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Unusual irreversible magnetic behavior in three unrelated systems

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Thermal irreversibility in DC magnetic measurements under magnetic field (H) is readily observed in ferromagnetic (FM) or antiferromagnetic (AFM) materials, in spin-glasses and in superconducting systems. In all standard cases the zero-field-cooled curves (ZFC) lie below field-cooled (FC) branches (FC>ZFC) up to a typical characteristic temperature corresponding to the various physical states. An unusual magnetic behavior where the FC branches cross the ZFC curves (ZFC>FC) has been recently observed in three unrelated systems: (i) Inhomogeneous commercial and fabricated amorphous carbon powders synthesized with sulfur (a-CS) which exhibit pronounced peaks in their virgin ZFC curves at $T_p \sim 50-80$ K. Around these peaks the FC curves cross the ZFC plots thus at a certain temperature range ZFC>FC. This complex behavior is irreproducible and disappears in the second ZFC run. (ii) In a chiral-based magnetic memory device where the main components are: α -helix L-polyalanine adsorbed on gold, Al₂O₃ and Co or Ni layers. The peculiar ZFC>FC behavior is observed in the hard direction only. (iii) In a pathological liver tissues taken from a patient with hematological malignancies. This peculiar phenomenon cannot be ascribed to extra magnetic phases (oxygen or magnetite), and is believed to be an intrinsic property of the three unrelated systems. We may assume that in the ground state the intrinsic magnetic moments in each system are randomly distributed. In the first ZFC runs, low H, allign these moments to flip along its direction in a FM manner up to TP. Above TP, an antiparallel exchange (AFM) coupling is more favored and in the next ZFC and FC processes the net magnetic moments are lower and crosse the ZFC branchs. Alternatively, we may speculate that all systems are in the so called two-state system separated by a certain energy barrier.



Figure 1: Two ZFC and FC plots of a-CS sample measured at 500 Oe. The peak appears in the first ZFC(i) run and tottaly supresed in the second ZFC(ii) run. The two FCC curves coincide with each other.

Biography

Israel Felner has completed his PhD at the Hebrew University (HU) of Jerusalem, Israel and his Postdoctoral studies at UCSD, San-Diego, California, USA. Since 1973 till date, he has been working at the Racah Institute of Physics at the HU. He became a Full Professor in 1995 and served as the Chairman of Physics Studies during 2003-2006. His main interest topics are: magnetism and Mossbauer studies, magnetic, structural properties and mixed valencies of rare-earth based intermetallics, high Tc superconductivity and magneto-superconducting materials, search for new high Tc superconductors.

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