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A Tribute to Michael R. Berman

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Special Issue Preface

A Tribute to Michael R. Berman

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On behalf of the physical chemistry community, it is our greatest pleasure to present this Tribute for the virtual special issue honoring Michael R. Berman. While most of this community works on individual research projects with graduate students and postdocs, for three decades Mike Berman has been building intellectually diverse, ever-evolving research programs—both individual and group—that seek to understand both fundamental and applied phenomena. Mike is a senior program officer for the Molecular Dynamics and Theoretical Chemistry program at the Air Force Office of Scientific Research (AFOSR). His is a creative, confident, and consistent voice for excellence in science, which has touched the community of physical chemists well beyond the sum of its individual parts.

At mission-oriented agencies, research topics take on complex nuances to understand far-flung agency goals and address them with highly innovative research that is often risky but potentially revolutionary. Mike's ability to see and connect relationships among individual topics and research programs, while at the same time promoting new directions and young investigators, is legendary. His proactive and visionary leadership has been a remarkable benefit to the entire field of physical chemistry and the Air Force. His program has had an enormous impact on the scientific community, as illustrated by the overwhelming interest to establish this virtual special issue, touching on the basic science of a wide range of experimental and theoretical chemistry, including reaction dynamics, energy transfer, ultrafast spectroscopy, nanoparticles, materials, and photocatalysis. From this foundation, he fosters real-world technology transitions that create fuels and propellants, monitor spacecraft emissions, and incorporate new and advanced materials into harsh environments.

Michael Berman completed a B. S. in Chemistry at the State University of New York, Stony Brook, where he performed ground-breaking research using tunable lasers with Phil Johnson. He also worked in Dick Zare's lab at Columbia for a very productive summer in which he initiated Zare's long trajectory in chemical analysis using laser-induced fluorescence. Mike then earned his Ph. D. in Chemistry with C. Bradley Moore at the University of California, Berkeley. He held a postdoctoral associateship at the Naval Research Laboratory with M. C. Lin and spent eight years as a research scientist at McDonnell Douglas, where he was also an adjunct professor at University of Missouri − St. Louis part of the time. In 1991 he became a program officer at the AFOSR. Since joining the AFOSR, he has been personally responsible for supporting over $500M in research investments in primarily chemistry programs. The work that Mike funded to accurately incorporate the effects of chemistry into fluid dynamics models has been called by a leader in that field "the most important advance in aerothermochemistry in the past decade".

Mike is a Fellow of the American Chemical Society, a Fellow of the American Physical Society, and a Fellow of the American Association for the Advancement of Science. He is the recipient of numerous other honors, including the Arthur S. Flemming Award for outstanding federal employees, Fellow of

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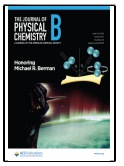

the Air Force Research Laboratory, AFOSR Senior Fellow, and the John L. McLucas Air Force Basic Research Award.

The core university programs supported by Mike Berman have stimulated vanguard research in fields as diverse as molecular and ionic clusters and their reactions, cluster catalysis and photo/electrocatalysis, superatom chemistry, ultrafast multidimensional spectroscopy, ultrafast X-ray/extreme ultraviolet spectroscopy, attosecond science, plasmonics and its applications to chemical reactivity, ionic liquids, and new methodologies for electronic structure calculations. His core programs at several of the Air Force Research Laboratories pioneer new aspects of the fundamental science underpinning ionic liquid thrusters, chemistry in the upper atmosphere and in the space environment, laser detection of constituents in working jet engines, and ion−molecule chemistry. Mike guides and shapes his programs with intense intellectual curiosity, openness to new ideas, and strategic thinking about how to connect Air Force needs to the most exciting basic science. While being intentional in his long-term goals, he still gives his investigators the freedom to be creative and to explore questions until we have done all we can to answer them.

To the uninitiated, these wide-ranging research topics might appear unrelated, but at contractor meetings, Mike brings in guests from the Air Force and Air Force Research Laboratories who illuminate highly visible pathways from the fundamental research to Air Force goals. These include the development of propellants, renewable fuels for jet aircraft, and novel materials for space applications. Unanimously, the scientists in the programs agree that the annual contractor meetings held by Mike Berman are often the best scientific meetings of the year. He also fosters interactions among scientists with complementary expertise at these meetings and via phone calls to individuals throughout the year. As a result of this approach, collaborations and joint projects spring up in Mike's program with astonishing frequency. An outstanding example of his leadership is the resurgence of gas phase physical chemistry, considered to be on life support (Mike's own words) 20 years ago. That field is now undergoing a rebirth, thanks, in no small part, to the many connections that Mike initiated, addressing space problems as the driver, for both the Air Force and the recently formed Space Force.

Given flat budgets, it has always been difficult to bring in new investigators to a funding portfolio, but through the Young Investigator Program (YIP) of the AFOSR, Mike has found an effective path to solicit, counsel, and obtain highly competitive young investigator proposals, allowing him to introduce many superb new investigators to the program. With mid-day phone calls, he seeks advice about fields from many researchers in the program, so that he is as well-informed about the new directions as the proposers themselves. Through the Defense University Research Instrumentation Program (DURIP), Mike encourages proposals and enacts strategic equipment investments that both originate novel science and sustain important efforts. There is no category of defense funding perhaps more important than the Multidisciplinary University Research Initiative (MURI), the ideas for which originate with the program officers in each defense agency. Mike has been extraordinarily successful in generating ideas that are timely and in partnering with other program managers to produce compelling cases for new MURI programs, greatly extending his portfolio of funding into new and visionary areas. Beyond creating the MURI topics themselves, his intentional and continual curation of research teams that bring synergistic talent together to do science that could not have been done individually is a constant feature of Mike's program. The scientific knowledge base has been enriched tremendously through his masterful approach to creating such research partnerships.

A few success stories about basic research connected with Mike are valuable to note. After many years of research work on high-energy-density materials for propellants, initiated in 1986, researchers learned an enormous amount about exotic and largely unstable chemical species containing multiple nitrogen atoms and incorporating metal atoms into fuels, all of which are, however, very difficult to synthesize and maintain. Emerging from a totally different direction of basic research, much of which arose under the programs of Mike Berman, were fabulous and practical concepts of very stable ionic liquid propellants. Ionic liquids are considered "green propellants", as they are nonvolatile and nontoxic and can replace hydrazine, a notoriously dangerous substance with which to work. Another example is the work in Mike's program that supports Air Force and Space Force experiments that temporarily modify regions in the ionosphere to investigate properties of communications and sensing. The basic research community has measured many of the fundamental thermodynamic and energetic pathways required to interpret these global-scale measurements. His program also provided key insights into the erosion and reactions of materials on orbiting vehicles caused by high-speed oxygen atoms. Moreover, reactions of those same fast atoms with propellants produce significant emission signatures that are telltale for the types of fuels and space vehicle origins. Cluster catalysis and plasmon-induced chemistries have blossomed under Mike's watchful eye. Superatom chemistry is something that first became known through basic AFOSR grants awarded to cluster research and is now producing realistic systems as the superatom building blocks for a whole new concept in materials chemistry. Attosecond science and the first isolated attosecond pulses in the United States were conceived in an MURI program overseen by Mike. Pioneering multiscale modeling of mechanical properties of materials came out of another one of Mike's MURIs, an early exemplar of the interdisciplinary teams he now regularly brings together. These low-key introductions by Mike often profoundly change the trajectories of multiple careers.

Michael Berman is not only an extraordinary science officer for the Air Force, but he is also a tremendous friend and contributor to the community. He served three terms as an American Chemical Society Councilor from the Physical Chemistry Division. He organized numerous symposia at national American Chemical Society meetings. He recently edited the book, "Emerging Trends in the Applications of Lasers to Chemistry," (2021) along with Linda Young and Hai-Lung Dai, bringing an original series that began in the 1970s into modern times. His scientific insights have touched the lives of all of us.

On behalf of our community, it is with great joy that we celebrate the achievements of Michael R. Berman by presenting him with this special virtual issue of the *Journal of Physical Chemistry A*, *B*, and *C*. The corresponding range of topics matches the breadth of research in Mike's programs, covering all subareas of physical chemistry: theoretical and experimental molecular spectroscopy, structure and potentials, thermodynamics, kinetics, statistical mechanics, dynamics, solid-state and interfaces, soft matter, liquids, nanotechnology,

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fuels and propellants, catalysis, and more. Mike's abilities to see into the future of science, to make exceptional decisions about important directions, and to address the long-term goals of the Air Force, are central to the magnificent success he has had within our community and to the major research accomplishments that continue to flow from them.

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■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acs.jpcb.3c03044.

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■ AUTHOR INFORMATION

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Notes

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