Summary of the Research done in Oman*

(27 September 2003 to present)

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This is the *Summary of the Research* done during my stay in Oman; at the Middle East College of Information Technology, Muscat (**MECIT**) and the Salalah College of Technology, Salalah, (**SCOT**).

MAIN FIELDS OF RESEARCH: *Mathematical Optics*
I am working towards a unified treatment of light beam optics and polarization, using the standard mathematical machinery of quantum mechanics. Dirac-*like* form of the Maxwell equations is well known in literature. Starting with the Dirac-*like* form of the Maxwells equations a unified treatment of light beam optics and polarization has been obtained. The traditional results (including aberrations) of the scalar optics are modified by the wavelength-dependent contributions. Some of the well-known results in polarization studies are realized as the leading-order limit of a more general framework of our formalism. The existing matrix representations of the Maxwells equations were found to be approximate for the formalism developed here; hence, an exact matrix representation of the Maxwells equations was derived.

A related study was made starting with the scalar approximation of the Maxwells equations. Using the analogy of the Helmholtz equation with the Klein-Gordon equation and the Feshbach-Villars approach to the Klein-Gordon equation a formalism utilizing the powerful techniques of quantum mechanics has been developed for scalar optics including aberrations. This provides an alternative to the traditional *square-root* approach and gives rise to wavelength-dependent contributions modifying the aberration coefficients.

Some of the results have been published and others have been communicated.

*Updated on Friday the 28 November 2008

PATENTS

Quadricmeter is the instrument devised to identify (distinguish) and measure the various parameters (axis, foci, latera recta, directrix, etc.,) completely characterizing the important class of surfaces known as the quadratic surfaces. Quadratic surfaces (also known as quadrics) include a wide range of commonly encountered surfaces including, cone, cylinder, ellipsoid, elliptic cone, elliptic cylinder, elliptic hyperboloid, elliptic paraboloid, hyperbolic cylinder, hyperbolic paraboloid, paraboloid, sphere, and spheroid. Quadricmeter is a generalized form of the conventional spherometer and the lesser known cylindrometer (also known as the Cylindro-Spherometer). With a conventional spherometer it was possible only to measure the radii of spherical surfaces. Cylindrometer can measure the radii of curvature of a cylindrical surface in addition to the spherical surface. In both the spherometer and the cylindrometer one assumes the surface to be either spherical or cylindrical respectively. In the case of the quadricmeter, there are no such assumptions.

- Sameen Ahmed Khan,
  Quadricmeter,
  Official Journal of the Patent Office, Issue No. **43/2008**, Part-I, pp. 25296 (24 October 2008).
  Application No.: **2126/MUM/2008 A**, International Classification: **B69G1/36**,
  Controller General of Patents Designs and Trade Marks, Government of India.

  `http://ipindia.nic.in/ipr/patent/journal_archieve/journal_2008/patent_journal_2008.htm`

  `http://ipindia.nic.in/ipr/patent/journal_archieve/journal_2008/pat_arch_102008/official_`

  `http://www.patentoffice.nic.in/`, `http://www.ipindia.nic.in/`

  (*patent in process*, http://www.geocities.com/rohelakhan/quadricmeter.html).

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PUBLICATIONS

Contributions to International Reports:

- $\cdots$, Sameen Ahmed KHAN, $\cdots$, (*one of the 250+ Contributors, from 79 Institutions*),
  GLD Detector Outline Document (**GLD DOD**),
  GLD: A Large Detector Concept study for International Linear Collider for TeV Physics
  Report of the
  GLD Concept Study Group,
  World Wide Study of Physics and Detectors for future Linear e^+e^- Colliders, (March 2006).
  GLD: Gaseous tracker based Large Detector.
  E-Print: http://arXiv.org/abs/physics/0607154/.
- $\cdots$, Sameen Ahmed KHAN, $\cdots$, (*one of the 500+ Contributors, from 325 Institutions*),
  International Linear Collider Reference Design Report, (*Four Volumes*)
  ILC Global Design Report and World Wide Study,
  (August 2007).
  ILC: International Linear Collider.
  E-Print: http://arxiv.org/abs/0712.1950/.

A. Review Articles

- Sameen Ahmed Khan,
  Wavelength-Dependent Effects in Light Optics,
  in *New Topics in Quantum Physics Research*,
  Editors: Volodymyr Krasnoholovets and Frank Columbus,
  (Nova Science Publishers, New York, 2006, http://www.novapublishers.com/).
  pp. 163-204 (30 December 2006).
  (ISBN-10: 1600210287 and ISBN-13: 978-1600210280).
- Sameen Ahmed Khan,
  The Foldy-Wouthuysen Transformation Technique in Optics,
  Invited article in:
  Advances in Imaging and Electron Physics, *Editor*: Peter W. Hawkes,
  (Elsevier, 2008) **Vol. 152**, pp. 49-78 (August 2008).
  (ISBN-10: 0123742196 and ISBN-13: 978-0-12-374219-3).

B. Refereed Publications

1. Sameen Ahmed Khan,
   Wavelength-dependent modifications in Helmholtz Optics,
   International Journal of Theoretical Physics, **44**(1), 95-125 (January 2005).
   (Kluwer Academic Publishers, https://www.editorialmanager.com/ijtp/).

2. Sameen Ahmed Khan,
   An Exact Matrix Representation of Maxwells Equations,
   Physica Scripta, **71**(5) 440-442 (2005).
   (http://www.physica.org/).

3. Sameen Ahmed Khan,
   The Foldy-Wouthuysen Transformation Technique in Optics,
   Optik-International Journal for Light and Electron Optics, **117**, Issue 10, pp. 481-488 (October 2006).
   (http://www.elsevier-deutschland.de/ijleo/).

4. Sameen Ahmed Khan,
   Maxwell Optics of Quasiparaxial Beams,
   Optik-International Journal for Light and Electron Optics, **120**, Issue ??, pp. ???-??? (??? 2009).
   (http://www.elsevier-deutschland.de/ijleo/). (*in press*, Digital Object Identifier, http://dx.doi.org/10.1016/j.ijleo.2008.07.027).

5. Sameen Ahmed Khan,
   Quantum Methodologies in Light Beam Optics.
   (*in preparation*).

The corrections to the traditional descriptions rigorously derived in the above articles have a significant bearing on the celebrated Scherzer Theorem in the wavelength-dependent regime in electron microscopy and the algebraically equivalent system of fiber optics. I shall be applying for a patent in the near future.

C. Expository Publications

1. Fathiya Khamis Al Rawahi, Sameen Ahmed Khan and Abdul Huq,
   Microsoft Excel in the Mathematics Classroom: A Case Study,
   in *Proceedings* of **The Second Annual Conference for Middle East Teachers of Mathematics, Science and Computing** (**METSMaC 2006**), The Petroleum Institute, Abu Dhabi, United Arab Emirates, 14-16 March 2006. *Editors*: Seán M. Stewart, Janet E. Olearski and Douglas Thompson, pp. 131-134 (2006).

2. Sameen Ahmed Khan,
   Microsoft Excel in the Physics Classroom,
   in *Proceedings* of **The Third Annual Conference for Middle East Teachers of Mathematics, Science and Computing** (**METSMaC 2007**),
   The Petroleum Institute, Abu Dhabi, United Arab Emirates, 17-19 March 2007.
   Editors: Seán M. Stewart, Janet E. Olearski, Peter Rodgers, Douglas Thompson and Emer A. Hayes, pp. 171-175 (2007).

3. Sameen Ahmed Khan,
   Data Analysis Using Microsoft Excel in the Physics Laboratory,
   Bulletin of the IAPT, **24**(6), pp. 184-186 (June 2007).
   (**IAPT**: Indian Association of Physics Teachers).

4. Sameen Ahmed Khan,
   Spherometer and Cylindrometer, (*communicated*).
   The article discusses the traditional spherometer and some variants such as the ring spherometer and the cylindrometer (also known as Cylindro-Spherometer), fabricated by the author.
5. Sameen Ahmed Khan,
   Doing Numerical Calculus using Microsoft EXCEL. (*in preparation*).
6. Sameen Ahmed Khan,
   Numerical Techniques using Microsoft EXCEL. (*in preparation*).
7. ..., Sameen Ahmed Khan, ...,
   Numerical Methods with Microsoft Excel. (*in preparation*).

Popular Writings:
I have a keen interest in the theme, *Science for Development*, resulting in over a hundred popular articles (over sixty-five of these were published after my arrival in Oman) in National/International Journals, Magazines, Bulletins/Newsletters and Conference Proceedings across the continents (http://www.geocities.com/rohelakhan/popular-writings.html). Two of these are with my MECIT students.