

Muhammad Sabieh Anwar

Department of Physics
Syed Babar Ali School of Science and Engineering
Lahore University of Management Sciences (LUMS), Pakistan
URL: <http://physlab.org>

Education

- **D.Phil Physics, University of Oxford, UK** 2004
Dissertation topic: *NMR Quantum Information Processing Using Para-Hydrogen.*
- **BS in Electrical Engineering with specialization in Communications, University of Engineering and Technology, Lahore, Pakistan** 2000
Thesis title: *Design and implementation of signal acquisition and DSP systems for cardiodynamic measurements*

Academic Appointments

- **Associate Professor of Physics (Tenured)** March 2013–present
LUMS School of Science & Engineering, Pakistan
- **Visiting Research Physicist** 2017
Advanced Light Source, Lawrence Berkeley National Laboratory, USA
- **Chair of Physics Department** December 2011–January 2015
LUMS School of Science & Engineering, Pakistan
- **Visiting Associate Professor** August 2013 - December 2013
Middle East Technical University (METU) North Cyprus Campus, Turkey
- **Assistant Professor of Physics (Tenure Track)** April 2007–2013
LUMS School of Science & Engineering, Pakistan
- **Postdoctoral Physicist** September 2005–March 2007
Division of Materials Science, Lawrence Berkeley National Labs, Berkeley and
Department of Chemistry, University of California, Berkeley.
- **Postdoctoral Physicist** January 2005–August 2005
National Center for Physics, Islamabad.
- **Assistant Professor (Adjunct)** March 2005–August 2005
Department of Physics, COMSATS Institute of Information Technology, Islamabad.

Research Interests

Optical detection of spintronic and magnetic resonance effects; Magneto-plasmonics; Nano-magnetism; Physics education and development of low-cost educational tools; Scientific instrumentation design and development

Awards and Fellowships

1. Pakistan National Innovation Award (2015)
2. Research and Productivity Award from Pakistan Council of Science and Technology (2011, 2012)
3. TWAS Prize in Physics for Pakistan (2007)
4. Rhodes Scholarship (2001-04)

5. G. A. Paul Scholarship, University College, Oxford (2003-04)
6. Allama Iqbal Medal, Ministry of Education, Pakistan (2000)
7. Aizaz-e-Sabqat (1999), from the President of the Islamic Republic of Pakistan
8. Government College Academic Roll-of-Honour (1996)
9. Government College Extra-curricular Certificate of Merit (1996)

Research grants

1. **Optical detection of spin phenomena**, *Higher Education Commission 2012* (\approx Rs. 20 million).
2. **Development of low field, low cost, reconfigurable NMR and MR**, *Pakistan Science Foundation 2016* (\approx Rs. 2.5 million).
3. **Development and running of weather station for monitoring fog in the Indo-Ganges plain**, in collaboration with *NUST School of Environmental Engineering 2016* (\approx Rs. 0.2 million).
4. **National Science and Math Campaign**, *Alif Ailaan 2016* (\approx Rs. 2.4 million).
5. **Observing magnetization dynamics of single molecular magnets using polarized light**, *LUMS's Faculty Initiative Fund 2014* (\approx 0.5 million).
6. **Fine-tuning of an in-house developed atomic force microscope**, *LUMS's Faculty Initiative Fund 2015* (\approx 1 million).
7. **Building quantum communication laboratories at LUMS**, *LUMS's Faculty Initiative Fund 2016* (\approx 1 million).
8. **Low-field, hyperpolarized magnetic resonance**, *LUMS's Faculty Initiative Fund 2017* (\approx 1 million).
9. **Physics entrepreneurship**, developed and transferred physics experiments to various Universities in Pakistan, 2009-18 (\approx Rs. 7 million).
10. *Submitted: Optical properties of quantum materials*, Higher Education Commission (\approx Rs. 20 million).
11. *Submitted: Ultrafast spectroscopy of stable perovskite based solar cells*, Pakistan Science Foundation and National Science Commission, People's Republic of China (\approx Rs. 20 million).
12. *Co-P.I. with Dr. Falak Sher (Chemistry, SSE) on the project: Development of thermoelectric oxides for renewable energy conversion technologies* *LUMS's Faculty Initiative Fund* (\approx Rs. 1 million).
13. *Co-P.I. with Dr. Basit Yameen (Chemistry, SSE) on the project: Development of protonic groups containing polymer brush modified additives to improve the proton conductivity of polyelectrolytic membranes for fuel cell applications*, *Higher Education Commission* (\approx Rs. 6 million).

Selected academic assignments (outside LUMS only)

1. Member Board of Studies COMSATS Institute of Information Technology, Physics Department, Islamabad; Electrical Engineering Department, Government College University, Lahore; Khawaja Fareed University of Engineering and Technology, Rahim Yar Khan; Centre for High Energy Physics, University of the Punjab, Lahore; Department of Physics, University of the Punjab; Faculty of Engineering Sciences (for the Photonics Programme), Ghulam Ishaque Khan Institute of Engineering Sciences and Technology, Topi; Member Advisory Board, Usman Institute of Technology Karachi; external expert on the Postgraduate Research Committee, University of Engineering and Technology, Lahore.
2. Member Task Force on Strengthening Math and Science Education in Punjab, Planning Commission Punjab and Punjab Higher Education Commission.
3. Member task force on the Culture of Science, Islamic World Academy of Sciences, Amman, Jordan.
4. Math and science adviser, Alif Ailaan education campaign.
5. Member National Scientific Advisory Council, National Centre for Physics, Islamabad.
6. General Secretary Khwarizmi Science Society, Pakistan.
7. Frequent reviewer for HEC's National Research Program for Universities (NRPU) scheme
8. Former Secretary of the HEC's National Curriculum Revision Task Force for Physics, 2013
9. Developed curriculum for the Federal Public Service Commission (PFSC) examination in physics (2014)
10. Ph.D. examiner, Department of Physics, COMSATS Institute of Information Technology; Ghulam Ishaque Khan Institute of Engineering Sciences and Technology (Topi, Swabi).
11. Reviewer for the journals: Proceedings of the National Academy of Science (PNAS), Applied Optics, Photonics Research, Bulletin of Materials Science, American Journal of Physics, Journal of Crystal Growth, Solid State Sciences, Photonics Research, Optical Engineering, European Journal of Physics.
12. Former member of the Lahore Chamber of Commerce and Industries Task Force on Science and Technology.
13. COMSATS Science Diplomat in the Area of Technology (selected in 2015).
14. Member Lahore Knowledge City Task Force.
15. Member OIC consultative committee on physics (2014-15).
16. Member Rhodes Scholarship selection committee for Pakistan.

Research Publications

Refereed International Journals

1. "Novel bimetallic complexes Cu(II)/Nd(III) and Ni(II)/La(III) derived from bifunctional Schiff base: synthesis, characterization and magnetic studies", T. Fatima, A. Akbar, I. Din, M.N. Tahir, A. Raheel and **M.S. Anwar**, submitted to Acta Crystallographica Section C.
2. "Polarization insensitive and multifunctional all dielectric nanowaveguides", M. Q. Mehmood *et al*, submitted to ACS Nano (2018).

3. "Optimization of DyFe nanostructures using E-beam lithography for magneto-optical applications", A. Akbar, S. Naseem, K. Abbas, S. Atiq, **M.S. Anwar**, submitted to Journal of Magnetism and Magnetic Materials (2018).
4. "Optimization of magneto-dielectric coupling in Mn substituted BiFeO₃ for potential memory devices", A.H. Khan, S. Aatiq, **M. S Anwar**, S. Naseem and S.K. Abbas, Journal of Materials Science: Materials in Electronics, doi: 10.1007/s10854-018-9281-z, 2018.
5. "Magnetic dynamics and all-optical switching in 5 nm Dy-Fe nanostructures", A. Akbar, M. Saleem, S. Atiq and **M.S. Anwar**, IEEE Transactions in Magnetism, doi: 10.1109/TMAG.2018.2825956 (2018).
6. "Copper modified anode for inverted planar perovskite solar cells with enhanced open-circuit voltage and efficiency", C. Han et al, submitted to Organic Electronics (2018).
7. "Improved efficiency of inverted perovskite solar cells via surface plasmon resonance effect of Au@PSS core-shell tetrahedra nanoparticles", H. Hao et al, Solar RRL, <https://doi.org/10.1002/solr.201800061> (2018).
8. "Synthesis and properties of nickel doped nanocrystalline barium hexaferrite ceramic materials", M. Waqar, M.A. Rafiq, F.A. Khalid, A. Khaliq, **M.S. Anwar**, M. Saleem, Applied Physics A 124, 286 (2018).
9. "Magneto-optic characterization of terbium gallium garnet under Voigt geometry", A. Akbar, W. Khalid and **M.S. Anwar**, Optics Express 25, 30550 (2017).
10. "Dielectric meta-holograms enabled with dual magnetic resonances in visible light", Z. Li, I. Kim, L. Zhang, M.Q. Mehmood, **M.S. Anwar**, M. Saleem, D. Lee, K.T. Nam, S. Zhang, B.S. Luk'yanchuk, Y. Wang, G. Zheng, J. Rho, and C.-W. Qiu, ACS Nano 10.1021/acsnano.7b04868 (2017).
11. "'PhysTrack': a Matlab based environment for video tracking of kinematics in the physics laboratory", U. Hasan and **M.S. Anwar**, European Journal of Physics 38, 045007 (2017).
12. "Demonstrating the value of physics", **M.S. Anwar**, Physics World (December, 2016).
13. "Structural engineering of ZnO with doping of group-II (Mg, Sr, Ba) elements as suitable candidates for light emitting diodes", M. Saleem, S.Z. Hussain and **M.S. Anwar**, Applied Physics A 122, 589 (2016).
14. "700 keV Ni⁺² ions induced modification in structural, surface, magneto-optic and optical properties of ZnO thin films", M. F. Khan, K. Siraj, M. Irshad, **M.S. Anwar**, J. Hussain, H. Faiz, S. Majeed, M. Dosmailov, J. Patek, J. D. Pedarnig, M. S. Rafique, S. Naseem, Nuclear Instruments and Methods 368, 45–49 (2016).
15. "Structural, dielectric, and impedance study of ZnO-doped barium zirconium titanate (BZT) ceramics", Q.K. Muhammad, M. Waqar et al., Journal of Materials Science, doi:10.1007/s10853-016-0231-y (2016).
16. "Near fields from disk and spherical magnets: Comment on "Measurement of the magnetic field of small magnets with a smartphone [Eur. J. Phys. 36, 065002 (2015)]", A. Iqbal and **M. S. Anwar**, European Journal of Physics 37, 028001 (2016).
17. "Effect of CuO on structure and impedance of (K_{0.5}Na_{0.5}Nb_{0.995}Mn_{0.005}O₃) lead free piezoelectric ceramics", A. Kamal, Muhammad A Rafiq, M. Usman, **M. S. Anwar**, submitted to Applied Physics A (2016).
18. "Analyzing combinations of circular birefringence, linear birefringence and elliptical dichroism in magneto-optic rotators", **M.S. Anwar**, H. Majeed, A. Shaheen, Journal of Modern Optics 62, 72–84 (2015).

19. "Dielectric and magnetic investigations of mixed cubic spinel ferrites with controlled Mg content", A.H. Piracha, M. Saleem, S.M. Ramay, S. Atiq, S.A. Siddiqi, **M.S. Anwar**, Journal of Electroceramics DOI:10.1007/s10832-014-9960-y (2014).
20. "Defects induced magnetization in B-doped ZnFeO dilute magnetic semiconductors", M. Saleem, **M.S. Anwar**, A. Mahmood, S. Atiq, S.M. Ramay, S.A. Siddiqi, Physica B: Condensed Matter, DOI:10.1016/j.physb.2015.03.001 (2015).
21. "Chitosan-based electrospun nanofibrous mats, hydrogels and cast films: Novel anti-bacterial wound dressing matrices for controlled release of cefixime", S. Shahzada, M. Yarb, S.A. Siddiqi, N. Mahmood, A. Rauf, Z. Qureshi, **M.S. Anwar**, S. Afzaal, Journal of Materials Science: Materials in Medicine, DOI:10.1007/s10856-015-5462-y (2015).
22. "Tritethyl orthoformate mediated a novel crosslinking method for the preparation of hydrogels for tissue engineering applications: characterization and in vitro cytocompatibility analysis", M. Yar, S. Shahzad, S.A. Siddiqi, N. Mahmood, A. Rauf, M.S. Anwar, AA. Chaudhry, I. Rehman, Materials Science and Engineering C 54, 154–164 (2015).
23. "Ultra-large rotary dispersion in terbium gallium garnet crystal at low temperatures", A. Shaheen, J. Majeed, **M.S. Anwar**, Applied Optics 52, 5549–5554 (2015).
24. "Video motion analysis with automated tracking using elementary computer vision techniques: an insight", B.A. Usman, **M.S. Anwar**, European Journal of Physics 36, 065049 (2015).
25. "Accessing select properties of the electron with ImageJ: an open-source image-processing paradigm", J. Alam, A. Shaheen, **M.S. Anwar**, European Journal of Physics, 35, 015011 (2014) [Cover image].
26. "Fourier analysis of thermal diffusive waves", M. Wasif, J. Alam, Rafiullah, S. Shamim, W. Zia, **M.S. Anwar**, American Journal of Physics 82, 928 (2014) [Featured article].
27. "Complete Stokes polarimetry of magneto-optical Faraday effect in a terbium gallium garnet crystal at cryogenic temperatures", H. Majeed, A. Shaheen, **M.S. Anwar**, Optics Express, 21, 25148-25158 (2013).
28. "A visual classroom demonstration of frustrated total internal reflection as an analogue to optical tunnelling", R. Salman, S. Rashid and **M.S. Anwar**, European Journal of Physics, 34, 1439-1444 (2013).
29. "Video-based investigations on a nonlinear vibrating string", U. Hassan, Z. Usman, **M.S. Anwar**, American Journal of Physics, 80, 862 (2012) [Cover article].
30. "Effect of annealing time on structural and magnetic properties of laser ablated oriented Fe₃O₄ thin films deposited on Si (100)", S.M. Ramay, Saadat A. Siddiqi, **M.S. Anwar**, C.Y. Park, S-C. Shin, Bulletin of Materials Science, 35, 501 (2012).
31. "Enhanced Magnetic Moment of Epitaxial γ -Fe₄N Films at Low Temperatures", Shahid Atiq, M. Saleem, Saadat A. Siddiqi, **M.S. Anwar**, S-C. Shin, Journal of the Korean Physical Society, 60, 1745-1748 (2012).
32. "Precise measurement of velocity dependent friction in rotational motion", J. Alam, H. Hassan, S. Shamim, W. Mahmood, **M.S. Anwar**, European Journal of Physics, 32, 1367-1375 (2011).
33. "Carriers-mediated Ferromagnetic Enhancement in Al-Doped ZnMnO Dilute Magnetic Semiconductors", M. Saleem, S.A. Siddiqi, S.Atiq, **M.S. Anwar**, I. Hussain, S. Alam, Materials Characterization, 62, 1102-1107 (2011).
34. "Experimental determination of heat capacities and their correlation with theoretical predictions", W. Mahmood, **M.S. Anwar**, W. Zia, American Journal of Physics, 79, 1099-1103 (2011).

35. "The sound card: an inexpensive tool for data acquisition", U. Siddiqui, S. Pervaiz, **M.S. Anwar**, *The Physics Teacher*, 49, 537 (2011).
36. "Enhancement of energy product with insertion of Ti between exchange coupled SmCo and Fe layers", F. Shahzad, S.A. Siddiqi, S-S. Yan, **M.S. Anwar**, S.M. Ramay, *Int. Jour. Mod. Phys. B*, 25, 2957-2963 (2011).
37. "Influence of temperature on structural and magnetic properties of CoMnFeO ferrites", S.M. Ramay, M. Saleem, S. Atiq, S. A. Siddiqi, S. Naseem, **M.S. Anwar**, *Bulletin of Materials Science*, 34, 1415-1419 (2011).
38. "Room temperature magnetic behavior of sol-gel synthesized Mn doped ZnO", M. Saleem, S.A. Siddiqi, S. Atiq, **M.S. Anwar**, *Chinese Journal of Chemical Physics*, 23, 469-472 (2010).
39. "Curie point, susceptibility and temperature measurements of rapidly heated ferromagnetic wires", **M.S. Anwar**, W. Zia, *Review of Scientific Instruments*, 81, 124904 (2010).
40. "Investigating viscous damping using a webcam", S. Shamim, W. Zia, **M.S. Anwar**, *American Journal of Physics*, 78, 433-436(2010). [**Featured article**]
41. "Structure-independent universality of Barkhausen criticality in iron-nitride thin films", S. Atiq, S.A. Siddiqi, H-S. Lee, **M.S. Anwar**, S-C. Shin, *Solid State Communications* doi:10.1016/j.ssc.2010.04.022.
42. "Reducing Noise by Repetition: Introduction to Signal Averaging", Umer Hassan and **M.S. Anwar**, *Eur. J. Phys.* 31, 453-465, 2010.
43. "Effect of temperature on structural and magnetic properties of laser ablated iron oxide deposited on Si(100)", S.M. Ramay, S.A. Siddiqi, **M.S. Anwar**, S-C. Shin, *Chinese Physics Letters*, 26, 117504 (2009).
44. "Simple circuit for investigating noise in the undergraduate laboratory", U. Hassan, S. Shamim, **M.S. Anwar**, *European Journal of Physics*, 30, 1143-51 (2009).
45. "Undesired gradients in low field magnetic resonance imaging", Rafullah, **M.S. Anwar**, *Concepts in Magnetic Resonance Part A*, 34A, 173-190 (2009).
46. "Picomolar sensitivity MRI and photoacoustic imaging of Co nanoparticles", L.S. Bouchard, **M.S. Anwar**, G. L. Liu, B. Hann, H. Xie, G.W. Gray, X. Wang, A. Pines. F. Chen, *Proceedings of National Academy of Science* 106, 4085-4089 (2009).
47. "Imaging of catalytic hydrogenation in microreactors using para-hydrogen", L.-S. Bouchard, S.R. Burt, **M.S. Anwar**, K.V.Kovtunov, I.V. Koptug and A. Pines, *Science* 319, 442 (2008).
48. "Synthesis of matched magnetic fields for controlled spin precession", L.-S. Bouchard, **M.S. Anwar**, *Physical Review B* 71, 011430 (2007).
49. "Spin coherence transfer in chemical transformations monitored by remote detection NMR", **M.S. Anwar**, C. Hilty, C. Chu, L.-S. Bouchard, K. Pierce, A. Pines, *Analytical Chemistry* 79, 2806 (2007).
50. "Para-hydrogen induced polarization in heterogeneous hydrogenation reactions", I.V. Koptug, K. Kovtunov, S.R. Burt, **M.S. Anwar**, C. Hilty, S.-I. Han, Z. Sagdeev, A. Pines, *Journal of American Chemical Society* 129, 5580 (2007).
51. "Para-hydrogen enhanced gas-phase MRI", L.-S. Bouchard, K. Kovtunov, S.R. Burt, **M.S. Anwar**, I.V. Koptug, Z. Sagdeev, A. Pines, *Angewandte Chemie International Edition* 46, 4064 (2007) - ranked very important paper (VIP).

52. "Sharing polarization within quantum subspaces", **M.S. Anwar**, J.A. Jones, S.B. Duckett, Physical Review A 73, 022322 (2006).
53. "Contrasting photochemical and thermal reactivity of $Ru(CO)_2(PPh_3)(dppe)$ towards hydrogen rationalized by parahydrogen NMR and DFT studies", D. Blazina, J. P. Dunne, S. Aiken, S. B. Duckett, C. Elkington, J. E. McGrady, R. Poli, S. J. Walton, **M.S. Anwar**, J. A. Jones, H. A. Carteret, Dalton Transactions 2072 (2006).
54. "Creation and interrogation of a pure nuclear spin state using para-hydrogen enhanced NMR spectroscopy: a defined starting point for quantum computation", D. Blazina, S. B. Duckett, T. K. Halstead and R. J. K. Taylor, **M.S. Anwar**, J. A. Jones and H. A. Carteret, Magnetic Resonance in Chemistry 43, 200208 (2005).
55. "Practical implementation of the twirl operation ", **M.S. Anwar**, L.Xiao, A. Short, J.A. Jones, D. Blazina, H.A. Carteret, S.B. Duckett, Physical Review A 71, 032327 (2005).
56. "Superconductivity in Sr-Y-Ba-Cu-O oxides", S. A. Siddiqi and **M.S. Anwar**, Czechoslovak Journal of Physics 55, 8592 (2005).
57. "Implementing quantum search on a para-hydrogen pure state NMR quantum computer ", **M.S. Anwar**, D. Blazina, H.A. Carteret, S. Duckett, J.A. Jones, Chemical Physics Letters 400, 9497 (2004), quant-ph/0407091.
58. "Implementation of quantum computation with para-hydrogen derived pure quantum states ", **M.S. Anwar**, D. Blazina, H.A. Carteret, S. Duckett and J.A. Jones, Physical Reviews A 70, 032324 (2004), quant-ph/0406044.
59. "Preparing pure initial states for nuclear magnetic resonance quantum computing" , **M.S. Anwar** et al., Physical Review Letters 93, 040501 (2004), quant-ph/0312014.
60. "Impedance spectroscopy, XRD and SEM of oxide added Si₃N₄", Nasir A. Khan, S. A. Siddiqi and **M.S. Anwar**, Modern Physics Letters B, 16(14), 525538, 2002.

Refereed International Conferences

61. "Investigating nonlinear dynamics in the physics teaching laboratory", J. Alam, U. Latif, and **M.S. Anwar**, poster presentation at the The 2015 Hands-On School on Research in Complex Systems, Abdus Salam ICTP, Trieste (Italy), 28 June to 10 July 2015.
62. "A case study of lab development in the developing world", **M.S. Anwar**, poster at the Physics Education Research Conference PERC 2015, Maryland (USA), 29 to 30 July 2015.
63. "Smart Physics Experiments using Smartphone-based sensors and Automatic Tracking in Video Analysis", B.A. Usman, **M.S. Anwar**, The International Conference on Physics Education, Cordoba, Argentina, Aug 18-22 (2014).
64. "Employing real experiments and modern viewpoints in the teaching of introductory quantum physics", **M.S. Anwar**, The International Conference on Physics Education, Cordoba, Argentina, Aug 18-22 (2014).
65. "Investigating connections between thermal energy, electric currents and magnetism in the laboratory setting", **M.S. Anwar**, The International Conference on Physics Education, ICPE-EPEC, Prague, Aug 5-9 (2013).
66. "Developing Physics Laboratories in the Developing World", **M.S. Anwar**, The International Conference on Physics Education, ICPE-EPEC, Prague, Aug 5-9 2013.
67. "Hyperpolarized gas-phase MR imaging of reactions in microreactors", **M.S. Anwar**, Louis-S Bouchard, S. R. Burt, K. Kovtunov, I. Koptuyug, A. Pines, Euromar 2009, July 5-7 (2009), Goteborg, Sweden.

68. “Para-hydrogen induced polarization in heterogeneous hydrogenation reactions”, S.R. Burt, **M.S. Anwar**, K. Kovtunov, I. V. Koptug, Z. Sagdeev, A. Pines at 48th Experimental Nuclear Magnetic Resonance Conference, April 2227, (2007), Pacific Grove, California.
69. “Gas-phase hyperpolarized imaging”, L.-S. Bouchard, **M.S. Anwar**, S.R. Burt, K. Kovtunov, I. V. Koptug, Z. Sagdeev, A. Pines at 48th Experimental Nuclear Magnetic Resonance Conference, April 2227, (2007), Pacific Grove, California.
70. “Para-hydrogen induced polarization in heterogeneous hydrogenation reactions catalyzed by supported catalysts”, S.R. Burt, **M.S. Anwar**, K. Kovtunov, I. V. Koptug, Z. Sagdeev, A. Pines at Eurocat V11 International Conference, 26-30 August, (2007), Torku, Finland.
71. “Para-hydrogen spin order in heterogenized homogeneous catalytic systems at International Conference on relationships between homogeneous and heterogeneous catalytic systems , 16-20 July, (2007), Berkeley, United States.
72. “Sharing Polarization in NMR Quantum Information Processors”, **M.S. Anwar**, J. A. Jones, S. B. Duckett, 47th Experimental Nuclear Magnetic Resonance Conference, April 2328, (2006), Pacific Grove, California.
73. “Remote Detection of NMR Applied to Imaging and Spectroscopy in Microfluidic Devices”, C. Hilty, E. McDonnell, J. Granwehr, K. Pierce, S-I. Han, C. Chu, **M.S. Anwar**, A. Pines, 47th Experimental Nuclear Magnetic Resonance Conference, April 2328, (2006), Pacific Grove, California.

National Conferences

74. “Achieving entanglement in liquid state NMR”, **M.S. Anwar**, 10th National Symposium on Frontiers in Physics, Pakistan Physical Society and Government College University, Lahore, Pakistan, 2005.
75. “Ensemble quantum computing with para-hydrogen”, 9th National Symposium on Frontiers in Physics, Pakistan Physical Society and Government College University, Lahore, Pakistan, 2003.
76. “Impedance spectroscopy, XRD and SEM of oxide added silicon nitride”, Nasir A. Khan, S. A. Siddiqi and **M.S. Anwar**, International Science Conference, Institute of Chemical Engineering and Technology, Punjab University, 26 - 28 October 2000.

Student supervision

PhD

I am currently supervising two PhD students: Ali Akbar and Muzamil Shah. Ali is in his fifth year of doctoral research. His dissertation is titled “Magneto-optical detection of spintronic effects” while Muzamil’s, who is in his third year, area of research is “Magneto-optic properties of low dimensional materials”.

Masters

1. Syed Waqar Ahmad (MS LUMS, 2018), *Design and development of a mobile nuclear magnetic resonance spectrometer*
2. Amna Najam (MS LUMS, 2018), *Rashba ferromagnets: magneto-optical properties*
3. Muhammad Umer (MS LUMS, 2015), *Magneto-optic ellipsometry of superlattices: theory, experiment and simulations*
4. Mehdi Khan (MS Chalmer University, Sweden, 2012), *Development of open access, reconfigurable MRI scanners*

5. Osama Usman (MS COMSATS, 2012), *Superoperators in NMR*
6. Mujtaba Hussain (MS COMSATS Islamabad, 2011), *Atomic studies of Rb vapor*
7. Aysha Aftab (MPhil Punjab University, 2009), *Phase-sensitive Faraday rotation in terbium gallium garnet and diamagnetic liquids*
8. Hadiah Binte Noor (MPhil Punjab University, 2009), *Computational X-ray crystallography*

Selected BS Final Year Projects

1. Waleed Khalid (LUMS, 2017), *Voigt effect in TGG crystal*
2. Ahmed Hembel *et al.* (LUMS, 2017), *Design and implementation of electric vehicle for Shell-Eco Marathon*
3. Azeem Iqbal (UMT, 2017), *Kalman filtering for the physics laboratory*
4. Injila Rasul (LUMS, 2017), *Mechanics of precessing disks and rings*
5. Usman Javid (NUST, 2015), *Atomic force microscopy*
6. Anusha Shahid (LUMS, 2015), *Magneto-optics of nanostructures*
7. Syed Alamdar Hussain Shah (LUMS, 2014), *Vibrating sample magnetometry: analysis and construction*
8. Sultan Abdul Wadood (NUST, 2015), *Design of a high-speed Field Programmable Gate Array FPGA for muon lifetime and velocity measurements*
9. Ammar Ahmad Khan *et. al* (LUMS, 2012), *Real-time polymerase chain reaction cyclers*
10. Abdullah Khalid *et. al* (LUMS, 2012), *Domestic concentrated solar thermal co-generation plants for Pakistan*
11. Hafiz Ahmed Masoud (Punjab University, 2010), *Differential detection of Faraday rotation, generation and detection of elliptically polarized light*
12. Rafi Ullah (Punjab University, 2008), *Concomitant gradients in magnetic resonance imaging*
13. Saman Naseer (Punjab University, 2008), *Numerical optimization of pulse sequences for NMR quantum information processors*

Summer Research Projects

Over the past several years, I have supervised around 100 research projects of varying durations. These projects have mostly involved investigations of physical phenomena, novel measurements, development of new gadgets and instruments, simulations on existing experiments and synthesis and characterization of materials.

Selected Courses Taught

Quantum Field Theory (2018); Magnetism: Theory and Experiments (2016); Electrodynamics (2016); Experimental Physics I (2008, 2009, 2010, 2011); Recitations for Electricity and Magnetism and Waves and Oscillation (2008); selected lectures in Mathematical Biology dealing with transcription networks (2008); Modern Physics (2009, 2011, 2013, 2018); Waves and Optics (2009); Demonstration on electrocardiography and pulse oxymetry and a lecture on “biological rhythm” in the Physiology Class (2009); reading group on “Quantum Magnetism” (2010); Atomic, Molecular and Laser Physics (2010, 2011); Experimental Physics II (2010, 2011, 2014, 2016); Experimental Physics III (2011, 2012); Lectures on NMR spectroscopy for the course Molecular Spectroscopy

(2011); Biophysics (2012); Condensed Matter Physics (2013); Quantum Mechanics I (2014); Quantum Mechanics II (2014); Electricity and Magnetism (2014, 2015); General Physics (Mechanics) (2013); Classical Mechanics (2015); Introduction to Quantum Information Science (course taught at Quaid-e-Azam University 2005); Nanoelectronics (MS course taught at UET, Lahore 2005).

Course material The webpage: <http://physlab.org/courses-taught/> compiles the course material, outlines, syllabi as well as video recordings of most courses I've taught.

Online recordings of classroom lectures Video recordings on the course *Modern Physics and statistical mechanics* are available on YouTube:

<http://www.youtube.com/playlist?list=PLeG1bdj-IqXNV61uorh0ARQuQA40t5kwU>

and for *Electricity and magnetism*, they can be accessed at

<https://www.youtube.com/playlist?list=PLeG1bdj-IqXMt68MOVLNR1kY1uTkxlmEt>.

Lectures on *Magnetism* can be found here: <http://physlab.org/class-teaching/magnetism-2016/>.

Classroom demonstrations I regularly design and build pedagogically relevant and intellectually appealing classroom demonstrations to assist in my teaching. For example, a mainstay of the course Electricity & Magnetism that I taught in Fall 2014 were the nearly dozen demonstrations that were studied throughout the span of the course. It was a real pleasure building these demonstrations, and refining the subtleties while maintaining their direct visual appeal. Thanks to our technical staff in the Physics Lab (Hafiz Rizwan, Khadim Mehmood, Azeem Iqbal, Afshan Jamshaid), who elegantly materialized my ideas as we slowly build an impressive array of demonstrations all supplied with pictorial procedures and in most cases, video recordings to help teachers replicate these ideas in their own teaching. See the link:

<http://physlab.org/class-demos/>.

Course evaluations

Sr. No.	Course	Semester	Instructor (5.00)	Course (5.00)
1.	Quantum Field Theory	S2017	4.20	4.28
2.	Modern Physics (enrollment > 280)	S2017	4.57	4.27
3.	Magnetism: theory and experiment	F2016	4.55	4.41
4.	Electricity & magnetism	F2015	4.43	3.66
5.	Electricity & magnetism (enrollment > 120)	F2014	4.79	4.40
6.	Experimental physics II	F2014	4.28	4.22
7.	Quantum mechanics II	F2014	4.56	4.56
8.	Quantum mechanics I	S2014	4.42	4.11
9.	Condensed matter physics	S2013	4.83	4.83
10.	Modern physics (enrollment > 200)	S2013	4.83	4.60
11.	Experimental physics II	F2012	3.94	3.56
12.	Biophysics	S2012	4.88	4.42
13.	Experimental physics III	S2012	4.44	4.33
14.	Atomic, molecular and laser physics	F2011	4.44	4.34
15.	Modern physics	F2011	4.16	3.85
16.	Atomic, molecular and laser physics	F2010	4.49	4.52
17.	Experimental physics II	F2010	4.27	4.20
	Average		4.47	4.27

The Physics Laboratory and Outreach

1. I have designed, developed and implemented ≈ 100 new laboratory experiments for introductory and advanced physics and engineering students, at both the undergraduate and graduate

levels. These experiments are supported by detailed tutorials, laboratory manuals, softwares for computer interfacing and data analysis. Several of these experiments have been published in the leading journals on physics education and laboratory instruction. I established mechanical, electrical and wood workshops for large-scale manufacturing and trained and led a team of development scientists, several of whom have now gone for fully funded PhD's at the world's topmost places. Details of these experiments can be downloaded from <http://physlab.org>.

2. The experiments developed at LUMS have now been manufactured in-house and replicated at six universities in Pakistan (GIKI of Engineering Sciences and Technology, Topi; Preston University, Islamabad; Institute of Space Technology; Islamabad; NUST Centre for Advanced Math and Physics; Habib University, Karachi and Nusrat Jehan Degree College, Rabwah).
3. New teaching and research laboratory experiments that have been designed and established include: optics, radiation, materials, and recently a *Smart Physics Laboratory* that uses smart sensors (smart phones, cameras, accelerometers) for physics instruction.
4. As **Founding Life Member** and **Joint Secretary** of **Khwarizmi Science Society**, I have the distinction of coordinating Pakistan's most active grass-roots science organizations. The Society has enabled a paradigm shift of scientific education in select institutions inside Pakistan, and since 1997, has served thousands of students and members of the public with the free dissemination of scientific knowledge in the form of seminars, workshops, exhibitions, panel discussions, informal gathering, conferences and symposiums. The details are available on the website <http://www.khwarizmi.org>. I was also the coordinator for celebrating the **International Year of Astronomy 2009**. The Society has emerged as Pakistan's most noted science organizations at the public and student levels.
5. My course on Modern Physics was repeated at D.H.A. Suffa University Karachi through video recordings. I was available offline for answering student inquiries.
6. I designed and made public physics courseware deployed at the Physics Department. The courseware can be seen here <http://physcourses.lums.edu.pk>.
7. I was overseeing a program with the name Maktab aimed at preparing video content for F.Sc. students. Material in the categories mathematics and physics has been uploaded to YouTube. <http://maktab.pk>.

Selected Professional Services

1. Elected Member and Deputy Speaker of the LUMS Faculty Council, 2009-2010.
2. Previously served as members of several committees including: Undergraduate Admissions Committee, Library Committee, SSE Admissions Committee, SSE Space and Equipment Committee, IT Policy Committee, various sub-committees of the Faculty Council.
3. Convener of the School's internal School Appointments, Promotion and Tenure Committee (*i*SAPTC).
4. I was a member of the team who wrote the PC-1 submitted to the Government of Pakistan, for the establishment of LUMS's School of Science and Engineering and was largely responsible for the part focusing on experimental facilities: the core labs and the Physics and Chemistry research and teaching labs. The project worth approximately Rs. 1.5 billion was approved by the Government.
5. I played a defining role in the determination and specifications of the services, facilities and layouts of the labs in the SSE Science Complex. This includes detailed analysis and specification provisions for the mechanical services (nitrogen, compressed air, vacuum, natural gas);

architectural layout and design of the basement for the shared facilities, labs in the physics and chemistry areas; selection of specialized research equipment for the core facilities and the support gear required to service these; layout of electrical supply and power requirements; drainage and sinks; selection and design of research furniture.

6. I was member of the screening committees for physics, chemistry and electrical engineering in the nascent stages of the School. I am actively and continually involved in this process of recruiting and discovering new Faculty, support academic and technical staff.
7. I have contributed towards the defining of the admission policies in 2008 and prepared admission tests for physics and partially for chemistry and mathematics in 2008 and assisted my colleagues in subsequent years. I have interviewed prospective admits and participated in the complete admission cycle in various ways. I have visited Islamabad for open days to attract and counsel prospective students.
8. I have also taken active part in devising the physics and core courses curriculum for SSE students.
9. Being cognizant of the role of smooth and efficient support services oriented towards a science and engineering school, I have been championing the cause of friendly and efficient processes in the technical Procurement of goods. I have participated in numerous meetings and have attempted at streamlining processes relevant to procurement.
10. As the SSE representative for the LUMS Central Library in 2007-9, I have affected the steady growth of physics, chemistry and engineering resources. Several hundred books now adorn in the library, handpicked to meet the diverse needs of a vibrant academic institution such as LUMS. I have also led the cause of access to journals and electronic databases. Luckily, the institution, to a fair extent, is self-sufficient in its subscription to important research literature.

Miscellaneous

Organization of scientific activities as P.I.

In addition to organizing the following events, I also secured national and private funding for these.

1. First National Lab Immersion Program (2012).
2. Second National Lab Immersion Program (2013).
3. Third National Lab Immersion Program (2014).
4. National Workshop on Mathematical Aspects of Quantum Information Science, in collaboration with the Centre for Advanced Studies in Mathematics (May 2012).
5. International School on New Trends in Quantum Information Theory, LUMS (September 2014).
6. Fourth Regional Lab Immersion Program (2016).
7. First National STEM School (2016).
8. Lahore Science Mela (2017, 2018). These festivals attracted around 20,000 visitors over a span of four days.

Memberships of learned societies

1. Life member Khwarizmi Science Society
2. Life member Pakistan Vacuum Society

3. Life member Pakistan Physical Society
4. Member Institute of Physics, UK
5. Member American Physical Society, US
6. Member American Association for Physics Teachers
7. Member New York Academy of Sciences

Selected invited talks

1. “What is a quantum computer”, Third National Stem School, Cadet College Hasan Abdal, 13 July 2018.
2. “How to create novel physics experiments for our students”, M.A.O. College Lahore, 25 April 2018.
3. “Resuscitating the physics laboratory in our educational institutions”, Government Post Graduate College Sahiwal, 22 March 2018.
4. “Communicating Physics to the non-physicist in the laboratory, classroom and the playing field”, SSE Public Lecture Series, Habib University, 16 February 2018; Engineers Meet Scientists Day 2, Comsats University Islamabad, Lahore Campus, 14 May 2018.
5. “Smart physics with smart devices”, Sixth Saudi International Meeting on Frontiers in Physics, Jazan University, Saudi Arabia, 27 February to 1 March 2018; 14th Frontiers in Physics, Government College University, Lahore 21-23 November 2016; Benade Physics Society, FC College 20 April 2017; Lahore Garrison University 27 April 2017.
6. Series of lectures on “Cosmology and first few moments of the universe” Lahore Astronomical Society, February 2017.
7. “An introduction to light and spectroscopy for astronomers”, Astronomers League of Pakistan, 24 September 2016, <http://theastronomicalleagueofpakistan.com/alop-symposium/>.
8. “Smart physics with smart devices and motion sensors”, Department of Physics, Jordan University, Amman, Jordan, 12 November 2017.
9. “The Laboratory in the Muslim World”, 21st Islamic Academy of Sciences Conference, Konya, Turkey 8-11 October, 2017.
10. Invited speaker at the International Workshop on “Science Communication: Enhancing Public Understanding of Science”, COMSTECH, Islamabad, 11 January 2017.
11. Invited speaker at the Prime Minister House, with the Prime Minister Muhammad Nawaz Sharif, on the status of science education in Pakistan, 28 January 2017
<https://www.youtube.com/watch?v=pYzZL5MPNg8>.
12. “Interferometry: from nothing to black holes”, popular lecture on gravitational waves, Riphah University, Lahore 22 May 2016; Centre for Advanced Math and Physics, NUST 20 November 2016.
13. Lecturer at the Summer School on Quantum Information Science, Habib University, Karachi, 25-28 July 2016. <https://habib.edu.pk/qiss2016/>
14. “Video tracking for physics experiments”, Department of Physics, Karachi University, 29 February 2016.
15. “Nonlocality in quantum mechanics”, Department of Physics, NED Karachi, 28 July 2016.

16. "Magneto-optics at the nanoscale", International Symposium on Light and Life, COMSATS Islamabad, 14-16 October 2015. <http://ww2.comsats.edu.pk/lightandlife2015/>
17. "Magneto-optics meets nanoscience", Symposium on Nanomaterials Research, National Centre for Nanotechnology, PIEAS, Islamabad, 15-17 June 2015.
18. "Magneto-optical Kerr microscopy", Workshop on Contemporary Topics in Nanomagnetism, National Centre for Physics, Islamabad, 23-27 February 2015. <http://www.ncp.edu.pk/wctn-2015.php>
19. "Demonstrating Maxwell's equations", Buraq Science Camp, Buraq Space Camp, Islamabad, 19-31 December 2014.
20. "Educating the scientists of tomorrow", Oxford University Press, Lahore, 6 December 2013.
21. "Nanotechnology inspired biomedical magnetic resonance", 3rd International Symposium on Biomedical Materials: Recent Advances and Challenges, COMSATS IRCBM, Lahore, 18-20 December 2012.
22. "NmR with a small 'm': the physics of low field magnetic resonance", 13th National Symposium on Frontiers in Physics, Peshawar University, Peshawar, 19-21 December 2012.
23. "Spectroscopic techniques for surface characterization", The 6th Vacuum and Surface Sciences Conference of Asia and Australia, Islamabad, 11 October 2012.
24. "MRI: 'Spin' on Spin", University of Management Technology (UMT), Lahore, 18 September 2012.
25. "Miniaturized, polarized and mobilized magnetic resonance", International Conference and Workshop on Nano Science and Technology, Quaid-e-Azam University, Islamabad, 1-5 October 2012.
26. "Innovation in Scientific Research", National Academy of Young Scientists' 2nd Annual Workshop, Punjab University, 7 January 2012.
27. "Developing Physics Laboratory for the Developing World", special session during International Conference on Nanomaterials and Nanoethics, 1-3 December 2011, COMSATS Institute of Information Technology, Lahore.
28. "Low-field PHIP", Institute of Technical and Molecular Chemistry, RWTH Aachen, Germany, 10 August 2011.
29. "How NMR enriches quantum information processing", **Keynote lecture** at the National Symposium on Quantum Information Processing, COMSATS Islamabad, 9 April 2011.
30. "Spins take on the Heat: introduction to Spin Caloritronics", 12th National Symposium on Frontiers in Physics, Government College University, Lahore, 2-4 February 2011.
31. "Seeing Chemical Reactions with Spin", 9th National Symposium on Frontiers in Physics, Government College University, Lahore, 28-30 January 2009.
32. "Pure State Quantum Computing with Nuclear Spins", International School and Conference on Quantum Information, Institute of Physics, Bhubaneswar, India, 9-12 March 2008.
33. "Para-hydrogen: Opportunities in Hyperpolarized NMR and MRI", Indian Institute of Science (IISc), Bangalore, India, 17 March 2008.
34. "'Nanoparticle MRI'", One-day Nanobiotechnology Seminar, NIBGE (National Institute of Biotechnology and Genetic Engineering), Faisalabad, 10 September 2007.

35. "Entanglement in Liquid State Quantum Information Processors", 2nd International Symposium on Quantum Optics, Centre for Quantum Physics, COMSATS and National Centre for Physics, Islamabad, August 7-9, 2007.
36. "Magnetic Resonance: From Brain Tissue to Chloroform Computers", Institute of Biochemistry and Biotechnology, University of the Punjab, Lahore, 9 May, 2007.
37. "Quantum computing with nanostructures", invited lecture at the International Conference on Electrical Engineering, Department of Electrical Engineering, University of Engineering and Technology, Lahore, April 2007.
38. "Quantum computing and nanotechnology", invited lecture at the International Conference on Nanotechnology, COMSATS and National Commission for Nanotechnology, March 2005.
39. "How NMR enriches quantum information processing", Physics Department, Quaid-e-Azam University, Islamabad, 2005.
40. "Entanglement and NMR", 10th National Symposium on Frontiers in Physics, Pakistan Physical Society and Government College University, Lahore, Pakistan, 2005.
41. "Frozen Qubits at Room Temperature", Physics Department, COMSATS, Islamabad, 10 Jan, 2005.
42. "Quantum Computing: Thinking Atoms", FAST-National University of Computer and Emerging Sciences, Lahore, 9 Oct, 2004.
43. "Quantum Computing: Thinking Atoms", Physics Department, Government College University, Lahore, 5 Oct, 2004
44. "Quantum computing with pure states derived from para-hydrogen", Department of Chemistry, University of California at Berkeley, Berkeley, California, US, 3 Jun, 2004.
45. "Preparing pure initial states using para-hydrogen", Fourth Canadian Summer School on Quantum Information, University of Waterloo, Canada, 20-25 Jun, 2004.
46. "Ensemble quantum computing", 9th National Symposium on Frontiers in Physics, Pakistan Physical Society and Government College University, Lahore, Pakistan, 2003.
47. "Information processing: The quantum way forward?", The IEE and British Computer Society, Bristol, UK, 1 Mar, 2004.
48. "Quantum information processing using para-hydrogen", Informal Quantum Information Gathering , Imperial College, London, UK, 19-22 Sep, 2002.
49. "Making atoms think", Pakistan Institute of Physics, Centre for High Energy Physics, Punjab University, Lahore, Pakistan, 2002.
50. "Introduction to Computer Interfacing", National Workshop on Computer Interfacing, organized by the Khwarzimidic Science Society , Centre for Solid State Physics, Punjab University, Lahore, Pakistan, 15 Sep, 2001.
51. "Magnetic Resonance Imaging", Symposium on Biomedical Imaging ,organized by the Khwarzimidic Science Society, Allama Iqbal Medical College, Lahore, Pakistan, 30 Jan, 1998. 28. Several Popular talks on quantum information processing; conduction physics, the human genome, grand unification theory, mathematical programming at the University of Engineering and Technology, Lahore; Edge Systems Pvt. Ltd. and the Centre for Solid State Physics, Punjab University, Lahore, Pakistan, 2001-03.

Scientific measurement capabilities developed

I have developed most of these instruments in-house: atomic force microscope, scanning tunneling microscope, MOKE imager, nuclear magnetic resonance spectrometer, variable temperature (5-500 K) dielectric, DC conductivity, Seebeck effect measurement; Kerr microscopy; atomic force microscopy; FPGA based timing and coincidence measurement system; magnetic pendulum; hydraulic press; room temperature vibrating sample magnetometer; electrospinning apparatus; surface-plasmon waves excitation and detection system; thermal diffusivity measurement by periodic heating (3ω method).

Scientific instruments frequently employed in research

Field-emission scanning electron microscopy; magnetron sputtering; spectroscopic ellipsometry; vibrating sample magnetometry; Hall effect measurement; e-beam lithography; X-ray diffraction; X-ray fluorescence; energy-dispersive X-ray spectrometry.