "Observation of a Griffiths Phase in Paramagnetic La1-xSrxMnO3," *Phys. Rev. Lett.*, vol. 95, no. 25, p. 257202, Dec. 2005, doi: 10.1103/PhysRevLett.95.257202.

[187] E. Talik, A. Guzik, M. Oboz, P. Zajdel, and G. Ziółkowski, "Magnetocaloric and Hopkinson effects in slowly and rapidly cooled Gd 7 Pd 3," *Int. J. Mater. Res.*, vol. 107, no. 1, pp. 3–12, 2016, doi: 10.3139/146.111318.

[188] M. L. Dahlberg, M. J. Matthews, P. Jiramongkolchai, R. J. Cava, and P. Schiffer, "Low-temperature dynamic freezing and the fragility of ordering in Tb 2Sn2O7," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 83, no. 14, pp. 1–4, 2011, doi: 10.1103/PhysRevB.83.140410.

[189] B. G. Ueland, G. C. Lau, R. J. Cava, J. R. O'Brien, and P. Schiffer, "Slow spin relaxation in a highly polarized cooperative paramagnet," *Phys. Rev. Lett.*, vol. 96, no. 2, pp. 1–4, 2006, doi: 10.1103/PhysRevLett.96.027216.

[190] A. Pal *et al.*, "Electronic structure by X-ray absorption spectroscopy and observation of field induced unusually slow spin relaxation from magnetic properties in pyrochlore Eu 2−x Fe x Ti 2 O 7," *J. Magn. Magn. Mater.*, vol. 476, no. May 2018, pp. 7–17, 2019, doi: 10.1016/j.jmmm.2018.12.046.

[191] J. Knolle, G. W. Chern, D. L. Kovrizhin, R. Moessner, and N. B. Perkins, "Raman scattering signatures of Kitaev spin liquids in A2IrO3 iridates with A=Na or Li," *Phys. Rev. Lett.*, vol. 113, no. 18, pp. 1–5, 2014, doi: 10.1103/PhysRevLett.113.187201.

[192] A. Ito, H. Aruga, E. Torikai, M. Kikuchi, Y. Syono, and H. Takei, "Time-Dependent Phenomena in a Short-Range Ising Spin-Glass Fe0.5Mn0.5TiO3," *Phys. Rev. Lett.*, vol. 57, no. 4, pp. 483–486, Jul. 1986, doi: 10.1103/PhysRevLett.57.483.

[193] T. Sato, T. Ando, T. Ogawa, S. Morimoto, and A. Ito, "Spin freezing and the ferromagnetic and reentrant spin-glass phases in a reentrant ferromagnet," *Phys. Rev. B*, vol. 64, no. 18, p. 184432, Oct. 2001, doi: 10.1103/PhysRevB.64.184432.

[194] C. Sow, D. Samal, P. S. A. Kumar, A. K. Bera, and S. M. Yusuf, "Structural-modulation-driven low-temperature glassy behavior in SrRuO3," *Phys. Rev. B*, vol. 85, no. 22, p. 224426, Jun. 2012, doi: 10.1103/PhysRevB.85.224426.

[195] R. B. M. E. Filho, A. P. Ayala, and C. W. De Araujo Paschoal, "Spin-phonon coupling in Y2NiMnO6 double perovskite probed by Raman spectroscopy," *Appl. Phys. Lett.*, vol. 102, no. 19, 2013, doi: 10.1063/1.4804988.

[196] D. Kumar, S. Kumar, and V. G. Sathe, "Spin-phonon coupling in ordered double perovskites A2CoMnO 6 (A=La, Pr, Nd) probed by micro-Raman spectroscopy," *Solid State Commun.*, vol. 194, pp. 59–64, 2014, doi: 10.1016/j.ssc.2014.06.017.

[197] S. Kamba *et al.*, "Strong spin-phonon coupling in infrared and Raman spectra of SrMnO 3," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 89, no. 6, pp. 1–7, 2014, doi: 10.1103/PhysRevB.89.064308.

[198] M. Taguchi *et al.*, “Unusual coexistence of negative and positive charge transfer in mixed-valence NaxCa1-xCr2 O4,” *Phys. Rev. B*, vol. 96, no. 24, pp. 1–6, 2017, doi: 10.1103/PhysRevB.96.245113.

[199] J. P. Perdew, K. Burke, and M. Ernzerhof, “Generalized gradient approximation made simple,” *Phys. Rev. Lett.*, vol. 77, no. 18, pp. 3865–3868, 1996, doi: 10.1103/PhysRevLett.77.3865.

[200] P. E. Blöchl, “Projector augmented-wave method,” *Phys. Rev. B*, vol. 50, no. 24, pp. 17953–17979, Dec. 1994, doi: 10.1103/PhysRevB.50.17953.

[201] S. Baidya and T. Saha-Dasgupta, “Electronic structure and phonons in La2CoMnO6: A ferromagnetic insulator driven by Coulomb-assisted spin-orbit coupling,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 84, no. 3, pp. 1–5, 2011, doi: 10.1103/PhysRevB.84.035131.

[202] X. Z. Lu, M. H. Whangbo, S. Dong, X. G. Gong, and H. J. Xiang, “Giant ferroelectric polarization of CaMn 7O 12 induced by a combined effect of Dzyaloshinskii-Moriya interaction and exchange striction,” *Phys. Rev. Lett.*, vol. 108, no. 18, pp. 1–5, 2012, doi: 10.1103/PhysRevLett.108.187204.

[203] F. Li *et al.*, “Modified surface electronic and magnetic properties of La 0.6Sr0.4MnO3 thin films for spintronics applications,” *J. Phys. Chem. C*, vol. 115, no. 34, pp. 16947–16953, 2011, doi: 10.1021/jp112064y.

[204] D. K. Satapathy *et al.*, “Magnetic proximity effect in YBa 2Cu 3O 7/La 2/3Ca 1/3MnO 3 and YBa 2Cu 3O 7/LaMnO 3+δ superlattices,” *Phys. Rev. Lett.*, vol. 108, no. 19, pp. 1–5, 2012, doi: 10.1103/PhysRevLett.108.197201.

[205] S. Y. Istomin *et al.*, “An unusual high-spin ground state of Co3+ in octahedral coordination in brownmillerite-type cobalt oxide,” *Dalt. Trans.*, vol. 44, no. 23, pp. 10708–10713, 2015, doi: 10.1039/c4dt03670k.

[206] Y. Bitla *et al.*, “Origin of metallic behavior in NiCo2O4 ferrimagnet,” *Sci. Rep.*, vol. 5, pp. 1–8, 2015, doi: 10.1038/srep15201.

[207] K. Anand *et al.*, “Existence of Griffiths phase and unusual spin dynamics in double perovskite Tb2CoMnO6,” *J. Magn. Magn. Mater.*, vol. 528, no. January, p. 167697, 2021, doi: 10.1016/j.jmmm.2020.167697.

[208] N. X. Phuc and P. Nordblad, “Coexistence of ferromagnetic and glassy behavior in the (formula presented) perovskite compound,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 59, no. 6, pp. 4189–4194, 1999, doi: 10.1103/PhysRevB.59.4189.

[209] R. J. Booth *et al.*, “An investigation of structural, magnetic and dielectric properties of R2NiMnO6 (R = rare earth, Y),” *Mater. Res. Bull.*, vol. 44, no. 7, pp. 1559–1564, 2009, doi: 10.1016/j.materresbull.2009.02.003.

[210] S. Yáñez-Vilar *et al.*, “Multiferroic behavior in the double-perovskite Lu2MnCoO6,” *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 84, no. 13, pp. 1–8, 2011, doi: 10.1103/PhysRevB.84.134427.

[211] H. S. Nair *et al.*, “Magnetization-steps in Y2CoMnO6 double perovskite: The role of antisite disorder,” *J. Appl. Phys.*, vol. 116, no. 12, 2014, doi: 10.1063/1.4896399.

[212] T. Gao, S. Cao, Y. Liu, T. Zhou, Z. Feng, and J. Zhang, “Remarkable magnetic

relaxation and metamagnetic transition in phase-separated La0.7Ca0.3Mn0.9Cu0.1O3 perovskite," *J. Appl. Phys.*, vol. 117, no. 16, pp. 1–7, 2015, doi: 10.1063/1.4918912.

[213] J. Souletie and J. L. Tholence, "Critical slowing down in spin glasses and other glasses: Fulcher versus power law," *Phys. Rev. B*, vol. 32, no. 1, pp. 516–519, Jul. 1985, doi: 10.1103/PhysRevB.32.516.

[214] X. K. Zhang *et al.*, "Phase coexistence and exchange-bias effect in m2O4 nanorods," *Phys. Rev. B*, vol. 97, no. 10, p. 104405, Mar. 2018, doi: 10.1103/PhysRevB.97.104405.

[215] E. Vincent, V. Dupuis, M. Alba, J. Hammann, and J.-P. Bouchaud, "Aging phenomena in spin-glass and ferromagnetic phases: Domain growth and wall dynamics," *Europhys. Lett.*, vol. 50, no. 5, pp. 674–680, Jun. 2000, doi: 10.1209/epl/i2000-00323-8.

[216] S. Bedanta and W. Kleemann, "Supermagnetism," *J. Phys. D. Appl. Phys.*, vol. 42, no. 1, 2009, doi: 10.1088/0022-3727/42/1/013001.

[217] M. N. Iliev *et al.*, "Raman spectroscopy of orthorhombic perovskitelike YMnO3 and LaMnO3," *Phys. Rev. B*, vol. 57, no. 5, pp. 2872–2877, 1998, doi: 10.1103/PhysRevB.57.2872.

[218] J. Laverdière, S. Jandl, A. A. Mukhin, V. Y. Ivanov, V. G. Ivanov, and M. N. Iliev, "Spin-phonon coupling in orthorhombic RMn O3 (R=Pr,Nd,Sm,Eu,Gd,Tb,Dy,Ho,Y): A Raman study," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 73, no. 21, pp. 1–5, 2006, doi: 10.1103/PhysRevB.73.214301.

[219] R. X. Silva *et al.*, "Spin-phonon coupling in multiferroic Y2CoMnO6," *J. Alloys Compd.*, vol. 690, pp. 909–915, 2017, doi: 10.1016/j.jallcom.2016.07.010.

[220] M. N. Iliev, M. V. Abrashev, A. P. Litvinchuk, V. G. Hadjiev, H. Guo, and A. Gupta, "Raman spectroscopy of ordered double perovskite La2 CoMn O6 thin films," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 75, no. 10, pp. 1–6, 2007, doi: 10.1103/PhysRevB.75.104118.

[221] M. Balkanski, R. F. Wallis, and E. Haro, "Anharmonic effects in light scattering due to optical phonons in silicon," *Phys. Rev. B*, vol. 28, no. 4, pp. 1928–1934, 1983, doi: 10.1103/PhysRevB.28.1928.

[222] M. N. Iliev, H. Guo, and A. Gupta, "Raman spectroscopy evidence of strong spin-phonon coupling in epitaxial thin films of the double perovskite La2NiMnO6," *Appl. Phys. Lett.*, vol. 90, no. 15, pp. 88–91, 2007, doi: 10.1063/1.2721142.

[223] A. Nonato *et al.*, "Spin-phonon and magnetostriction phenomena in CaMn7O12 helimagnet probed by Raman spectroscopy," *Appl. Phys. Lett.*, vol. 105, no. 22, pp. 1–5, 2014, doi: 10.1063/1.4902234.

[224] M. Viswanathan, P. S. Anil Kumar, V. S. Bhadram, C. Narayana, A. K. Bera, and S. M. Yusuf, "Influence of lattice distortion on the Curie temperature and spin-phonon coupling in LaMn0.5Co0.5O3," *J. Phys. Condens. Matter*, vol. 22, no. 34, 2010, doi: 10.1088/0953-8984/22/34/346006.

[225] V. Srinu Bhadram, B. Rajeswaran, A. Sundaresan, and C. Narayana, "Spin-phonon coupling in multiferroic RCrO3 (R-Y, Lu, Gd, Eu, Sm): A Raman study," *Epl*, vol. 101, no. 1, 2013, doi: 10.1209/0295-5075/101/17008.

[226] T. Jungwirth, X. Marti, P. Wadley, and J. Wunderlich, "Antiferromagnetic spintronics," *Nat. Nanotechnol.*, vol. 11, no. 3, pp. 231–241, 2016, doi: 10.1038/nnano.2016.18.

[227] J. Godinho *et al.*, "Electrically induced and detected Néel vector reversal in a collinear antiferromagnet," *Nat. Commun.*, vol. 9, no. 1, pp. 1–8, 2018, doi: 10.1038/s41467-018-07092-2.

[228] M. Asa *et al.*, "Electrical readout of the antiferromagnetic state of IrMn through anomalous Hall effect," *J. Appl. Phys.*, vol. 128, no. 5, 2020, doi: 10.1063/5.0009553.

[229] J. Železný, P. Wadley, K. Olejník, A. Hoffmann, and H. Ohno, "Spin transport and spin torque in antiferromagnetic devices," *Nat. Phys.*, vol. 14, no. 3, pp. 220–228, 2018, doi: 10.1038/s41567-018-0062-7.

[230] P. H. Lin *et al.*, "Manipulating exchange bias by spin–orbit torque," *Nat. Mater.*, vol. 18, no. 4, pp. 335–341, 2019, doi: 10.1038/s41563-019-0289-4.

[231] S. Brems, K. Temst, and C. Van Haesendonck, "Origin of the training effect and asymmetry of the magnetization in polycrystalline exchange bias systems," *Phys. Rev. Lett.*, vol. 99, no. 6, pp. 1–4, 2007, doi: 10.1103/PhysRevLett.99.067201.

[232] M. K. Chan, J. S. Parker, P. A. Crowell, and C. Leighton, "Identification and separation of two distinct contributions to the training effect in polycrystalline Co FeMn bilayers," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 77, no. 1, pp. 1–5, 2008, doi: 10.1103/PhysRevB.77.014420.

[233] A. G. Biternas, R. W. Chantrell, and U. Nowak, "Behavior of the antiferromagnetic layer during training in exchange-biased bilayers within the domain state model," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 82, no. 13, pp. 1–10, 2010, doi: 10.1103/PhysRevB.82.134426.

[234] A. G. Biternas, R. W. Chantrell, and U. Nowak, "Dependence of training effect on the antiferromagnetic structure of exchange-bias bilayers within the domain-state model," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 89, no. 18, pp. 1–8, 2014, doi: 10.1103/PhysRevB.89.184405.

[235] R. Pradheesh *et al.*, "Magnetic glass state and magnetoresistance in SrLaFeCoO6double perovskite," *J. Phys. Condens. Matter*, vol. 29, no. 9, p. aa5470, 2017, doi: 10.1088/1361-648X/aa5470.

[236] L. Balcells, J. Navarro, M. Bibes, A. Roig, B. Martínez, and J. Fontcuberta, "Cationic ordering control of magnetization in Sr2FeMoO6 double perovskite," *Appl. Phys. Lett.*, vol. 78, no. 6, pp. 781–783, Feb. 2001, doi: 10.1063/1.1346624.

[237] J. Kumar, S. N. Panja, S. Dengre, and S. Nair, "Identification of a Griffiths singularity in a geometrically frustrated antiferromagnet," *Phys. Rev. B*, vol. 95, no. 5, p. 054401, Feb. 2017, doi: 10.1103/PhysRevB.95.054401.

[238] Y. Guo, L. Shi, S. Zhou, J. Zhao, and W. Liu, "Near room-temperature magnetoresistance effect in double perovskite La 2 NiMnO 6," *Appl. Phys. Lett.*, vol. 102, no. 22, p. 222401, Jun. 2013, doi: 10.1063/1.4808437.

[239] A. Pal *et al.*, "Probing the Griffiths like phase, unconventional dual glassy states, giant exchange bias effects and its correlation with its electronic structure in Pr 2− x Sr x CoMnO 6," *J. Phys. Condens. Matter*, vol. 32, no. 21, p. 215801, May 2020, doi:

10.1088/1361-648X/ab5326.

[240] C. J. P. (compilation and A.V. Naumkin, A.K. Vass, S.W. Gaarenstroom and H. nist. gov/xps. evaluation) NIST Standard Reference Database, 20, Version 4.1, "NIST X-ray Photoelectron Spectroscopy Database." Version 4.1, [Online]. Available: https://srdata.nist.gov/xps/Default.aspx.

[241] S. Laureti *et al.*, "Effect of oxygen partial pressure on PLD cobalt oxide films," *Appl. Surf. Sci.*, vol. 254, no. 16, pp. 5111–5115, Jun. 2008, doi: 10.1016/j.apsusc.2008.02.055.

[242] H. Z. Guo, A. Gupta, T. G. Calvarese, and M. A. Subramanian, "Structural and magnetic properties of epitaxial thin films of the ordered double perovskite La2CoMnO6," *Appl. Phys. Lett.*, vol. 89, no. 26, pp. 2–5, 2006, doi: 10.1063/1.2422878.

[243] T. Yamashita and P. Hayes, "Analysis of XPS spectra of Fe 2+ and Fe 3+ ions in oxide materials," *Appl. Surf. Sci.*, vol. 254, no. 8, pp. 2441–2449, 2008, doi: 10.1016/j.apsusc.2007.09.063.

[244] G. U. Kulkarni, C. N. R. Rao, and M. W. Roberts, "Nature of the oxygen species at Ni(110) and Ni(100) surfaces revealed by exposure to oxygen and oxygen-ammonia mixtures: Evidence for the surface reactivity of O- type species," *J. Phys. Chem.*, vol. 99, no. 10, pp. 3310–3316, 1995, doi: 10.1021/j100010a048.

[245] R. Ang, Y. P. Sun, Y. Q. Ma, B. C. Zhao, X. B. Zhu, and W. H. Song, "Diamagnetism, transport, magnetothermoelectric power, and magnetothermal conductivity in electron-doped CaMn1-xvxO3 manganites," *J. Appl. Phys.*, vol. 100, no. 6, p. 063902, 2006, doi: 10.1063/1.2337557.

[246] X. J. Liu, Z. Q. Li, P. Wu, H. L. Bai, and E. Y. Jiang, "The effect of Fe doping on structural, magnetic and electrical transport properties of CaMn1-xFexO3 (x=0-0.35)," *Solid State Commun.*, vol. 142, no. 9, pp. 525–530, 2007, doi: 10.1016/j.ssc.2007.03.021.

[247] Y. Murano *et al.*, "Effect of pressure on the magnetic, transport, and thermal-transport properties of the electron-doped manganite CaMn1-xSb xO3," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 83, no. 5, pp. 1–13, 2011, doi: 10.1103/PhysRevB.83.054437.

[248] S. K. Tolpygo, I. G. Mikhailov, A. E. Horozovsky, and S. K. Yushchenko, "° f," vol. 189, pp. 1097–1098, 1991.

[249] N. Kumar and A. Sundaresan, "On the observation of negative magnetization under zero-field-cooled process," *Solid State Commun.*, vol. 150, no. 25–26, pp. 1162–1164, 2010, doi: 10.1016/j.ssc.2010.03.016.

[250] A. K. Nayak *et al.*, "Large zero-field cooled exchange-bias in bulk Mn2PtGa," *Phys. Rev. Lett.*, vol. 110, no. 12, pp. 1–5, 2013, doi: 10.1103/PhysRevLett.110.127204.

[251] T. Maity, S. Goswami, D. Bhattacharya, and S. Roy, "Superspin glass mediated giant spontaneous exchange bias in a nanocomposite of BiFeO3-Bi2Fe4O9," *Phys. Rev. Lett.*, vol. 110, no. 10, pp. 1–5, 2013, doi: 10.1103/PhysRevLett.110.107201.

[252] C. Binek, "Training of the exchange-bias effect: A simple analytic approach," *Phys. Rev. B*, vol. 70, no. 1, p. 014421, Jul. 2004, doi: 10.1103/PhysRevB.70.014421.

[253] J. Nogués and I. K. Schuller, "Exchange bias," *J. Magn. Magn. Mater.*, vol. 192, no. 2, pp. 203–232, Feb. 1999, doi: 10.1016/S0304-8853(98)00266-2.

[254] S. Jenkins, R. W. Chantrell, and R. F. L. Evans, "Atomistic origin of the athermal training effect in granular IrMn/CoFe bilayers," *Phys. Rev. B*, vol. 103, no. 10, pp. 1–11, 2021, doi: 10.1103/PhysRevB.103.104419.

[255] M. Pan *et al.*, "Thermal stability of exchange bias in FeMn based bilayers," *J. Appl. Phys.*, vol. 91, no. 8, pp. 5272–5274, 2002, doi: 10.1063/1.1446661.

[256] R. Grau-Crespo, S. Hamad, C. R. A. Catlow, and N. H. De Leeuw, "Symmetry-adapted configurational modelling of fractional site occupancy in solids," *J. Phys. Condens. Matter*, vol. 19, no. 25, p. 256201 (16pp), 2007, doi: 10.1088/0953-8984/19/25/256201.

[257] H. J. Xiang and M. H. Whangbo, "Cooperative effect of electron correlation and spin-orbit coupling on the electronic and magnetic properties of Ba2 NaOs O6," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 75, no. 5, pp. 1–4, 2007, doi: 10.1103/PhysRevB.75.052407.

[258] K. D. Truong, M. P. Singh, S. Jandl, and P. Fournier, "Influence of Ni/Mn cation order on the spin-phonon coupling in multifunctional La2 NiMnO6 epitaxial films by polarized Raman spectroscopy," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 80, no. 13, pp. 1–8, 2009, doi: 10.1103/PhysRevB.80.134424.

[259] M. C. Weber *et al.*, "Raman spectroscopy of rare-earth orthoferrites RFeO3 (R =La, Sm, Eu, Gd, Tb, Dy)," *Phys. Rev. B*, vol. 94, no. 21, pp. 1–8, 2016, doi: 10.1103/PhysRevB.94.214103.

[260] K. Anand *et al.*, "Emergence of metamagnetic transition, re-entrant cluster glass and spin phonon coupling in Tb2CoMnO6," *J. Phys. Condens. Matter*, vol. 33, no. 27, p. 275802 (10pp), 2021, doi: 10.1088/1361-648X/abfe94.

[261] R. Rawat, D. M. Phase, and R. J. Choudhary, "Spin-phonon coupling in hexagonal Sr0.6Ba0.4MnO3," *J. Magn. Magn. Mater.*, vol. 441, pp. 398–403, 2017, doi: 10.1016/j.jmmm.2017.05.089.

[262] A. N. Vasiliev *et al.*, "Valence states and metamagnetic phase transition in partially B -site-disordered perovskite Eu Mn0.5 Co0.5 O3," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 77, no. 10, pp. 2–6, 2008, doi: 10.1103/PhysRevB.77.104442.

[263] D. S. Inosov, "Quantum magnetism in minerals," *Adv. Phys.*, vol. 67, no. 3, pp. 149–252, Jul. 2018, doi: 10.1080/00018732.2018.1571986.

[264] V. Zapf, M. Jaime, and C. D. Batista, "Bose-Einstein condensation in quantum magnets," *Rev. Mod. Phys.*, vol. 86, no. 2, pp. 563–614, May 2014, doi: 10.1103/RevModPhys.86.563.

[265] S. F. Maehrlein *et al.*, "Dissecting spin-phonon equilibration in ferrimagnetic insulators by ultrafast lattice excitation," *Sci. Adv.*, vol. 4, no. 7, Jul. 2018, doi: 10.1126/sciadv.aar5164.

[266] X. Moya and N. D. Mathur, "Turn your phonon," *Nat. Mater.*, vol. 16, no. 8, pp. 784–785, Aug. 2017, doi: 10.1038/nmat4952.

[267] R. Kumar *et al.*, "Existence of a critical canting angle of magnetic moments to induce

multiferroicity in the Haldane spin-chain system Tb2BaNiO5," *Phys. Rev. B*, vol. 99, no. 10, p. 100406, Mar. 2019, doi: 10.1103/PhysRevB.99.100406.

[268] A. Tiwari *et al.*, "Spin-lattice-charge coupling in quasi-one-dimensional spin-chain NiTe2O5," *Phys. Rev. Mater.*, vol. 6, no. 4, p. 044409, Apr. 2022, doi: 10.1103/PhysRevMaterials.6.044409.

[269] U. Adem *et al.*, "Magnetodielectric and magnetoelastic coupling in TbFe3(BO3)4," *Phys. Rev. B*, vol. 82, no. 6, p. 064406, Aug. 2010, doi: 10.1103/PhysRevB.82.064406.

[270] J. A. Barth *et al.*, "und allgemeine Chemie," vol. 616, pp. 27–34, 1992.

[271] H. Takatsu, H. Yoshizawa, S. Yonezawa, and Y. Maeno, "Critical behavior of the metallic triangular-lattice Heisenberg antiferromagnet PdCrO2," *Phys. Rev. B - Condens. Matter Mater. Phys.*, vol. 79, no. 10, pp. 1–7, 2009, doi: 10.1103/PhysRevB.79.104424.

[272] H. Takatsu, H. Yoshizawa, S. Yonezawa, and Y. Maeno, "Critical behavior of the metallic triangular-lattice Heisenberg antiferromagnet NiTe2O5," *Phys. Rev. B*, vol. 79, no. 10, p. 104424, Mar. 2009, doi: 10.1103/PhysRevB.79.104424.

[273] C. B. Walker and D. T. Keating, "Neutron diffraction study of short-range order in β-CuZn," *Phys. Rev.*, vol. 130, no. 5, pp. 1726–1734, 1963, doi: 10.1103/PhysRev.130.1726.

[274] P. Wells and J. H. Smith, "Neutron diffraction study of short range order in γ MnCu alloys," *J. Phys. F Met. Phys.*, vol. 1, no. 6, pp. 763–770, 1971, doi: 10.1088/0305-4608/1/6/309.

[275] H. Yamauchi *et al.*, "High-temperature short-range order in Mn3RhSi," *Commun. Mater.*, vol. 1, no. 1, p. 43, Dec. 2020, doi: 10.1038/s43246-020-0042-1.

[276] A. Dubey and V. G. Sathe, "The effect of magnetic order and thickness in the Raman spectra of oriented thin films of LaMnO 3," *J. Phys. Condens. Matter*, vol. 19, no. 34, p. 346232, Aug. 2007, doi: 10.1088/0953-8984/19/34/346232.

[277] C. Roy and R. C. Budhani, "Raman- and infrared-active phonons in hexagonal BaMnO3," *Phys. Rev. B*, vol. 58, no. 13, pp. 8174–8177, Oct. 1998, doi: 10.1103/PhysRevB.58.8174.

[278] B. Poojitha, A. Rathore, A. Kumar, and S. Saha, "Signatures of magnetostriction and spin-phonon coupling in magnetoelectric hexagonal 15RBaMnO3," *Phys. Rev. B*, vol. 102, no. 13, p. 134436, Oct. 2020, doi: 10.1103/PhysRevB.102.134436.

[279] "http://www.jass-code.org/index.php."

List of Publications:

1. "Existence of Griffiths phase and unusual spin dynamics in double perovskite Tb_2CoMnO_6" **Khyati Anand** *et al.* J. Magn. Magn. Mater. 528 (2021) 167697.

2. "Emergence of metamagnetic transition, re-entrant cluster glass and spin phonon coupling in Tb_2CoMnO_6" **Khyati Anand** *et al.* J. Phys.: Condens. Matter **33** (2021) 275802.

3. "Giant exchange bias in antiferromagnetic $Pr_2CoFe_{0.5}Mn_{0.5}O_6$: a structural and magnetic properties study" **Khyati Anand** *et al.* J. Phys. D: Appl. Phys. 55 (2022) 365004.

4. "Magnetic properties and coupled spin-phonon behavior in quasi one-dimensional screw-chain compound $BaMn_2V_2O_8$" **Khyati Anand** *et al.* (under review).

5. "Reentrant double glassy states and simultaneous presence of short- and long-range ordering in metamagnetic Co-doped Bi0·5La0·5Fe0·5Mn0·5O3 multiferroic" Prince K Gupta[a], **Khyati Anand[a]** *et al.* **([a]equally contributed authors)** Solid State Sci. 131 (2022) 10693.

6. "Observation of both Debye type and Maxwell-Wagner relaxation in $Y_{1.9}Ce_{0.1}CoMnO_6$" **Khyati Anand** *et al.* AIP Proceeding 2100(1):020028 (2019).

7. "Observation of structural change-driven Griffiths to non-Griffiths-like phase transformation in $Pr_{2-x}Sr_xCoFeO_6$ (x=0 to 1)" Arkadeb Pal, **Khyati Anand** *et al.* J. Magn. Magn. Mater. 562 (2022) 169764.

8. "Extraordinary magnetic properties of double perovskite Eu_2CoMnO_6 wide band gap semiconductor" Mohd Alam, Prajyoti Singh, **Khyati Anand** *et al.* J. Phys.: Condens. Matter 32 (2020) 365802.

9. "Roles of Re-entrant cluster glass state and spin–lattice coupling in magneto–dielectric behavior of giant dielectric double perovskite $La_{1.8}Pr_{0.2}CoFeO_6$." Prajyoti Singh., Mohd Alam., Shiv Kumar, **Khyati Anand** *et al.* J Phys: Condens Matter, 32(44), (2020). 445801.

10. "Relaxor-super-paraelectric behaviour and crystal field driven spin-phonon coupling in pyrochlore $Eu_2Ti_2O_7$" Mohd Alam, Arkadeb Pal, **Khyati Anand** *et al.* EPL, 137 (2022) 26003.

11. "Multifunctional behaviour in B-site disordered double perovskite $EuPrCoMnO_6$" Mohd Alam, Labanya Ghosh, Supriyo Majumder, Prajyoti Singh, Satya Vijay Kumar, Srishti Dixit, Dheeraj Kumar**, Khyati Anand** *et al.* J. Phys. D: Appl. Phys. 55 (2022) 255003.

12. "Double glassy states and large spontaneous and conventional exchange bias in $La_{1.5}Ca_{0.5}CoFeO_6$ ferrimagnetic double perovskite" Prajyoti Singh, Rahul K Singh, Srishti Dixit, Neha Patel, Mohd Alam, Sambhab Dan, Anil K Jain, **Khyati Anand** *et al*. J. Phys.: Condens. Matter 34 (2022) 375803.

13. "Existence of exchange bias and Griffith phase in $(Tb_{1-x}Ce_x)MnO_3$" Surajit Ghosh, Abhishek Kumar, Arkadeb Pal, Prajyoti Singh, Prince Gupta**, Khyati Anand** *et al.* J Magn. Magn. Mater. 500 (2020) 166261.

14. "Probing the Griffiths like phase, unconventional dual glassy states, giant exchange bias effects and its correlation with its electronic structure in $Pr_{2-x}Sr_xCoMnO_6$'' Arkadeb Pal**,** Prajyoti Singh, Vinod K Gangwar, Amish G Joshi, G. D. Dwivedi, Prince K Gupta, Md. Alam, **Khyati Anand** *et al.* J. Phys.: Condens. Matter 32 (2020) 215801.

15. "Magneto-thermal property study of geometrically frustrated hybrid pyrochlore $Dy_{2-x}Er_xTi_2O_7$" Arkadeb Pal**, Khyati Anand** *et al.* AIP Conference Proceedings 2115(1):030531.

1. **Awarded third position** for the oral presentation titled ‘Metamagnetic transition and re-entrant cluster glass phase in Tb2CoMnO6’ at Students’ Research Convention’22 held at IIT Kanpur.

2. Delivered oral presentation in “**7th Conference on Neutron Scattering (CNS-2021) BARC**” held during 25-27 November 2021 in Mumbai.

3. School Attended- **XVIII School on Neutrons as Probes of Condensed Matter (NPCM- XVIII 2018**), (October 28-November 1, 2018, BARC, Mumbai).

4. Poster Presentation - national conference on physics and chemistry of materials-2018 (NCPCM-2018) 27^{th}-28^{th} December, 2018.

5. Poster Presentation – “64^{th} **DAE Solid State Physics Symposium 2019**”, IIT Jodhpur December 18-22, 2019.

6. Online One-week National Workshop Attended - “Advanced Physical Tools and Techniques for Materials Characterization” held during 28^{th} July to 03^{rd} August (2020).

7. Online Workshop – “Rietveld Refinement Methods”, Organised by **UGC-Dae, CSR Mumbai** during 22-24 September (2020).

8. Poster Presentation- “**65th DAE Solid State Physics Symposium”** held during 15-19 December 2021.

9. Oral presentation- **International Conference on "Advanced Functional Materials: Future Perspectives" (AFMFP-2022) (August 06 - 08, 2022)** organised Dr. B. R. Ambedkar National Institute of Technology Jalandhar, Punjab, India.