Curriculum Vitae

Prof. Chandrasekhar Roychoudhuri

Research Professor, Department of Physics; University of Connecticut
Cell: (860)-465-6259
Email: chandra.roychoudhuri@.uconn.edu

Current Research

I am in the process of experimentally re-establishing the hard causality in Physics by re-introducing a thousand years old understanding by Alhazen, the Non-Interaction of Waves (NIW). Light waves, from different visible scenes, always cross through each other without perturbing any image quality of each other. In 1670's, Huygens presented the NIW-property more formally: Light waves continue to propagate diffractively as secondary wavelets out of every point on the wave front without perturbing each other. Fresnel integrated this NIW-property in the classic Huygens-Fresnel diffraction integral (HF-DI) in 1817 without calling out the NIW-property explicitly. HF-DI, or some of its more advanced mathematical versions, is at the very foundation of continued successes in optical science and engineering, even today. However, so far, the NIW-property has been formally recognized only in my book, "Causal Physics; Photon by Non-Interaction of Waves" (Taylor & Francis, 2014). The impacts of NIW in all major optical phenomena is significant and have been elaborated in this book.

The recognition of the NIW-property immediately brings out a profound conceptual confusion, the correction of which will help us bring back the hard causality in Physics. To start with, we need to differentiate between the un-observable mathematical Superposition Principle (SP) from the experimentally observable Superposition Effect (SE). Just connecting physical amplitudes of multiple superposed waves with ***operators*** "+" (or, $\sum$) does not make SP become observable SE. SE is the square modulus of the sum of dipolar stimulation**s** of a detecting dipole induced by multiple superposed waves, ***present simultaneously*** on the detector while passing through the detector at the same time. Only a complex nonlinear entity can carry out this nonlinear square modulus ***operation***. The linear wave amplitudes cannot execute this nonlinear operation by themselves. In fact, the correct expression for SP should be written as the joint dipolar stimulation $\sum_n \chi E_n$ of a detecting dipole, where χ represents its interacting polarizability. The straight summation of amplitudes $\sum_n E_n$ may be interpreted as simultaneous passing or crossing of multiple fields through the same volume. This ***interaction-free*** SP, as it is written now, $\sum_n E_n$, does not represent any operational physical principle of nature. Consequently, experimentalists and instruments designers should draw physically valid conclusions only from expressions like, $\sum_n \chi E_n$, and $(\sum_n \chi E_n)^*(\sum_n \chi E_n)$, which model real physical interaction process. The experimentally validated expression, $(\sum_n \chi E_n)^*(\sum_n \chi E_n)$,

clearly implies that a quantum entity fills up its "quantum cup" with the required energy hv proportionately out of all the incident fields E_n, not just "a photon" out of ***one*** of the fields. Let us appreciate the critical roles played by detectors in determining the Superposition Effect. Different physical characteristics of different detectors give ***different SE for the same set of superposed waves*.** A multimode He-Ne laser will be reported as a CW laser with time-steady output signal by a slow detector. However, a multi GHz fast detector will display a time varying heterodyne signal, representing inter-mode beating.

The NIW-property also implicates that the time-frequency Fourier theorem (TF-FT), albeit being a correct mathematical logic, does not represent physically and operationally correct model for spectrometric studies. Collinear superposition of phase steady beams of a set of periodic frequencies do not sum themselves to re-distribute their energies in the time domain. Only a non-linear medium can execute the square modulus operation. That is why we always need a mode-locking device within a pulsed laser.

Currently, I have been extending the NIW-property to Quantum Optics, Special Relativity and some Astrophysics.

.

Summary of Distinctions and Professional Services

- Author of the book, "Causal Physics: Photon Model by Non-Interaction of Waves", Taylor & Francis, 2014. The book (i) formalizes non-interaction of waves; (ii) brings back causality in physics and (iii) removes the need for wave-particle duality in physics; (iv) underscores the necessity of re-evaluating Doppler Effect and Cosmic Microwave Background Radiation; and hence the models of Expanding Universe; (vi) develops and demonstrates how iterative application of Interaction Process Mapping Epistemology (IPM-E), in conjunction with the prevailing Measurable Data Modeling Epistemology (MDM-E), can get closer and closer to cosmic logics behind the light-matter interactions we observe. This is simply the application of iterative reverse engineering approach utilized by all species on earth.
- Was the organizer of the biennial conference series: "The Nature of Light: What is a Photon?", 2005-2015. This was organized to bring together out-of-box thinkers to re-energize the foundation of physics thinking. We must engender perpetual re-structuring of the foundational postulates of all "working" theories since they were constructed based upon insufficient knowledge of the cosmic logics.
- Have organized many seminar series in different fields of optics for SPIE and OSA since early eighties.
- Organized many industry-university workshops on accelerating the development of high power diode lasers during 1980's, besides managing various classified projects of high power diode lasers while working for industries. This has eventually led me to be elected as a fellow of OSA and SPIE.

- Deliver frequent workshops and lectures around the world on the impact of Non-Interaction of Waves in Optical Sciences and Physics in general, as an OSA Traveling Lecturer.
- Associate Editor (2006 -): Journal of Nano Photonics,
- Associate Editor (2010 –): Physics Essays.
- Advisory Board Member: Engineering & Technology Dept., Manchester Community College, CT, 2008-2014.
- Advisory Board Member: Jagdish Bose National Science Talent Search, Kolkata, INDIA.
- Guest Editor, OSA Optics and Photonics Trend, "The Nature of Light: What is a Photon?" Oct. 2003
- Elected Director-at-Large to SPIE Board for three calendar years, 2000, 2001 & 2002.
- Elected by SPIE Board as a US Representative to the International Commission of Optics for 2003, '04, '05
- Board of Directors and Chair of Membership and Education Council of OSA for two calendar years, 1997 and 1998.
- National Award in Science from Optical Society of MEXICO, 1995.
- Guest Editor: Optical Engineering; Special topic - Micro-optics; 1994
- Xerox Award at UConn: For identifying and organizing over 100 Connecticut optics/photonics companies into an economic cluster for effective collaboration; 1994, as the Director of the Photonics Research Center at UConn.
- Life Member: American Physical Society.
- Elected Fellow (1996) & Life Member (2013): OSA (Optical Society of America).
- Elected Fellow (1996) & Member: SPIE (Society of Photo-Optical Instrumentation Engineers).
- Life Member (2014): IEEE (Photonics Society).
- Elected Fellow (1995): Connecticut Academy of Science and Engineering
- Fellow 1998-2012, Academy of Global Economic Advancement, UConn Business School
- Life Member (1998): Optical Society of India.
- Life member (1999): Bio-photonics Society of India.
- Fulbright Scholar (1968) from India.
- Initiator and organizer of many timely scientific topics in science, engineering and education topics for OSA and SPIE conferences.
- Participated in NSF and NIH program review panels, besides reviewing individual proposals.
- Best execution and reporting of internal R&D award at TRW (now Northrop Grumman): 1984 and 1985.
- Best technical program manager award (by employees) at Perkin Elmer, Danbury: 1988.

Education

- Ph. D (1973) in Optical Sciences, Institute of Optics, University of Rochester.
- MS, Physics (Nuclear specialization), Jadavpur University, Kolkata, India.
- BS, Physics Honors, First Position, Jadavpur University, Kolkata, India.

Employment History

1. 2000- Present:

University of Connecticut, Storrs, CT.

Research Professor
Department of Physics.

Research Activities: Summary of current research is given at the top of this document. My overall approach is to access and articulate ontological realities (nature's actual logics behind all light-matter interaction processes). This will require some fundamental epistemological transformation, badly needed in current physics thinking.

2. 1992-2000:

University of Connecticut, Storrs, CT.

Director, Photonics Research Center, University of Connecticut: Joined UConn as the founding Director to organize the Photonics Research Center (PRC) with grants from industry and the State Government. Organized the Connecticut photonics industry into a Photonics Cluster for methodical interactions with the State's broader economic cluster office. Collaborated with OSA, SPIE and other national and international industry clusters to develop global networking between regional clusters.

Carried out personal research, taught some optics courses and trained PhD students in the following sub-fields of optics and photonics:

(i) Physics of ultra-short pulse interference and diffraction: Impact of short pulse diffraction phenomena on dense WDM communication systems.

(ii) Ultra-short pulse diode laser: Pico- second pulses directly from miniature diode lasers and their amplifications to high peak power for non-linear microscopy, material processing, and communications. Demonstrated Q-switched 1W/10ps/ 10MHz pulses from 10 mW CW Fabry-Perot (FP) diodes and 100W/50ps/1KHz pulses from 10 diode FP array, rated for 1W CW. Led to spin-off of "Infinite Photonics" (later re-constituted as Radiant Energy) supported by DARPA grant of $13M to construct compact ultra-short pulse diode lasers.

(iii) Continuously tunable GCSEL (grating coupled surface emitting laser) **for WDM & spectrometric sensing:** Demonstrated continuous tunability of GCSEL laser over 132 nm

@ 980 nm with line width narrower than 1 GHz. Tunable gain switched pulses of 150 ps demonstrated; shorter pulse is possible.

(iv) High power diode lasers: Developing high power diode laser technology including grating coupled surface emitting laser (GCSEL) system for various applications including desktop manufacturing. [GCSEL laser activities were carried out in collaboration with Ioffe Institute, St. Petersburg, Russia]

(v) Laser material processing: Successfully demonstrated that material processing like sintering of metal powder, soft soldering, etc., can be carried out with compact high power laser diodes.

3. 1990-1992:

United Technologies Optical Systems.

Chief Scientist of Optics and Applied Technology Lab: The key responsibility was to identify the needs of the various business divisions of United Technologies and develop appropriate research programs/directions leading to external funding at United Technologies Optical Systems.
Specific activities were related to:
(i) High power semiconductor lasers for precision manufacturing (sintering, cutting, drilling, welding, etc.) for Pratt & Whitney & Sikorsky;
(ii) Commercialization of high power diode systems for the above applications;
(iii) Replacement of side-view mirrors by fiber-optic imaging for UT Automotive group;
(iv) Compact laser diode radar for precision metrology of helicopter blade coning angle for Sikorsky and for liquid-level sensing applications, welding, etc., for Pratt & Whitney & Sikorsky.

4. 1986-1990

Perkin-Elmer Corporation.

Manager, Laser Systems: Applied Science and Technology (AST) Division: Proposed and managed research programs that maximized Perkin-Elmer's business opportunities in high power diode laser technologies. Successfully managed two major Air Force programs.

(i) The first project ("Classified") was called PILOT (Phased Integrated Laser Optics Technology), sponsored by the Air Force Research Lab. This program developed and demonstrated a novel 2-dimensional grating coupled surface emitting distributed feedback laser diodes and external (Talbot) cavity phase locking of Fabry-Perot diode arrays.
(ii) The second project ("Classified") was from Rome Air Development Center under which six-inch 30-moment-actuator (radial shear) deformable mirror along with a

complete operational optical system (interferometer, computer and electronics) was developed, built and delivered.

5. 1978-1986

TRW, Inc., Redondo Beach, CA. (Now Northrop & Grumman)

Senior Staff Scientist/ Senior Scientist/ Scientist: Major responsibility was to conceive and demonstrate various diode laser application technologies. Successfully attracted funding and guided a large number of R&D projects, some of which led directly to major contracts for deliverable hardware. Accomplishments include: (1) Significant contribution to a project on 20-channel wavelength multiplexed laser diode system for 1 GHz AM communications (industry's first 20-channel WDM in 1978). This "classified" project brought in $100M space communication contract for TRW. (2) Creation of a blue-green laser by non-linear summation of 1.3 and 0.85 micrometer CW laser diodes submarine-satellite communications (first such scientific demonstration in 1980); (3) Enhancement of laser diode longitudinal mode contrast to 30 dB by external cavity for an RF spectrum analyzer, (4) Miniaturization (to approximately 1 cm) of a laser diode external grating cavity for tunable and narrow line-width applications; (5) Demonstration of a seven-channel space domain (angular) multiplexing for communication potential by multimode fibers; (6) Development of a high resolution fiber optic Fabry-Perot spectrometer and an interferometric sensor. All these programs required identifying, addressing and resolving the optical, mechanical and electronic system issues since DoD is always interested in systems that work failure-proof in DoD environment. Also, served as an Adjunct Professor at the University of California Los Angeles; was responsible for teaching courses in advanced Physical Optics.

6. 1974-1978

National Institute of Astrophysics, Optics & Electronics (INAOE), Mexico.

Senior Scientist/Coordinator of Physical Optics:

Research: Carried out research activities in fundamental concepts behind optical superposition effects through spectroscopy, holography and interferometry. My experimental research at INAOE clearly indicated that light beams do not interact with each other in the absence of detecting dipoles even when they are physically superposed. This also implied that the time-frequency Fourier theorem (summation of light beams of different frequencies) cannot represent any real physical principle of nature.

Teaching: Taught graduate level optics courses. Guided eight MS theses on lasers, holography and spectroscopy. Significantly improved the optics laboratory and curriculum at the Institute by serving as an active member of the Academic Council. Guided the design and fabrication of a holographic interference microscope. All eight of my MS students have finished their Ph.D. from US, Canada & Europe and are now holding key positions in various Mexican institutions.

7. 1968-1969

University of Vermont, Physics Department, Fulbright Scholar
Graduate student for two semester. Then transferred to University of Rochester.

8. 1969-1974

University of Rochester, *Institute of Optics*

Fulbright Scholar, Graduate Student/Post-Doc: (i) investigated the coherence properties of pulsed Nd- and Rb-lasers using holographic interferometry. (ii) Designed and built a high-resolution, ultra-stable, multi-pass, Fabry-Perot spectrometer to study Brillouin scattering. The spectrometer was actively used over a decade at the Institute of Optics.

9. Patents

- 1 Gigahertz, 20 channel WDM diode laser system for satellite communication (demonstrated in 1979; patent granted in 1986). Patent No. 4930855.
- External cavity laser diode radar by backscatter modulation (Demonstrated 1988, granted 1990). Patent No. 5,594,543.
- Several more granted and applied through UConn, Perkin-Elmer and NSG Co.

10. Other services and outreach activities

(i) Actively promoting the need to revisit the issue of "wave-particle-duality" and "single photon interference". Raised funds to cover the publication of a special issue of "Optics and Photonics News" (Oct. 2003) on "The Nature of Light: What is a Photon?" which contains prevailing views of photon from five well established groups in quantum optics. The initiative has been converted into a biannual international conference series from 2005 through 2015.

(ii) Actively promoted SPIE's international interests in India as the Ad-Hoc Co-Chair for this initiative. Completed an extensive seminar/lecture tour of India during December, 2004. India is now organizing photonics industry cluster, initiating photonics technician curriculum, and inspired organization of about a dozen student chapters in various universities including all IIT's.

(iii) Summary of other activities: Facilitated the organization of the Connecticut Photonics Industry Cluster. Past Member of the Education Committee of SPIE. Invited participant of OSA "Leadership Council" during 1990's. Organizing Co-Chair for Conference on "Education Forum" of 1995 and 1996 at OSA Annual Meetings; this day-long forum used to bring the best optics professors, teachers and demonstrators to promote education and invites the regional school teachers for advanced training. This effort has now been integrated within the ongoing biennial ETOP (Education and Training in Optics and Photonics) conference series, co-sponsored by ICO, SPIE, OSA and IEEE-Photonics Society.