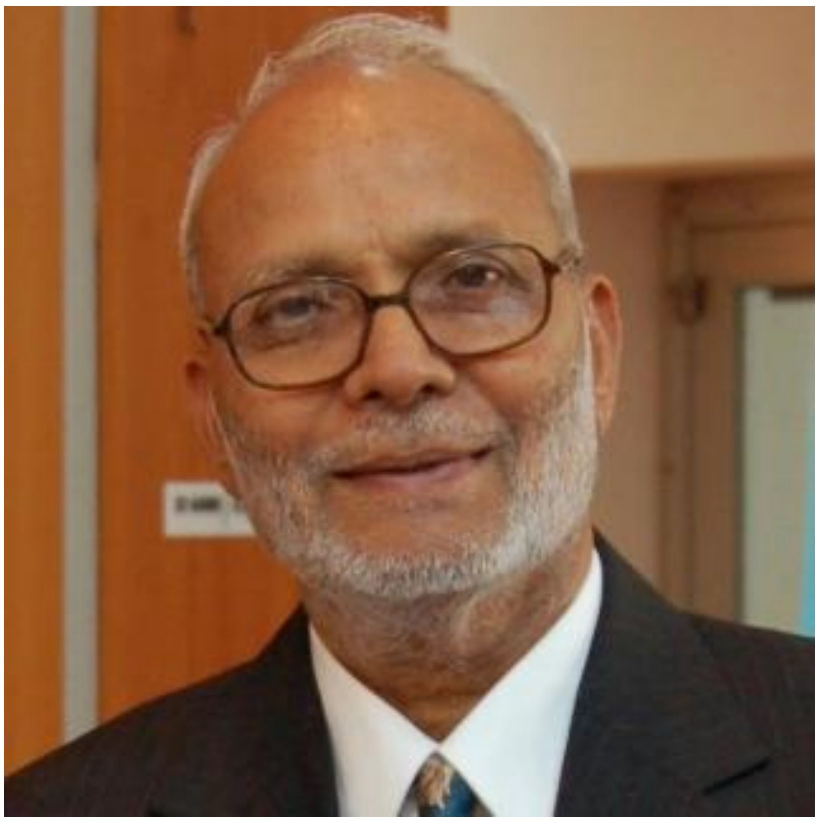
DASARI FEST

An afternoon of short talks honoring the life and research of Dr. Ramachandra R. Dasari

Tuesday, December 8, 2020



1932– 2020

Ramachandra Rao Dasari was born in the Krishna district of Andhra Pradesh in India. He obtained his B.S. degree from Andhra University in 1954, his Master's degree from Benaras Hindu University in 1956, and his Ph.D. from Aligarh Muslim University in 1960, all in physics. In 1962 he joined the Physics faculty at the Indian Institute of Technology-Kanpur, and in 1966 came to MIT as a fellow for two years to work in the newly formed group of Charles Townes and Ali Javan. He subsequently returned to IIT Kanpur, where he collaborated with Putcha Venkateswarlu to establish one of the largest laser laboratories for university research in India.

During his 17-year tenure there, Ramachandra trained numerous Ph.D. students and established relationships between IIT Kanpur and several national and industrial laboratories. In 1978, Ramachandra, his wife Suhasini and his children moved to Canada, spending a year each at the National Research Council, Ottawa, and the University of British Columbia, Vancouver. In 1980 he returned to MIT as a Visiting Professor in Physics for several years. He continued as Principal Research Scientist in the Spectroscopy Laboratory. In 1992 he was appointed its Associate Director, and continued in this role until 2018.

Ramachandra's research contributions at IIT Kanpur include obtaining the first electronic spectrum of NSe and devising a new method for obtaining laser emission in copper vapor. His iodine vapor research foreshadowed laser emission in that molecule. As a physics panel member of India's University Grants Commission, he helped initiate new programs to improve undergraduate education, including teacher training workshops. IIT Kanpur has established the Dasari Ramachandra Rao distinguished lecture series in his honor.

In his work at MIT with Ali Javan, Ramachandra pursued the first measurements of laser frequencies in the far-infrared and, with Joel Parks, conducted a very high-resolution study of N_2 laser transitions. Working with Takashi Oka at the National Research Council, he observed Dicke narrowing of infrared transitions for the first time. Working with Michael Feld, his numerous contributions include development of novel laser optical pumping techniques including observation of single atom laser and, with Charles H. Holbrow and Daniel Murnick, studies to detect gamma ray anisotropy in optically pumped rubidium vapor. In the Laser Biomedical Research Center his major contributions include noninvasive glucose detection, instant cancer diagnosis. He has more than 340 journal publications with H-index 93. He is also largely responsible for development of the Spectroscopy Laboratory's Raman facilities for biomedical and physical science research.

As Associate Director of the Spectroscopy Laboratory, he coordinated project and facility development at the MIT Laser Biomedical Research Center, an NIH Biomedical Research Resource, and the MIT Laser Research Facility, a physical science resource. Ramachandra was a confidante, project organizer, and troubleshooter to Spectroscopy Laboratory graduate students and scientists. His legacy is that of a cherished mentor, groundbreaking researcher, and a beloved figure in the spectroscopy community. He is greatly missed.

Ishan Barman, Ph.D.

Johns Hopkins University
Sidney Kimmel Comprehensive Cancer Center

"Sometimes the stars and photons align: The Ramachandra and Raman congruence"

Understanding the metastatic progression of cancer remains challenging due in part to a rudimentary knowledge of metabolic, physiologic, and molecular adaptations that allow for the cancer to survive and thrive within different tissue types. Raman spectroscopy is particularly attractive for the analysis of cancer cells and their microenvironment as it permits a rapid and simultaneous fingerprinting of inherent biologic content, extraneous materials and functional state without the use of labeled probes. Leveraging such non-perturbative analysis, we have generated novel molecular descriptions of the poorly understood pre-metastatic niche, which represent the collective changes at the distant metastatic sites prior to the arrival of the tumor cells. Additionally, we have determined spectral markers of early metastatic disease in bone that permit detection significantly before morphologic variations are captured through radiographic diagnosis. This talk will also focus on engineering nanostructured plasmonic probes for ultrasensitive detection of specific molecular species. The high sensitivity and broad applicability of these plasmonic nanoprobes, in conjunction with their inert composition, render them a promising agent for serum profiling as well as for precise delineation of microscopic tumors that are impossible to visualize with currently available imaging technologies. Use of such nanoparticles in flexible skin-like biosensing platforms, which are capable of conformally wrapping a soft or irregularly shaped object, also enables 3D label-free acquisition of spatially resolved molecular signatures from live cells.

"Little did I know when I first walked into the Spec Lab, then housed in the Francis Bitter Magnet Laboratory, that my life would undergo a radical transformation. Ramachandra catalyzed that transformation. As a mentor, Ramachandra was patient yet persistent (I was made to tune the Ar-ion laser for my first week in the lab!), considerate but tough to please (never happy about the quality of the Raman signal). And, he always had one eye on the pie in the sky – otherwise known as the non-invasive glucose sensor! But, most of all, what stood out through all these years was his warmth and generosity. Ramachandra inspired by example. His own journey of a boy from the rural heartland of India to playing such a key role in the growth of biophotonics inspired his mentoring style; he was constantly encouraging (and coaxing) his mentees yet providing them with the space to make their own mark. Steven Spielberg once said that the delicate balance of mentoring someone is not creating them in your own image, but giving them the opportunity to create themselves. Ramachandra had mastered that incredibly difficult art."

Jeon Woong Kang, Ph.D.
Laser Biomedical Research Center,
Massachusetts Institute of Technology

"Noninvasive glucose monitoring by NIR Raman spectroscopy"

Noninvasive blood glucose monitoring has been a long-standing dream in diabetes management. The use of Raman spectroscopy, with its molecular specificity, has been investigated over the past decades. Previous studies reported on glucose sensing based on indirect evidence such as statistical correlation to the reference glucose concentration. However, these claims fail to demonstrate glucose Raman peaks, which has raised questions regarding the effectiveness of Raman spectroscopy for glucose sensing.

Recently, we have demonstrated the first direct observation of glucose Raman peaks from in vivo skin. The signal intensities varied proportional to the reference glucose concentrations. Tracking spectral intensity based on linearity enabled accurate prospective prediction. Our direct demonstration of glucose signal may quiet the long debate about whether glucose Raman spectra can be measured in vivo.

"I first met Ramachandra when I visited MIT for a postdoc interview at 2009. Since then, I have been working with him on so many projects such as spectroscopic tissue scanner and noninvasive glucose monitoring. Ramachandra was a hard worker and wanted us to be, too. After usual Saturday's meeting, he used to bring us to home parties organized by his friends and relatives. Ramachandra encouraged us to eat and drink. I even received wines as a gift from the host! It was fun days.

Although glucose was one of his favorite projects, Ramachandra was always complaining why he cannot see the glucose peak in the spectrum. In my last phone conversation with Ramachandra, I told him that I finally could see the clear glucose peak in the skin spectrum. Ramachandra was so happy and I was lucky to tell him the message before too late."

Gabriel Popescu, Ph.D.

Beckman Institute for Advanced Science and Technology,
University of Illinois at Urbana-Champaign

"Lessons from the Guru"

"I was fortunate enough to meet Ramachandra in April 2002, when I joined the Spectroscopy Lab as a postdoc. Interacting with Ramachandra on a daily basis at MIT impacted my research, career, and personal life, all for the better. I will tell some of my stories with Ramachandra and how, with his help, I landed a microscope from Ali Javan's lab, with which I took the first quantitative phase image…"

…Since then, quantitative phase imaging (QPI) has gained significant interest, especially in the past decade, because of its ability to study unlabeled cells and tissues. As a result, QPI can extract structure and dynamics information from live cells without photodamage or photobleaching. However, in the absence of labels, QPI cannot identify easily particular structures in the cell, i.e., it lacks specificity. Inspired by recent prior work, we applied deep learning to QPI data, generated by SLIM and GLIM. These methods are white-light and common-path and, thus, provide high spatial and temporal sensitivity. Because they are add-on to existing microscopes and compatible with the fluorescence channels, SLIM and GLIM provide simultaneous phase and fluorescence from the same field of view. As a result, the training data necessary for deep learning is generated automatically.

We present a new microscopy concept, where the process of retrieving computational specificity is part of the acquisition software, performed in real-time. We demonstrate this idea with various fluorescence tags and operation on live cells as well as tissue pathology. This new type of microscopy can potentially replace some commonly used tags and stains and eliminate the inconveniences associated with phototoxicity and photobleaching. Phase imaging with computational specificity (PICS) has an enormous potential for biomedicine.

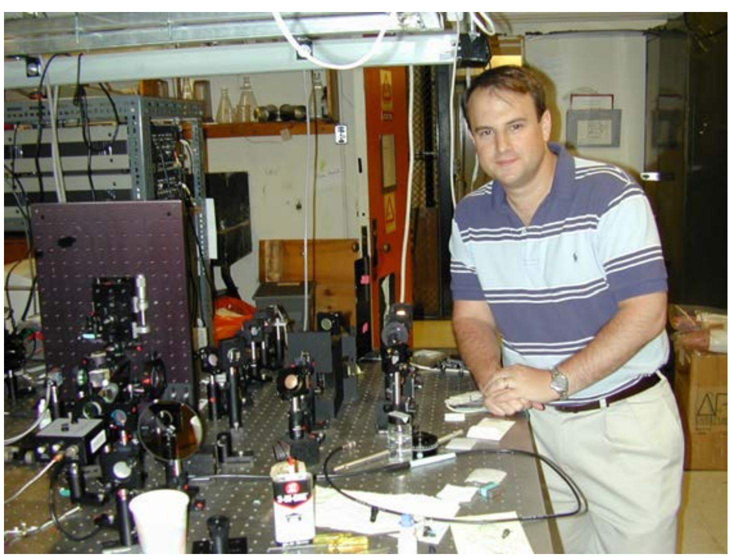
Adam Wax, Ph.D.

Department of Biomedical Engineering,
Duke University

"Designing and building biophotonics instruments for clinical studies"

Since the telecom boom in the 1990's, researchers have been repurposing optical components for biomedical studies, birthing the field of biophotonics. The ready availability of high quality, low cost photonics equipment such as laser diodes, fiber optics and photodetectors, were assembled into research systems for evaluating new biophotonics approaches in the laboratory. The MIT G.R. Harrison Spectroscopy Laboratory was a pioneer in creating such systems and conducting clinical studies. Here I will discuss my experience working with Ramachandra Dasari to develop early research systems and how my training at the Spec Lab enabled me to develop more advanced biophotonics systems for clinical applications, including early cancer detection using light scattering in the early 2000's and more recently low-cost Optical Coherence Tomography systems.

Adam Wax trained under Ramachandra Dasari from 1999-2002 as a postdoctoral fellow of the NIH. Dr. Wax learned to develop biomedical instrumentation as well as how to manage a large interdisciplinary lab. These skills were immensely helpful as he established his own research program at the department of biomedical engineering at Duke University. Adam considered Ramachandra both a colleague and friend with many shared professional and personal interests.



Dr. Adam Wax during his time in the Spectroscopy Laboratory with Ramachandra Dasari

Dasari Fest Speakers

Ishan Barman is an Associate Professor in the Department of Mechanical Engineering at Johns Hopkins University with joint appointments in the Departments of Oncology, and Radiology and Radiological Science. He graduated from the Indian Institute of Technology, Kharagpur,

before moving to Massachusetts Institute of Technology for his doctoral work, where he investigated transcutaneous blood analyte detection using vibrational spectroscopy. His laboratory's research is focused on the development of cutting-edge and transformative biophotonics technologies with the goal of disease detection at early, manageable stages, monitoring therapeutic effects and treatment outcomes, and guiding interventions. The optical tools generated from the laboratory's investigations have been successfully adopted in diverse biomedical environments such as in automated recognition of biopsy specimen, real-time diagnosis of middle ear pathology, and as a customized monoclonal antibody identification platform. His work has been featured in leading scientific (Technology Review, Physics Today, Physics World, C&E News) and popular media (Wall St. Journal, CNN Newsroom) outlets. Dr. Barman's awards for his research contributions include the NIH Director's New Innovator Award, Emerging Leader in Molecular Spectroscopy Award, EAS Young Investigator Award, Maryland Outstanding Young Engineer Award, American Society for Lasers in Surgery and Medicine (ASLMS) Dr. Horace Furumoto Innovations Young Investigator Award, and the Tomas Hirschfeld Award by the Federation of Analytical Chemistry and Spectroscopy Societies.

Jeon Woong Kang is a research scientist at MIT Laser Biomedical Research Center. After receiving PhD from POSTECH (South Korea), he joined Wellman Center for Photomedicine (MGH) as a research fellow. With Prof. Seok-hyun Yun, he developed a two-photon fluorescence imaging system based on wavelength-swept laser source.

After two years at MGH, he moved to MIT Laser Biomedical Research Center at 2009. Since then, he has been working on biomedical spectroscopy projects including spectroscopic cancer diagnosis, noninvasive glucose monitoring, intra needle optical sensor and so on. He is also interested in commercialization and co-founded a medical device startup Medisight.

Gabriel Popescu is a Professor in Electrical and Computer Engineering, University of Illinois at Urbana-Champaign. He received his Ph.D. in Optics in 2002 from the School of Optics/

CREOL (now the College of Optics and Photonics), University of Central Florida. He continued his training with the late Michael Feld at M.I.T., working as a postdoctoral associate. He joined Illinois in August 2007 where he directs the Quantitative Light Imaging Laboratory (QLI Lab) at the Beckman Institute for Advanced Science and Technology. He served as Associate Editor of Optics Express and Biomedical Optics Express, Editorial Board Member for Journal of Biomedical Optics and Scientific Reports. He authored two books, edited another book, authored 185 journal publications, 220 conference presentations, 32 patents, gave 220 lecture/plenary/invited talks. He founded Phi Optics, Inc., a start-up company that commercializes quantitative phase imaging technology. He is a Fellow of OSA, SPIE, AIMBE, and Senior member of IEEE.

Adam Wax received dual B.S. degrees in 1993, one in electrical engineering from Rensselaer Polytechnic Institute, Troy, NY and one in physics from the State University of New York at Albany, and the Ph.D. degree in physics from Duke University, Durham, NC in 1999. He joined the George R. Harrison Spectroscopy Laboratory at the Massachusetts Institute of Technology, as a postdoctoral fellow of the National Institutes of Health immediately after his doctorate. In 2002, Dr. Wax joined the faculty of the Department of Biomedical Engineering at Duke University. In 2006, Dr. Wax founded Oncoscope, Inc. to commercialize early cancer detection technology developed in his laboratory and in 2014, founded Lumedica, Inc. to develop low cost OCT systems. He is a fellow of the Optical Society of America, SPIE, and AIMBE and is inventor on 19 US patents. Recently, he has been appointed as the Editor-in-chief of the SPIE journal, *Optical Engineering*. His research interests are in the use of light scattering and interferometry to probe the biophysical properties of cells for both diagnosis of disease and fundamental cell biology studies.