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Response to B. C. Eu[1]

J. Robert Dorfman[2]

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I will confine my reply to a few brief remarks, since my book review was very clear about my thoughts on this matter.

1. Despite Prof. Eu's thoughts on the "mainstream," etc., the fact remains that there is a consistent view of the kinetic theory of dense gases that is logical, founded on careful analysis at an acceptable level of mathematical rigor, and amply supported by computer simulations and experiment. While the divergences in the virial expansions of the transport coefficients, the resulting logarithmic terms in density expansions, and long-time tails in the time correlation functions are all an integral part of this theory, they are by no means all of it. Some mention of other aspects of kinetic theory, not covered in Eu's book, was given in my review. I believe that my review was fair in calling attention to this other line of work, since Eu is opposed to it, and criticizes it often.

2. While Prof. Eu disputes the conclusions reached by many other workers that divergences exist in the virial expansions of transport coefficients for moderately dense gases, both for classical and quantum systems, several authors have failed to find his arguments convincing. For example, an analysis along the lines suggested by the Faddeev approach to scattering theory was provided by Hoogeveen and Tjon.[1] They showed that for the quantum mechanical Lorentz gas, the divergence was real. They also pointed out some errors in earlier work by other authors which had led to a contrary conclusion.

It should be noted here that in three dimensions, the three-body collision integral is not divergent, but the four-body term and the higher-order

[1] The response by B. C. Eu to the book review appearing in *J. Stat. Phys.* **73**:799–801 (1993) appears in the present issue.

[2] Department of Physics and Institute for Physical Science and Technology, University of Maryland, College Park, Maryland.

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terms are. In two dimensions, the three-, four-, and higher-body terms diverge. These divergences are not due to an incorrect treatment of disconnected diagrams. They are an indication that one should not expect transport coefficients to possess virial expansions in powers of the density where each term depends solely on the dynamical behavior of a fixed number of particles in infinite space.

3. Even if the logarithmic terms in the density were never discovered experimentally—a situation that may be remedied by a study of electron mobilities in helium[2]—there is substantial evidence that the arguments for its existence are correct. The resummations necessitated by the divergences lead directly to both the logarithmic terms in the density expansions of the transport coefficients as well as to the long-time tails in the time correlation functions. These tails are real and have been seen in computer simulations, as well as in neutron scattering experiments on fluids, contrary to the views expressed in Prof. Eu's book.

REFERENCES

1. W. Hoogeveen and J. A. Tjon, *Physica* **115A**:101 (1982).
2. K. I. Wysokinski, Wansoo Park, D. Belitz, and T. R. Kirkpatrick, Density expansion for the mobility of electrons in helium gas, preprint (March 1994).