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J. Ortiz de Sarate, J.V. Sengers: Hydrodynamic Fluctuations

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Since the rather lapidal note published back in 1934 by L. Landau and G.E. Placzek using linearized hydrodynamics to calculate the spectrum of light scattered by density fluctuations in a dense fluid, the field of hydrodynamic fluctuations has been given considerable attention. The authors of this book provide a very complete account of the work done along these lines for the past sixty years. It is very likely to be considered as a long awaited book in the field after the somewhat classical books of Berne and Pecora and Boon and Yip, written almost thirty years ago.

After an introductory chapter in which the basic concepts of non-equilibrium thermodynamics are provided, the authors proceed to discuss in a very systematic way the main subject namely, hydrodynamic fluctuations. The classical work on equilibrium fluctuations is reviewed in chapter three and from there on they proceed to deal with non-equilibrium fluctuations both in one-component fluids and fluid mixtures, the basic contents of Chaps. 4 and 5. The results there studied are then used to incorporate complications arising from finite size effects. This is done in Chap. 6. Chapters 7–9 deal with the more sophisticated aspects of the problem in both one component fluid layers and binary fluid layers including the behavior of thermal fluctuations close to the Rayleigh-Bénard instability.

These six chapters mainly theoretical in their contents, are in my opinion very nicely organized. Without including many technicalities involved in the derivation of the mathematical equations which constitute the core of particular aspects of the cases dealt with, the physical ingredients required to understand the ensuing results are very clearly expressed. A very rich bibliography is given at the end of the book where any reader interested in those missing mathematical aspects may easily locate them. The whole picture of the phenomena discussed develops in a rather elegant way as one is able to see how the basic results require modifications as the different facets of the situations studied, are brought into the fore.

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Chapter 10 deserves a special attention. Here they offer a comprehensive account of the different experimental techniques used to investigate the theoretical results obtained in the previous chapters. Light scattering experiments, widely treated in previous works are briefly reviewed and a long discussion on the most recent experimental technique namely, quantitative shadowgraphy is presented. This is enlightening from all points of view.

Chapter 11 contains a brief but interesting analysis of non-equilibrium fluctuations in other type of systems, liquids under shear, liquid crystals, interfaces, reaction-diffusion problems and others. The last chapter, the epilogue, together with the introduction really constitute the particular point of view from the authors to their own work.

One striking feature of the general methodology used in analyzing the different situations encountered in the systems under examination is based on linear perturbation techniques. In some case efforts made in incorporating non linear perturbations are superficially mentioned. This ought to be a source of inspiration for those researchers in the field who are seeking for interesting problems to work out. The whole question of non linear perturbative techniques in hydrodynamical problems is very likely to lead to rather surprising results.

Another comment is also pertinent. As the authors clearly point out, the whole theoretical basis of the fluctuating ingredients used here let them be the stochastic forcing, the noise correlation matrix and others, constitute a model. The model, unquestionably has been found to correctly account for the various features of the systems under study, but it is just a model. I remind the reader of the very wise thoughts of N.G. van Kampen: "Statistical mechanics leads, on the macroscopic level to a stochastic description in terms of a master equation. Subsequently deterministic equations plus fluctuations can be extracted from it by suitable limiting processes. The misconception that one should start from the known macroscopic equations and then somehow add the fluctuations on to them is responsible for much confusion in the literature." Hydrodynamics is not free from this observation. The canonical procedure to derive the basic equations of fluctuating hydrodynamic is still, in the reviewer's opinion, an open question. Finally one minor point: the equation $\mathrm{div}\vec{v} = 0$ defines an incompressible flow not an incompressible fluid.

The book on the whole is excellent. Any scientist regardless of his field of speciality interested in hydrodynamic fluctuations will find it very useful.