

Special issue in honor of the 70th birthday of Professor J.

Gary Eden

J. Gary Eden received the B.S. degree in Electrical Engineering from the University of Maryland (College Park) and the M.S. and Ph.D. degrees (also in Electrical Engineering) from the University of Illinois, Urbana, in 1973 and 1976, respectively, and was appointed a National Research Council Postdoctoral Research Associate at the U.S. Naval Research Laboratory (Washington, DC) in 1975. As a research physicist in the Laser Physics Branch (Optical Sciences Division) of NRL from 1976 to 1979, he made several contributions to the area of visible and ultraviolet lasers and laser spectroscopy, including the co-discovery of the KrCl rare gas-halide excimer laser, and received a Research Publication Award (1979) for his work at NRL in which he co-discovered the proton beam pumped laser (Ar-N₂, XeF). Since joining the faculty of the University of Illinois in 1979, he has been engaged in research in atomic, molecular and ultrafast laser spectroscopy and physics, the discovery, development, and applications of visible/ultraviolet/vacuum ultraviolet lasers and lamps, and the science and technology of microcavity plasma devices. He has served as Assistant Dean in the College of Engineering, Associate Dean of the Graduate College, and Associate Vice-Chancellor for Research. Currently, he is the Intel Alumni Endowed Chair Emeritus in the Department of Electrical and Computer Engineering and Director of the Laboratory for Optical Physics and Engineering, as well as Research Professor in the Coordinated Science Laboratory, and the Micro and Nanotechnology Laboratory. He has also held faculty affiliate appointments with the Departments of Bioengineering, Materials Science and Engineering, and Nuclear, Plasma, and Radiological Engineering. Dr. Eden has authored more than 320 refereed, archival publications, 102 awarded U.S. and international patents, and one book, is a member of four honorary organizations, and is a Fellow of the IEEE, the Optical Society of America, the American Physical Society (APS), the American Association for the Advancement of Science (AAAS), and the SPIE. He has served as Editor-in-Chief of the IEEE Journal of Quantum Electronics, and Editor-in-Chief of Progress in Quantum Electronics. He also served as an Associate Editor of the APS journal Applied Physics Reviews and is currently a member of the Advisory Board. In 1998, he served as President of the IEEE Lasers and Electro-Optics Society (LEOS), following earlier service as a member of the LEOS Board of Governors, and as the Vice-President for Technical Affairs. Dr. Eden received the LEOS Distinguished Service Award, was awarded the IEEE Third Millennium Medal in 2000, and was named a LEOS Distinguished Lecturer for 2003–2005. Between 2015 and 2017, he also served as a Distinguished Lecturer for the American Physical Society Division of Plasma Physics. From 1996 through 1999, he was the James F. Towey University Scholar at the University of Illinois. In 2005, he received the IEEE/LEOS Aron Kressel Award. He was awarded the C.E.K. Mees Medal of the Optical Society of America in 2007, and was the recipient of the Fulbright-Israel Distinguished Chair in the Natural Sciences and Engineering for 2007–2008. He is a co-founder of Eden Park Illumination (2007), EP Purification (2010-presently), Microplasma Ozone Technologies (MPO3), Cygnus Photonics (2018), and the Eden Park Foundation (2019), and was named the recipient of the Harold E. Edgerton Award of SPIE for 2010. He has directed the research and dissertations of 62 individuals who have received the Ph.D. degree in Electrical and Computer Engineering, Physics, Bioengineering, Materials Science and Engineering, Chemistry, Nuclear, Plasma, and Radiological Engineering, or Civil and Environmental Engineering. In 2014, he was elected into the National Academy of Engineering and the National Academy of Inventors. He received the Distinguished Alumnus Award from the Department of Electrical and Computer Engineering at the University of Maryland (College Park) in 2016 and was named the Intel

Alumni Endowed Chair at the University of Illinois in 2017. In 2020, Prof. Eden was inducted into the Innovation Hall of Fame of the A. James Clark School of Engineering at the University of Maryland. His current research focuses on coupled optical coherences in atoms, atomic clocks, VUV solid-state photochemistry for optical, electronic, and biomedical device fabrication, and laser fractal modes. In this special issue to celebrate Prof. Eden's birthday, you will get a glimpse of some of his contributions to quantum electronics, lasers, laser spectroscopy and plasma lamps. In addition to his technical achievements, to many of us, Gary is the advisor, mentor, colleague, or friend, to constantly inspire and bring out the best in each of us. Below are some reflections from a few of his former students or colleagues on his impact in their own words.

I've known J. Gary Eden since 1979. The first time we met at an international conference in Orlando (USA), which was called "Lasers'7900 and was devoted to quantum electronics, an intensively developing area of the fundamental and applied science. Over the years, he became a famous scientist who gained fame in various fields of science. Gary made a significant contribution not only to the study of the properties of various lasers, but also their applications. He paid much attention to the study of microplasma. His article "Microplasmas and applications" has over 700 citations on WoS. Gary is the author of articles and reviews in leading scientific journals, as well as reports at International conferences, including Lectures and Invited papers. We met with him constantly during conferences both in the USA and in Russia, as well as in other countries. The attached photo shows one of our meetings at the "Asia-Pacific Conference on Plasma and Terahertz Science" (August 2018, Xi'an, China), during which Gary presented Plenary Talk "Recent developments in the fundamental science, applications, and commercialization of microcavity plasma arrays". His reports have always attracted great interest from the audience. He is also well known for his applied works devoted to the creation of spontaneous emission sources of various spectral ranges, primarily flat UV/VUV lamps. It is my honor to have known Gary for the past 42 years, and to count him as a colleague and friend. I wish Gary excellent health, well-being for his family and new creative successes. Victor F. Tarasenko, Professor, Doctor of Physical and Mathematical Sciences. Chief Researcher of Optical Radiation Laboratory, Institute of High Current Electronics SB RAS. It has been an honor and pleasure to work with Gary over the past couple of decades. He was instrumental to our joint innovative development of both a microcavity plasma discharge space thruster and the exciplex/excimer pumped alkali laser. His knowledge of plasma physics and quantum electronics is invaluable, and he is able glean insights from nature at the quantum-scale that would explain certain puzzling phenomena we were measuring experimentally in the lab. Gary has been a guide and mentor to countless students and young professionals. His energy, optimism, and enthusiasm are infectious and helps to strongly motivate students and enable them to excel. Beyond his university-life he is the entrepreneurial co-founder of two small businesses focused on taking innovative plasma concepts to commercialization and production of those technologies. Being an entrepreneur scientist/engineer myself, I have a great appreciation of the exhilaration mixed with challenges of the startup small business environment through which Gary has hurdled. He is a tireless worker which has led to countless well-earned accolades and awards. Gary is an inspiration to his colleagues and friends. – David L. Carroll (SPIE Fellow, AIAA Fellow), President, CU Aerospace, L.L.C. There are few individuals in the field of Quantum Electronics, or for that matter any field, who has earned our respect and admiration as much as J. Gary Eden. His scientific and entrepreneurial credentials are outstanding, and his humanity is something we should all aspire to. The advances Gary has made in laser physics, molecular spectroscopy, photonics and micro-plasmas have, in many ways, helped to define these fields, from theory to state of the art diagnostics and devices. His service to the profession has gone well beyond the call of duty – from editor-in-chief of Journal of Quantum

Electronics to president of IEEE LEOS. Gary has taken his science to the commercial realm, having established multiple companies, and helping to provide photonic-based remedies to the Covid-19 crisis. Beyond his technical accomplishments, Gary is a humanitarian – a rare individual who has and continues to spend much of his time working towards the betterment and mentoring of his students, colleagues, friends, family and society as a whole. I have greatly benefited from being a colleague of Gary, having started my close relationship with Gary as an assistant professor at the University of Illinois in the 1980s. Just as he has helped frame the thinking of his students and post-doctoral fellows on what is important in science and in life, he has helped frame my thinking as well. Gary continues his innovative advances in science and humanity – only this past week an announcement of Gary's development of micro-plasma devices to treat middle-ear infections – hopefully long into the future. Mark J. Kushner, Professor, Electrical Engineering and Computer Science Department, University of Michigan. I have known Prof. Gary Eden since 2015 as a well-renowned scientist, an innovator, a mentor and more importantly as a great human being. Right from our first meeting in Brisbane, Australia (along with Prof. Jagadish) we have only been talking about taking innovative technology from laboratory to real-world to benefit the human kind. His profound work in micro-plasma and his continuous enthusiasm to create social impact through innovation inspired me to take a quantum leap from the academic world – transform myself to an entrepreneur. I subsequently started a company to bring about changes in the purification & decontamination industry utilizing his innovative micro-plasma technology. Since then our journey together has been phenomenal and made both social and commercial impact in communities and industries, alike. We mostly interacted through emails (as we are located in different continents) to discuss developments, challenges, and of course moments of joy after reaching certain milestones. Nevertheless, he has always stayed positive and continued to inspire us through his words of wisdom, which helped me to march ahead at challenging times. This perhaps could be the only long-distant relationship which has truly worked to bring a positive change in someone's life. I look forward to strengthening our collaboration with Gary further to reach far greater heights to build a sustainable planet (through continuous innovation) for the generations to come. Dinesh Venkat, Founder-Director, Eta Purification, India. My years as a PhD student under Gary's mentorship were exciting and full of new and diverse ideas. During my time at Illinois I saw the renaming of the lab from the “Gaseous Electronics Lab” to the “Laboratory for Optical Physics & Engineering”, which more aptly describes the breadth of Gary's interests, spanning from fundamental physics and spectroscopy, to device applications such as microcavity discharge light sources and UV lasers. I think this grounding in fundamental optical science explains a large portion of Gary's success in developing novel light sources, and conversely, his interests in applications have driven new discoveries in molecular dynamics and laser physics. Amy Oldenburg, Professor of Physics, University of North Carolina at Chapel Hill. Gary makes the world a better place, and he is the best life-long mentor anyone could only dream of. The relationship between Gary and me started back in the spring of 2011 as I joined his group as an undergraduate research assistant. Among many of his roles and responsibilities, he took a considerable amount of time meeting his students to guide them. As we all know, each student's academic capacity is different; the time he spent with his students he fathomed their capabilities. By doing so, he gave each one of us a challenging yet achievable goals so that we could taste many successes in our research. Come to think of it, allocating this much time with his students must have been challenging for him considering his busy schedule and his ambitions in the field; I am sincerely grateful that he did not give up on this time with his students. I should also specifically note that he is not only my advisor but also a life-long role model. His words and actions are truly inspirational, and he has a talent of spreading a positive energy to others around him. His self-discipline and perseverance make him an exemplary man. To this day, I ask myself ‘what would Gary do?’ whenever I need to make any major decisions in my life. It is truly an

honor and a pleasure to follow in his footsteps trying to make this world a better place. I enjoyed working with him, and I am eternally grateful that I met him in my life. Charles Shin, BS 012, MS015, PhD 018, University of Illinois, Electrical Systems Engineer, The Boeing Company. I first met Gary when he taught my ECE 210 class in undergraduate, and I was immediately struck by his both his strong character and his technical acumen. Gary is one of the kindest and friendliest people I have ever met. In addition to his mastery of the material, I was constantly impressed by the contagious curiosity and enthusiasm he shares with those around him. This experience led to me doing undergraduate research in Gary's lab, including my senior design project, and I later joined his group to pursue my Ph.D. There, I was able to experience firsthand his incredibly deep expertise in the areas of spectroscopy, optics, plasmas, and lasers. My favorite part of each week in graduate school was meeting with Gary for coffee on Friday mornings to excitedly discuss recent results and next steps. The time I spent working with him and other members of his group is one of the highlights of my career, and I wish him nothing but the best. - J.D. Readle (BS '06, MS '07, PhD '10, University of Illinois), Electrical Engineering Manager, Centrus Energy. "I first met Gary when he was younger than my current age. He was a supervisor of my first postdoc career. Since then, the time has passed for more than 22 years, and he and I worked together in many extraordinary ways and wonderful directions that I never imagined taking. During the time, I used to ask myself how I can be generous like him, how I can be compassionate like him, and how I can be inspirational like him. But, of course, I also realized how difficult it is to be consistent in that way for one's whole life. So I am just feeling lucky and grateful that I remain as a partner, a colleague, and a mentee around him all the time since we have met each other. Everyone who remembers him will not question that he is a scientist with numerous achievements, a devoted teacher. Still, I want to confess that Gary is a man of joy in seeking and finding unexplored things in his research or life. His favorite quote in the Star Trek explains him very well: To boldly go where no man has gone before! I often lost track of time for conversations with him on exploring things (it was such a great memory and asset to me), and if being allowed, I would be happy to set out on another bold voyage together with him during as many years to come. - Sung-Jin Park, Chief Technology Officer, Eden Park Illumination, Inc. and Adjunct Faculty, Department of Electrical and Computer Engineering, University of Illinois. "Gary is more than a Ph.D. advisor to me. Not only I enjoyed and benefited from our father-and-son talks over the years in his lab, but also his preaches and lunch talks at Stratford Park Bible Chapel had led my heart towards the Mighty Lord. Gary did an excellent job of shepherding his sheep and providing an environment and resources to carry out state-of-art research. He had never hesitated in giving us the freedom to pursue research directions as we see fit on the frontline. No doubt my graduate school years with Gary are the highlight of my life, and it has led me towards devoting my career to mimicking Gary as a hard-working scientist." - Jimmy H Ni, Research Engineer, U.S. Army, DEVCOM, Army Research Laboratory. Gary has been my colleague, collaborator and dear friend for almost 50 years, since we first met, possibly playing touch football, as new graduate students at Illinois. He is an outstanding scientist and engineer, a consummate professional, and a most remarkable man of great character. I like to think of Gary as someone who has treated life as a series of opportunities to achieve complementary balances among the things that matter to him. The first of these balances is in his technical work. Gary will tell you modestly that he is just a physicist. He is indeed a fine physicist and recognized as such around the world. But don't let his modesty fool you. He is most certainly also a fine engineer – and also recognized as such around the world. His contributions include the discovery of the KrCl excimer laser which constitutes a major landmark in the field of ultraviolet lasers. It can be stated unequivocally that this entire field owes much of its vibrancy to Gary's creativity and passion for interdisciplinary research. The second of these balances is professional. Gary has maintained extraordinary balance between technical achievement and service to his profession. He has been a role model in terms of leadership to the scientific community and I

have witnessed first-hand the passion, energy, and wise leadership he has provided. There is a third balance – a personal one. Those of us who know Gary well also know that, in a very real sense and as successful as he has been, he's just playing around at his hobby when he's in the lab. His deeper love and his greater passion are reserved for his family and his faith. I know Gary will be grateful for this Special Issue and he will thank us often in his characteristic way – which is usually much more often than necessary. Gary, congratulations on this milestone. We are all grateful to you for your creativity, your wisdom and your passion. James J. Coleman, Richard N. Claytor Distinguished Professor of Optics | Alfred R. and Janet H. Potvin Chair in Electrical Engineering University of Texas at Arlington. Gary Eden transmits enthusiasm in all what he does, from research to mentoring students, to entrepreneurship. In many occasions, over coffee or lunch, our discussions spanning from a new laser concept he and his students have demonstrated, to the ultraviolet microdischarges that are finding compelling societal applications, to ideas on to how to transition technologies have been truly motivating. Interacting with Gary makes you realize what a great profession we are in, and teaches you how to motivate others in their pursues. Gary has been an example and a mentor to me for his dedication to professional service. I was an assistant professor when Gary invited me to serve as Associate Editor for the IEEE Journal of Quantum Electronics. This was one of the many hats he wore at the IEEE Laser and Electro-Optics Society (LEOS), now the IEEE Photonics Society (IPS), to which he served in many different roles culminating with his election to President of the society in 1998. Now that I am in the same role, I feel fortunate to have interacted with 'giants' like Gary who were very influential in shaping the broad efforts of the society to the Photonics community. Thank you Gary for being such a wonderful colleague, and friend! Carmen S. Menoni, 2020–2021 President of the IEEE Photonics Society, University Distinguished Professor, Department of Electrical and Computer Engineering, Colorado State University. Since I started to work on short wavelength lasers Gary has been an inspiration. My first interactions with Gary were at very energizing conferences he was co-organizing in Santa Barbara on topics that included new lasers, spectroscopy and other related topics, starting in the mid 1980's. His achievements at the time already included the discovery of the KrCl laser emitting at 222 nm, the demonstration of new pumping schemes for excimer lasers, and contributions to the elucidation of the complex kinetics of these lasers. Gary's role in the discovery and understanding of excimer lasers is widely recognized. This important class of lasers became the driving force behind the lithography of advanced microprocessors, important eye surgery procedures, thin film laser deposition, modification of material surfaces. Excimer lasers continue to be investigated as possible nuclear fusion drivers. Gary's understanding of the physics of lasers, electrical discharges, and atoms and molecules has allowed him to pioneer the development of a very diverse set of light sources, that include high power ultraviolet excimer lasers, alkali-rare gas lasers, fiber-based lasers. He and other colleagues pioneered the development of micro-discharges as powerful sources of ultraviolet and deep ultraviolet light. These micro-discharges developed into a field of study that resulted in important industry products that provide scalable and economically advantageous technical solutions to major societal problems including water purification and virus disinfection. Gary's work in laser science and advanced light sources is extensive and expands significantly beyond these areas. In collaboration with his own group at the University of Illinois he has made numerous additional significant contributions to experimental and theoretical aspects of short wavelength light sources including the now very widely utilized fiber lasers, high order harmonic generation sources, and other areas ultrafast optical science. Common to all his work is the high degree of innovation, which has resulted in technological breakthroughs. Both the quality and breath of his contributions are impressive. This has been recognized by members of the National Academies, who elected him to the National Academy of Engineering in 2014. As part of these efforts, he has contributed to the educations of outstanding students. He has graduated an amazing number of 62 Ph.D students, many of which are recognized authorities in

their fields. His leadership also expands to the professional societies, university administration and the founding and nurturing of successful start-up companies. On the personal side it is impossible to find a person who does not like J. Gary Eden. I am honored to be his colleague and friend. Jorge J. Rocca, University Distinguished Professor, Departments of Electrical and Computer Engineering and Physics, Colorado State University. As an undergrad, Prof. J. Gary Eden introduced me to the world of lasers in the Optical Electronics class he taught. After a short stint in “big data” research in the astronomy community (before Machine Learning was a catchphrase), I was drawn by Gary’s unashamed enthusiasm for his research in laser spectroscopy and plasma-based light emitters. I worked first as an undergraduate and then as a graduate student in Gary’s Laboratory for Optical Physics and Engineering (LOPE, formerly known as the “Gas House”) for 6 years. During that time, Gary warmed his seat in the local coffee shop or in his “hideout” unofficial second office in the library seemingly more often than not, but was unfailing positive, encouraging, friendly, and sincere to all he came in contact with. This was and is a tremendous positive example in the lives of all his students. As a scientist, Gary’s far-ranging career touches on pulsed gas and solid-state lasers, basic spectroscopy and nonlinear optics, and low and higher-density plasmas useful in numerous applications. His contributions to these fields are significant, and somewhat in contrast with academic cultural norms, he instilled in his students the absolute requirement for quality in publications as more important than quantity. I believe that everyone that knows Gary well wish that there were more Garys in the world. Thank you, Gary, for your encouragement, mentorship, friendship, and support. Thomas M. Spinka, Program Element Leader for Laser Development, Advanced Photon Technologies, Lawrence Livermore National Laboratory. In honor of Gary Eden’s 70th birthday and this special issue, it is a privilege to share some thoughts on behalf of the many graduate students that he has taught and mentored over his long and illustrious career at the University of Illinois at Urbana-Champaign. I was one of Gary’s early Ph.D. students, joining his group over 35 years ago, before today’s impressive facilities of the Laboratory for Optical Physics and Engineering (LOPE). Gary’s laboratory at the time was the modest and historic Gaseous Electronics Laboratory, which he shared at the time with Prof. Joe Verdeyen and his group. Together, Gary and Joe provided a dynamic environment and a model for educational excellence, with joint seminars and mentoring that instilled the rich history of gaseous electronics from discharges and lamps, to emerging new laser science, spectroscopy, and applications. The large, open bay and mezzanine of the “Gas House” was a noisy environment, not only because it was packed with vacuum systems and excimer lasers that seemed to be under constant use and rearrangement as new experiments were explored, but because of the dynamic and sometimes boisterous discussions that resonated throughout the building as discoveries were made, problems were encountered, and scientific methods were transferred on the lab floor from professor to student. While each of us graduates took very different paths, from academia to industry, each of us was indelibly imprinted not only by Gary’s academic excellence and exemplary scientific methods, but his combination of positive spirit and humor. New ideas and the entrepreneurial spirit were as encouraged as pure science. In fact my career at Oak Ridge National Laboratory was enabled by my work with Gary in semiconductor film growth by laser chemical vapor deposition – which was quite different from my thesis topic of rare gas halide excimer spectroscopy and kinetics. For those of us who pursued careers in academia or national laboratories, where publications were our principal output, we also were influenced a great deal by Gary’s scientific integrity as to what constitutes a manuscript, and its purpose. I am grateful that I was able to be mentored by Gary when science was quite different. Journal impact factors and h-indexes had not yet been invented, and publications requiring significant and thorough investigations that built upon a body of work were published in the archival literature and were valued. I still strive to organize and write a manuscript as beautifully as Gary, who could somehow quickly and elegantly find a clear path through the disorganized drafts of his students. It is therefore

an honor to be able to thank Gary on behalf of the more than 50 Ph.D. students he's mentored who, like myself, owe him so much. David B. Geohegan, Leader, Functional Hybrid Nanomaterials Group, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory. Gary has been a dear friend and a colleague over almost 30 years. I feel fortunate to have known Gary through my volunteering activities at the IEEE Photonics Society (formerly Lasers and Electro-Optics Society). It has been a pleasure working with him in serving the community and he has been a wonderful role model to many of us with his generosity, kindness, creativity and serving the community through many roles. He has served as President of the IEEE Photonics Society and Editor-In-Chief of IEEE Journal of Quantum Electronics and Progress in Quantum Electronics. He has been a good mentor and motivator of people in addition to training and educating a large number of graduate and undergraduate students. In addition to being a professor and scientist/engineer making many discoveries in the fields of quantum electronics, visible and ultraviolet lasers, micro-plasmas and molecular spectroscopy, he has also been an entrepreneur, humanitarian and philanthropist. He has started multiple companies and commercialized technologies impacting and benefiting the broader community. His positivity, generosity and kindness have been phenomenal and made a huge difference to the broader community. His philanthropic activities are making a major impact and benefiting the community. We wish Gary and his lovely wife Carolyn good health and happiness for many, many years to come. Chennupati Jagadish, Distinguished Professor, Research School of Physics, Australian National University, Canberra, President, IEEE Photonics Society (2018, 2019).