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Dr. Anand Mohan Awasthi, Ph.D. (1991); UCLA, Los Angeles (USA)

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Education

Aug 1986 – Dec 1991	**University of California, Los Angeles** (USA) Ph.D., Condensed Matter Physics
Aug 1982 – Jul 1983	**University of Pittsburgh,** Pittsburgh (USA) M.S., Physics
Jul 1978 – Jun 1980	**Indian Institute of Technology Kanpur** (India) M.Sc., Physics

Doctoral Work

Anand Mohan Awasthi: *Electrodynamics of Heavy-Fermions*. Ph.D. Supervisor: Prof. George Grüner.

Research Experience

Sep 1993 – present	**Scientist- H** **UGC-DAE CSR, Indore (India)-- Thermodynamics Laboratory** Network (rigidity) Evolution in Chalcogenide Glasses (structural, thermal, and vibrational studies). Multiferroicity in Perovskites & Multiglasses. Colossal Dielectric Constants: Strange Kinetics. Quantum Paraelectric Variants.
Feb 1992 – Jan 1993	**Post-Doctoral Fellow** **Ludwig Boltzmann Institut für Festkörperphysik, Vienna (Austria)** Commissioned Millimeter-Wave Resonator-Facility (D-band, ~150 GHz). Investigated Non-linear Microwave Response in High-T_c Superconductors.
Jul 1986 – Dec 1991	**Research Fellow** **UCLA Physics Dept. and Solid State Science Center, Los Angeles (USA)** Microwave (35-150 GHz) Losses in HTSC's and Electrodynamics of Heavy-Fermion Intermetallics. Developed K_a-band (~35 GHz) Cavity Resonator, integrated with a ^{3}He (0.3 K-RT) Refrigerator. HTSC Losses (60 GHz) under 7 Tesla ***B***-field using Indigenously Developed Dielectric-Resonator Facility.

Teaching Experience

Jul 1994 – present **Past and Running Experience**
UGC-DAE CSR, Indore (India)-- Thermodynamics Laboratory
Adv. Math. Physics, Phase Transitions, Thermal Properties,
Fourier Techniques in Spectroscopy.

Aug 1983 – Jul 1986 **Teaching Assistant**
Univ. of California (Dep. Physics & Astronomy), Los Angeles, CA (USA)
Advanced MS Physics Tutorials and UG Laboratories.

Aug 1982 – Jul 1983 **Teaching Assistant**
University of Pittsburgh (Physics & Astronomy), Pittsburgh, PA (USA)
UG Laboratories.

Skills & Activities

Skills Condensed Matter Physics, Thermal Analysis, High Magnetic Fields, Low Temperature Physics, RF/Microwaves, Differential Scanning Calorimetry, Glasses, Multiferroics, Research Management, Academic Testing & Evaluation.

Interests Sports & Outdoors: Adventure, Trekking, Camping, Driving, DIY.
Popular Science: Scientific American, National Geographic, Quanta Magazine.
Favorite Journals: Rev. Mod. Phys, Adv. Physics, Rep. Prog. Phys, Physics.

Publication Highlights

Smita Chaturvedi, Priyank Shyam, Rabindranath Bag, Mandar M. Shirolkar, Jitender Kumar, Harleen Kaur, Surjeet Singh, A.M. Awasthi, Sulabha Kulkarni: *Nanosize effect: Enhanced compensation temperature and existence of magnetodielectric coupling in $SmFeO_3$*. Physical Review B **96**, 024434 (2017).

Suchita Pandey, Jitender Kumar, A.M. Awasthi: *Magneto-thermally Activated Spin-state Transition in $La_{0.95}Ca_{0.05}CoO_3$: Magnetically-tunable Dipolar Glass and Giant Magneto-electricity*.
Physical Chemistry Chemical Physics **18**, 6569 (2016).

Jitender Kumar, A.M. Awasthi: *Quantum paraelectricity in copper-titanates: Magnetic-order driven vitrification*. Journal of Applied Physics **118**, 034103 (2015).

Deepak Sharma, Sujatha Sampath, A.M. Awasthi: *Evolution of structural (α) relaxation-time anomalies in Ge_xSe_{1-x} Chalcogenide glasses*. Materials Research Express **2**, 055201 (2015).

Suchita Pandey, Jitender Kumar, A.M. Awasthi: *Magneto-dielectric behaviour in $La_{0.53}Ca_{0.47}MnO_3$.*
Journal of Physics D: Applied Physics **47**, 435303 (2014).

Sonu Namdeo, A.M. Awasthi, S.D. Kaushik, V. Siruguri: *Disorder-Driven Spin-Reorientation in Multiferroic h-$YMn_{1-x}Fe_xO_3$*. Journal of Applied Physics **116**, 024105 (2014).

A.M. Awasthi, S. Bhardwaj, V.P.S. Awana, A. Figini Albisetti, G. Giunchi, A.V. Narlikar: *Carrier transport in magnesium diboride: Role of nano-inclusions*. Applied Physics Letters **103**, 112601 (2013).

Jitender Kumar, A.M. Awasthi: *Glassy domain wall matter in KH_2PO_4 crystal: Field-induced transition*.
Applied Physics Letters **103**, 132903 (2013).

A.M. Awasthi, Jitender Kumar: *Discovery of strange kinetics in bulk material: correlated dipoles in $CaCu_3Ti_4O_{12}$*. Journal of Applied Physics **112**, 054108 (2012).

Journal Publications (*h*-index 23; Citations 2157)

T. Chabri, A.M. Awasthi, Kartik Ghosh, A. Venimadhav, and T.K. Nath: *Temperature and magnetic field dependent martensite transformation in Al doped Ni-Mn-Sn disorder alloys and its effects on magnetoresistance and magnetocaloric effect near room temperature*. Mater. Res. Express 06/2018, 5:086511. DOI: 10.1088/2053-1591/aacdca

T. Chabri, A. Ghosh, Sunil Nair, A.M. Awasthi, A, Venimadhav, and T.K. Nath: *Effects of the thermal and magnetic paths on first order martensite transition of disordered Ni45Mn44Sn9In2 Heusler alloy exhibiting a giant magnetocaloric effect and magnetoresistance near room temperature*. J. Phys. D: Appl. Phys. 03/2018, 51:195001. DOI: 10.1088/1361-6463/aaba9b

Anjali, Balbir Singh Patial,, S. Bhardwaj, A.M. Awasthi, Nagesh Thakur: *On the AC-conductivity mechanism in nano-crystalline Se79-xTe15In6Pbx (x = 0, 1, 2, 4, 6, 8 and 10) alloys*. Physica B: Condensed Matter 08/2017, 523:52. DOI: 10.1016/j.physb.2017.08.001

Smita Chaturvedi, Priyank Shyam, Rabindranath Bag, Mandar M. Shirolkar, Jitender Kumar, Harleen Kaur, Surjeet Singh, A.M. Awasthi, and Sulabha Kulkarni: Nanosize effect: *Enhanced compensation temperature and existence of magnetodielectric coupling in SmFeO3*. Physical Review B 07/2017; 96:024434. DOI: 10.1103/PhysRevB.96.024434

Kaushal K. Shukla, Arkadeb Pal, Abhishek Singh, Rahul Singh, J. Saha, A.K. Sinha, A.K. Ghosh, S. Patnaik, A.M. Awasthi, and Sandip Chatterjee: *Hidden transition in multiferroic and magnetodielectric $CuCrO_2$ evidenced by ac-susceptibility*. Europhysics Letters 06/2017; 118:27008. DOI: 10.1209/0295-5075/118/27008

Y. Govinda Reddy, A. Sadananda Chary, A.M. Awasthi, and S. Narender Reddy: *Structural, morphological, and impedance spectroscopic studies on (1-x)Pb(NO3)2: xCeO2 composite solid electrolytes*. Advanced Materials Proceedings 04/2017; 2(10):667. DOI: 10.5185/amp.2017/985

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Sanjay Singh, K.R.A. Ziebeck, E. Suard, P. Rajput, S. Bhardwaj, A.M. Awasthi, S.R. Barman: *Modulated structure in the martensite phase of Ni1:8Pt0:2MnGa: A neutron diffraction study*. Appl. Phys. Lett. 10/2012; 101(17):171904. DOI:10.1063/1.4760270

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N.S. Sangeetha, A Thamizhavel, C.V. Tomy, Saurabh Basu, A.M. Awasthi, S. Ramakrishnan, D. Pal: *Interplay of superconductivity and charge density wave ordering in pseudoternary alloy compounds: Lu2Ir3(Si1−xGex)5, Lu2(Ir1−xRhx)3Si5, and (Lu1−xScx)2Ir3Si5*. Physical Review B 07/2012; 8620(2-86, 024524):72-15. DOI:10.1103/PhysRevB.86.024524

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A. Edukondalu, M. Purnima, Ch. Srinivasy, T. Shripathi, A.M. Awasthi, Syed Rahman, K. Siva Kumar: *Mixed alkali effect in physical and optical properties of Li2O–Na2O–WO3–B2O3 glasses*. Journal of Non-Crystalline Solids 06/2012; 358(18-19):2581. DOI:10.1016/j.jnoncrysol.2012.06.004

Ch. Srinivasu, V. Sathe, A.M. Awasthi, Syed Rahman: *Structural and transport properties of quaternary glass system: LiF–Li2O–SrO–Bi2O3*. Journal of Non-Crystalline Solids 11/2011; 357(3-0022-3093):1051. DOI:10.1016/j.jnoncrysol.2010.10.027

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Mulayam Singh Gaur, Bhupendra Singh Rathore, Pramod Kumar Singh, Ajaypal Indolia, Anand Mohan Awasthi, Suresh Bhardwaj: *Thermally stimulated current and differential scanning calorimetry spectroscopy for the study of polymer nanocomposites*. Journal of Thermal Analysis and Calorimetry 07/2010; 101(1). DOI:10.1007/s10973-010-0675-2

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Research Briefs

Magneto-dielectric spectroscopy of $La_{0.95}Ca_{0.05}CoO_3$ covering the crossover of spin states reveals strong coupling of its spin and dipolar degrees of freedom [1]. Signature of spin-state transition at 30K clearly manifests in the magnetization data. Dispersive activation-step in the dielectric constant $\Delta\varepsilon'_\omega(T)$ and associated relaxation-peak in imaginary permittivity $\varepsilon''_\omega(T)$ characterize the allied influence of coexistent spin-states on the electrical transport character. The accelerating-influence of magnetic- field on strongly allied dipolar degrees of freedom simulates temperature-increment effects, establishing the disordered transition in $La_{0.95}Ca_{0.05}CoO_3$ as magneto-thermally-activated. Splitting of the low-spin (LS)-rich matrix into nanometric intermediate-spin (IS)-droplets (LS→LS-IS disorder) under applied magnetic field is found to dramatically alter the organization of their associated dipoles; from glassy character in the LS-state to super-paraelectric-like nano-clusters in the IS-state. The resulting giant magneto-electricity spanning sizeable thermo-spectral range registers diverse signatures here in the kinetic, spectral, and field behaviors.

Quantum Paraelectricity (QP) [2] manifests in the dielectric constant $\varepsilon'(T)$ following typical Barrett dependence [3], which deviates below a crossover temperature T_1 from that of thermally-randomized Curie-form ($\sim T^{-1}$), and saturates at low temperatures $T << T_1$. Quantum critical (QC) nature of QPs manifests as $\sim T^2$ behaviour of $1/\chi_e$ below T_1 [4]. An interesting electrical-variant discovered at CSR [5] exhibits both the high- and mid-T characteristics as per expected of QP's, but turns glassy near its antiferromagnetic (AFM) ordering temperature T_N, due to strong spin-phonon coupling rooted in Ti^{4+} cations. This exotic quantum paraelectric glass (QPG) state emerges since the bulk AFM ordering renders the quantum fluctuations sub-critical, assigning them medium-range dynamical length-scale; resulting in dispersive $\omega_p(T)$ humps in the dielectric constant, deviant from the low-T Barrett-saturation. Novelty of the QPG state has been rigorously established in two copper-titanates ($SrCu_3Ti_4O_{12}$ [5] and $Ca_{0.9}Li_{0.1}Cu_3Ti_4O_{12}$ [6]), where the high-T AFE-like dipolar-correlations found intrinsic to QP-parent unequivocally exclude any polar- organization (resemblance to the classical relaxors) of the dipoles at low-temperatures. A universal QC-regime in QPs is identified as $0.3T_1 \leq T \leq 0.6T_1$.

Thermodynamic and magneto-transport/dielectric investigations of $La_{0.53}Ca_{0.47}MnO_3$ characterize its magneto-isostructural phase transition at ferromagnetic T_C =253K. Skew-broadened first-order transition features superheating temperature T^{**} almost next to T_C and supercooling temperature T^* exhibiting kinetics. Above T_C, linearly-related magneto-capacitance (MC) and magneto-resistance (MR) reflect purely MR effect while below, the high-frequency MC(5T) much exceeding the magneto-losses is uncorrelated with dc MR(5T). This reflects intrinsic magneto-dielectricity in the FM-ordered state above ~ O(kHz) frequencies, traced to an intra-granular Maxwell-Wagner-type effect at the interface-region of PMI-FMM phase-coexistence [7]. Our study also suggests near-saturation of genuine (i.e., MR-independent) magneto-dielectricity with near-demise of FM-PM phase-coexistence beyond ~ O(T) fields. Therefore, in suitable ω-T-H domains, well-known magnetic phase-disorder features the non-polar yet appreciable magneto-dielectricity in this magneto-resistive system.

Field and temperature-dependent neutron diffraction of hexagonal-$YMn_{1-x}Fe_xO_3$ (x = 0, 0.05, 0.1) geometric-multiferroic [8] found the maiden compositional analogue of spin-reorientation [9], driven by the magnetic (Fe) doping. The magnetic ground state changes from a highly-frustrated ($\Gamma_1/YMnO_3$) to a lowly-frustrated ($\Gamma_2/YMn_{0.9}Fe_{0.1}O_3$) configuration, via a mixed [$(\Gamma_1+\Gamma_2)/YMn_{0.95}Fe_{0.05}O_3$] irreducible representation, which thermally evolves from Γ_1-rich (low-T) to Γ_2-rich (near-T_N) character. Lattice parameters and planar bond-lengths show large (minute) changes above (below) T_N, nearly uniformly altered in the doped specimens by the 5T field across the AFM transition, exhibiting strong magneto-elastic nature of the system. The applied 5T field adds to the disorder- induced suppression of the evaluated/planar-component of the ordered moment (μ_{ord}) via latter's off-plane/vertical canting, enhancing the doping-induced relief of the planar magnetic frustration. Concurrent to the disorder-driven spin-reorientation, magneto-electric coupling changes its sign.

Colossal dielectric constant (CDC) in $CaCu_3Ti_4O_{12}$ was attributed to the evolution of Kirkwood-Fröehlich dipole-correlations [10, 11], which reduce the moment-density with decreasing temperature, due to anti-parallel orienting dipoles. Maidenly estimated dipole-correlation-length achieves mesoscopic scale below 100K, suggesting a fractal-like self-similar configuration of Ca/Cu-rich sub-phases. Signatures of intrinsic nonlinearity as sub-Arrhenic kinetics, and of fractality in huge permittivity & its broad plateau mandate the prime role of *strange kinetics*-- witnessed for the first time in a *bulk complex-material*. The insight can be utilized to tune the CDC and characteristic-temperatures of CCTO; by enhancing the Ca/Cu site-occupancy disorder via chemical, thermal, mechanical, or electrical means, and to design advanced generation of CDC materials.

Dielectric study of KDP crystal below ferroelectric-T_C revealed that glassy domain-wall-matter (DWM) is sizescale-organized under high dc-bias-fields [12]. Vogel-Fulcher (VF) kinetics [13] of domain wall freezing (alpha-relaxation loss-peak at $T_f < T_C$) provides mildly $\boldsymbol{E}_{dc}$-variant VF- temperature ($T_0 \sim 90$K) and unusually smaller activation energy $U_a(\boldsymbol{E}_{dc}) \sim O(10\text{K})$, vis-à-vis both T_0 and T_f; latter starkly delineating the low- & high-field regimes. At high bias-fields, anomalous downshift in DW-pinning-frequency, changeover of sub-T_C electro-capacitance behavior, and steep- shrinkage of the sluggish-DW temperature-regime are all rooted in the segmentation (cooperativity) of domain wall motion. Higher-valued poled (vs. unpoled) permittivity obtained is compatible with the coexistence of pinned (metastable/field-quenched) and clustered DWM phases. A constructed *T-E* phase diagram correlates abrupt changes across $\boldsymbol{E}_{cr} \sim 70$kV/m in $T_C(V)$, $T_g(V)$, $T_0(V)$, $U_a(V)$, and glass- fragility $m(V)$ parameters, characterizing the mobile & sluggish (above & below T_g) states of DWM. The maiden findings mandate a field-induced glass-glass transition between locally-pinned and clustered phases of domain-wall-matter.

Long-elusive signature of the superconducting transition (T_c) in thermal conductivity of MgB_2 registers clearly in scarcely-explored specimen featuring MgO nano-inclusions (NI's) [14]. Extended NI's make irrelevant the otherwise hindering effects of two-bands and gap-anisotropy, and forbid the anomaly cancel-off resulting from equal and opposite electronic & phononic features. Anomaly- detection here is traced to relatively appreciable phononic conduction, and its dominant electronic- scattering. The self-formed MgO as extended defects strongly scatter the charge carriers, and minutely scatter the phonons with their longer-mean-free-path near T_c. Conversely, near room temperature, strong scattering of the shorter-dominant-wavelength phonons off the nano-inclusions localizes the atomic vibrations. This makes localized phonons to undergo ballistic to diffusive crossover, and eventually enter the Ioffe-Regel mobility threshold regime ($\ell_{ph} \sim a_{latt}$). The electronic-transport in nano-inclusioned MgB_2 seems akin to the single-gap (Δ_σ) BCS kind in its superconducting state.

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