In memoriam

José María Ortiz de Zárate Leira (1964-2020)

Dr. José María Ortiz de Zárate Leira of the Universidad Complutense de Madrid, tragically died on October 29, 2020 as a result of brain cancer. José was born in Ferrol, A. Coruña in his beloved Galicia to which he would return regularly during his life. José received his Bachelor of Science degree in 1987, after which he embarked on his research career at the Complutense University. His Ph.D. research, completed cum laude (Best dissertation prize of the School of Physics for 1989/1990) in 1990 under the direction of Prof. Juan Mengual, was concerned with experimental nonequilibrium thermodynamics, in particular with transport phenomena across porous membranes caused by temperature gradients. After having served a few years as an assistant professor, he became Associate Professor at the Universidad Complutense in applied physics in 1992.

Fluids in non-equilibrium steady states exhibit large long-range thermal fluctuations as originally predicted by Kirkpatrick, Dorfman, and Cohen in 1982 and confirmed experimentally by my research group including a collaboration with José. Subsequently, José became a leader in non-equilibrium fluctuating hydrodynamics demonstrating the profound effects of gravity and confinement on non-equilibrium temperature fluctuations in one-component liquids, and on non-equilibrium concentration fluctuations in liquid mixtures. He developed a unified approach for dealing with thermal non-equilibrium fluctuations covering stable non-equilibrium states away from and close to any convective instability. This work has inspired many experiments, both in Europe (Vailati and coworkers in Milano, Croccolo and Bataller in Pau, Shevtsova in Brussels) and in the United States (Ahlers and Cannell in Santa Barbara, CA, Oprisan in Charleston, SC). Furthermore, to check the predictions of José, experiments have also been performed at microgravity in the GRADFLEX program of the European Space Agency and NASA. The various experiments

have dramatically confirmed the theoretical prediction that the thermal fluctuations exhibit a non-equilibrium enhancement up to a factor of a million on earth and a factor of a billion in microgravity. The predictions of José of the effects of confinement on the decay rate of non-equilibrium fluctuations have also been confirmed, both experimentally by the research group in Pau and from computer simulations of Aleksandar Donev at the Courant Institute in New York. Because of his expertise in the theoretical development of non-equilibrium fluctuating hydrodynamics, José became also involved in the Giant Fluctuations Space Project, currently being developed for a flight in the International Space Station in 2024. José is the principal author of the first monograph specifically devoted to fluctuating hydrodynamics that has become a standard reference in the field of non-equilibrium fluctuations.

Probably the most important consequence of the confinement effects analyzed by José is the presence of giant non-equilibrium Casimir forces in liquids in the presence of a temperature gradient or a concentration gradient. From the work of José we have been able to conclude that these non-equilibrium Casimir forces will be several orders of magnitude larger than previously known Casimir forces in condensed-matter science.

The expertise of José was not restricted to non-equilibrium fluctuations, but also covered transport properties, such as experimental research with Mohamed Khayet on the thermal conductivity of liquids and solids including nanofluids, clays, and phase-change materials (PCMs). Most prominent was the expertise of José in mass diffusion and thermodiffusion of multicomponent fluids for which he has proposed a universal framework, referred to as brilliant by one expert on the subject.

José also provided outstanding service to the scientific community. He has been Executive Editor of the Revista Española de Física, as well as Deputy General Editor of the Royal Spanish Physical Society from 2010 till 2013. Together with Mohamed Khayet, José organized one of the conferences on thermodynamics of the Royal Spanish Physical Society (Termo 2006) and the 12th International Meeting on Thermodiffusion in 2016. José also demonstrated a special interest in the history of science by publishing reviews of some Spanish scientists. He has acted as a consultant on database management and maintenance to some Spanish societies and companies.

José died prematurely, but his fundamental contributions to non-equilibrium fluctuating hydrodynamics will stand forever. This obituary would be incomplete without mentioning the beauty of José as a kind and caring human person. He was personally interested in everybody he would meet and his enthusiasm for Spanish culture was contagious. It has been a privilege for many of us to have encountered José as a cherished colleague and friend on our journey in life.

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P.S. Comments from Mohamed Khayet of the Complutense University are gratefully acknowledged.