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Introduction

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The papers presented in this issue are dedicated to J. Robert Dorfman by his friends and colleagues at the occasion of his 65th birthday. The articles cover a wide range of subjects in nonequilibrium statistical mechanics and are a reflection of Bob's broad interests and research activities in physics since the time he defended his Ph.D. thesis on *The Theory of the Linear Response of Systems Subjected to External Forces* in 1961 at The John Hopkins University in Baltimore, with T. H. Berlin as his supervisor. His move to the Rockefeller Institute in New York City in 1961, his first scientific publication[1] on spectral properties of the Boltzmann collision operator, and the succession of T. H. Berlin by E. G. D. Cohen in September 1963, largely determined Bob's future career in physics. His "brother" M. H. Ernst, being Cohen's Ph.D. student at the time, also belongs to the collaborators of the first hour, and he too moved in September 1963 with his Ph.D. advisor Cohen from the University of Amsterdam to the Rockefeller Institute, which led to a lifelong friendship and close cooperation with Bob. In 1964 Bob became assistant professor at the University of Maryland, where he still is a professor today. He started to pursue his own research goals and to have his own students, but also kept working with his friends of the first hour, which has been characteristic of his life-long style of collaboration.

Bob's academic and research activities can be divided into four periods: (i) classical kinetic theory (1961)–(1980), (ii) quantum kinetic theory (1980)–(1985), (iii) administrative tasks (1985)–(1992), and his return to science, (iv) chaos theory (> 1992). In the history of kinetic theory Bob entered the field in the *Modern Era*,[2] the period of the

[1] Note on the linearized Boltzmann integral equation of rigid sphere molecules, *N.A.Sc.* **50**:804–806 (1963).

[2] Kinetic theory periods: *Classic Era* (1855)–(1945)-Maxwell, Boltzmann, Chapman, and Enskog; *Renaissance* (1946)–(1960)-BBGKY, Bogolyubov–Choh–Uhlenbeck theory, Green-Kubo formulas; *Modern Era* (1960)–(1980), and *Post-Modern Era* (> 1980)-Revised Enskog theory; ring and repeated ring equations, mode-coupling theory; quantum kinetic theory; lattice gas cellular automata, lattice Boltzmann equations, granular kinetic theory.

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breakdown of the virial expansion of transport coefficients, the discovery of their logarithmic density dependence and the long time tails of time correlation functions, as well as the development of ring kinetic theory.

From the very beginning Bob, in collaboration with Cohen, has been at the forefront of all these new developments. He was one of the first to identify the mechanism of correlated ring collisions, which signals the breakdown of molecular chaos. His careful and difficult analysis of the logarithmic divergence of the ring collision integrals[3] was originally met with scepticism in his environment at the Rockefeller Institute, for instance by G. E. Uhlenbeck, but by now it is well established.

Bob's work on binary collision or T-operators culminating in the derivation of the pseudo-Liouville equation in a paper,[4] referred to by some undisclosed person as the "criminal paper," describes the singular dynamics of hard sphere systems in a very elegant manner. Such a description has become the standard starting point in present day nonequilibrium theory of many particle systems with short range interactions. After the discovery of the long time tails by Alder and Wainwright, Bob and E. G. D. Cohen[5] gave the first molecular explanation of these algebraic tails $\sim t^{-d/2}$ on the basis of ring kinetic theory for a dense fluid of hard spheres in d dimensions. In many subsequent papers in the years till 1980 Bob explored in depth, with many different collaborators, the implications of the classical ring kinetic theory, e.g., on the non-analytic decay rates of hydrodynamic modes and on drag coefficients in hydrodynamic flows.

Much of this work was done together with his most steady collaborator for almost 30 years, H. van Beijeren, who joined Bob as a postdoc in 1974. From this period dates also one of the few authoritative, comprehensive and generally accessible reviews[6] on the role of correlated ring collisions in transport theory of classical gases. Another important application of ring kinetic theory in collaboration with T. R. Kirkpatrick and E. G. D. Cohen was the extension to fluctuations in nonequilibrium steady states (NESS), in which the effects on light scattering of long range correlations have been investigated in great detail. The theory developed for these generic long range NESS correlations away from critical points was confirmed exerimentally, and later successfully used to analyze long range correlations in stationary states of granular fluids and lattice gas cellular automata, which violate the requirements of detailed balance.

[3] with E. G. D. Cohen, *J. Math. Phys.* **8**:282 (1967).
[4] with M. H. Ernst, W. R. Hoegy, and J. M. J. van Leeuwen, *Physica* **41**:1217 (1969).
[5] *Phys. Rev. Lett.* **25**:1257 (1970).
[6] with H. van Beijeren, in *Statistical Mechanics*, B. B. J. Berne, ed. (Plenum Press, New York, 1977), pp. 65–179.

Around 1981 Kirkpatrick became Bob's postdoc. It was the beginning of another long lasting and productive collaboration, which made Bob move into the field of quantum kinetic theory. Together they evaluated transport coefficients, long time tails and localization phenomena in quantum Lorentz gases, dilute superfluids, and weakly interacting electron gases. In fact their results for the transport coefficients of dilute condensed Bose gases[7] are of great interest for the recent experimental and theoretical activities on Bose–Einstein condensation. According to authoritative sources their results have been rediscovered and rederived a few times during the last three years.

It was also during this period that Bob's qualities as a teacher and lecturer became generally appreciated, not only at UMD—where he received the Distinguished Scholar-Teacher Award—, but also internationally as a lecturer at summer schools and workshops, seminars, symposia and conferences to which he was frequently invited. Excellence both in teaching and in research is hard to come by. "To answer basic questions with simple models is the favorite topic in the work of Bob Dorfman," is the opening sentence, borrowed from one of the papers in this Festschrift. This gift for simplicity is also witnessed by his book *A Course in Statistical Thermodynamics*,[8] and the more recent one *An Introduction to Chaos in Nonequilibrium Statistical Mechanics*,[9] an excellent primer into this difficult field of mathematical physics.

During his whole life Bob had a deep interest in human relations, and responsibilities towards his fellow men. This manifested itself also inside academia. To name just a few examples: in his institute and department, as well as campus-wide he has served on many review and search committees, and on special task forces. Nationally and internationally he has been active as chairman or member on various NSF panels, on the Editorial Board of *Physical Review A and E* for several terms, and in organizing international conferences. To honor him he was awarded in 1988 the Chancellor's medal for Extraordinary Contributions to the University of Maryland College Park Campus. In 1980 he was elected Fellow of the American Physical Society. Outside the university he was active in his local community as a teacher in a religious school, as a telephone counselor for the Suicide/Crisis hot line of Montgomery County, Maryland, and teaching Talmud at local synagogues.

Given his personality it was clear that he would not avoid taking the imposing responsibilities of being the director of the Institute for Physical

[7] with T. R. Kirkpatrick, *J. Low. Temp. Phys.* **58**:301, 399 (1985).
[8] with Joseph Kestin (Academic Press, 1971).
[9] (Cambridge University Press, 1999).

Science and Technology, which he did from 1983 to 1985. He clearly did this so well that he was rocketed up the administrative ladder: from acting provost (1985) to acting dean (1986), to dean of the College of Mathematical and Physical Sciences (1987), and finally to vice president for academic affairs and provost (1989)–(1992). In this period it was difficult for his friends in physics to meet him. It was easier to see him on the local TV-stations, as it happened in 1986 during the Len Bias drug scandal. As the chair of the chancellor's task force on the academic achievement of student athletes he had to give frequent press conferences and interviews to the media.

His position as a high level university administrator came suddenly to a dramatic end when he was diagnosed with cancer on December 12, 1991, and operated a week later. He had to endure the hardship of six months of chemotherapy. He overcame all this, and to our great joy returned to science in the summer of 1992 and, to the benefit of all of us, has stayed in good health ever since. It was perhaps our biased view that he looked a lot happier being back in physics again after about seven years. But what to start investigating after having been out of it for such a long period? It was obviously a non-trivial question to answer. It shows Bob's strength of character as well as his great love of physics that he decided to learn the totally new field of dynamical systems and chaos theory, and to start research on its relationships to nonequilibrium statistical mechanics. At the University of Maryland he happened to have excellent teachers in his new fields, such as E. Ott, C. Grebogi, and J. Yorke. The student Bob rapidly advanced from being a "white belt" to being a "black belt," to describe his progress in terms of his former karate sport.

His contributions to the new field started with a nice little paper *Simple Maps with Fractal Diffusion Coefficients.*[10] Soon Bob found his niche there, became an expert in the field, wrote a book about it, was invited the world over to lecture about his new subject, and made significant contributions to it. Especially successful were his collaborations with P. Gaspard[11] and T. Gilbert[12] on various aspects of the deep connections between chaos theory and nonequilibrilium statistical physics, and his collaboration with van Beijeren on calculations of Lyapunov exponents for Lorentz gases and hard sphere systems, supported in crucial ways by the numerical work of H. Posch and C. Dellago. A very original extension of the Boltzmann Equation was proposed there, which made it possible to explicitly calculate Lyapunov exponents. In a way it is for Bob a return to

[10] with R. Klages, *Phys. Rev. Lett.* **74**:387 (1995).
[11] *Phys. Rev. E* **52**:28 (1995).
[12] *J. Stat. Phys.* **96**:225 (1999).

his roots, his very first paper. This extension of the Boltzmann equation is an achievement worthy of being added to the highlights in kinetic theory in the Post-Modern Era.

Before closing this introduction to Bob's works and accomplishments, we cannot fail to mention his wife Celia. She enriched his life with so much warmth, happiness, new friendships, and Jewish traditions, that Bob had been missing before. When his illness and therapies severed his life lines to his local community and university, it was she who was there nights and days, she helped him pull through depressing lonely periods, she helped him to recover physically and regain his mental strength. It is our privilege to enjoy Celia's friendship as well as Bob's.

Finally, a happy birthday, Yom Huledet Sameach, to Bob and Celia, and best wishes for many good years to come.