To My Colleagues

Of course, it is a tremendous honor and pleasure to have such a Festschrift volume of *The Journal of Physical Chemistry* produced on one's behalf, and I first extend my thanks and deepest gratitude to all those responsible. It is also wonderful to have the opportunity to express my tremendous indebtedness to all the individuals with whom it has been my honor and pleasure to collaborate. There is nothing like working with many brilliant people to make one look good, and I am enormously proud and fortunate to have had many of the very best students, postdoctoral fellows, and colleagues as co-workers. It is my considered opinion that the sum of the parts has been far greater than the individual components, and certainly, by myself, I would never have achieved the successes mentioned by John and Michael.

Along these lines, I particularly want to express my indebtedness and tremendous admiration for David Hoffman. Dave and I have been friends since 1960 when we were both extremely fortunate to be graduate students under C. F. Curtiss at the Theoretical Chemistry Institute of the University of Wisconsin. Chuck is a brilliant theoretical chemist and it was from him that I learned about body-frame descriptions of scattering, as well as integral equations and the Lippmann–Schwinger equation, while Dave learned about classical and quantum kinetic theory. After we had both graduated and were becoming established at our respective universities, we became interested in collaborating. There were several topics in particular that I wish to mention in which Dave made fundamental contributions. The first relates to the period that Michael has discussed and specifically involved the CS and IOS approximations for inelastic scattering. During the 70's and early 80's, there was great interest, and even more confusion, in understanding the physical basis of the decoupling of angular momentum achieved in these approximations. It was Dave, as a result of his extensive studies of molecular orientation effects in the kinetic theory of the Senftleben–Beenakker effect, who recognized the connection to quantization along the apse and together with Vijay Khare, the three of us were able to establish, both formally and computationally, that this was indeed the axis along which the z-component of angular momentum was approximately conserved. I believe this work beautifully illustrates the synergistic power of collaboration.

The second topic in which Dave has played a fundamental role is the distributed approximating functional (DAF) work mentioned by John. In fact, the discrete version of the DAFs, which was the progenitor of all of our subsequent work, was totally Dave's idea and creation. It actually took me a while to understand what the point was, and this essentially came about when I saw how to create a continuous version of the DAFs and developed an approach to path integration based on them. The subsequent work we have done is a similar blend of one or the other of us having ideas that we have then filled out together. Of course, this is a major part of the work to which John was referring as applied mathematics, and it has led us into a tremendously wide variety of research problems. These have included developing and applying DAF methods for numerically solving the linear and nonlinear Fokker–Planck equations, the Sine-Gordon equation, the nonlinear Schroedinger equation, the Kuramoto–Sivashinsky equation (a nonlinear equation describing pattern formation in flame fronts and in biology), Burger's equation, and the Navier–Stokes equations. In addition, the DAFs have turned out to be tremendously robust for analyzing experimental data (e.g., pattern formation in the dynamics of granular systems), as well as many types of digital signal processing (e.g., digital mammography, MRI, de-noising of signals, etc.). Indeed, this work has led to the first patent in which I am a co-inventor! And, as John has said, this work is just getting going good. We expect there will be even more exciting discoveries because, most recently, we have established that the Hermite DAFs are rigorous generalizations of the Gaussian. This has come about by showing that there exist relative minimum solutions of the Heisenberg uncertainty principle, such that the differential equation defining the Gaussian becomes inhomogeneous, and the absolute minimum solution simply is the first in an infinite hierarchy of functions. These solutions provide new bases for solving a variety of partial differential equations, and in their multidimensional realization, they constitute new, analytical, entangled exact solutions of the time-dependent Schroedinger equation describing either free or harmonically contained noninteracting Bosons. Their use also for path integration and functional representation and approximation provides an enormous opportunity for further research.

Even more recently, I have had the enormous pleasure of returning to some research that basically was responsible for my obtaining tenure at the University of Houston. This is the work of my first Physics Ph.D. student, Neal Sams, who Michael mentioned led him to decide to collaborate with me. The problem of interest is of fundamental and far-reaching significance, specifically that of inverse scattering. It is at the heart of a huge number of imaging modalities, as well as control theory. The essential achievement of Sams and my work was a renormalization technique for transforming the Lippmann–Schwinger equation from an inhomogeneous Fredholm integral equation of the second kind to an inhomogeneous Volterra integral equation of the second kind. In this new work, we have succeeded in doing this also for the inverse Fredholm integral equation relating the interaction to the scattering information. As a result, we now are able to produce absolutely and uniformly convergent series for the scattering interaction that can be used to treat not only quantum scattering but also any process governed by a Lippmann–Schwinger-type integral equation. This includes acoustic, electromagnetic, and quantum systems. This work is currently being pursued in collaboration with Amrendra Vijay and David Hoffman.

Finally, I take vicarious pleasure in the fact that my collaborators over the years have made tremendous contributions to the field, completely independent of their work with me. Michael and John, as well as many of the others such as Danny Neuhauser and Stuart Althorpe, have played major roles in making it possible to calculate, from first principles, detailed state-to-state integral and differential cross sections. I salute them and join them in celebrating the progress that has been made over the last 43 years.

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