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Dynamical Critical Phenomena and Related Topics

Proceedings, Geneva 1979

Edited by Charles P. Enz

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Dynamical Critical Phenomena and Related Topics

Proceedings of the International Conference, Held at the University of Geneva, Switzerland, April 2–6, 1979

Edited by Charles P. Enz

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INTRODUCTION

It is a great satisfaction to present this volume to the scientific community. For, it contains reports which, I believe, stand out in quality as well as actuality. Therefore, my first word is addressed to the authors of these reports thanking them for their enthousiastic collaboration as invited speakers to the "International Conference on Dynamical Critical Phenomena and Related Topics", held at the University of Geneva, Switzerland, from 2 to 6 April 1979, in short, the Critical Dynamics Conference - CDC 79. I also thank the invited speakers for having submitted their manuscripts quickly so that the remarkable freshness of the results reported in these proceedings is not impared by delays of publication.

It was the intention, that the program for CDC 79 should cover dynamical phenomena not only in the usual critical domain of closed, equilibrium systems but also around instabilities of open, non-equilibrium systems. This "opening" towards a new and fast developing field contained some risks, as was pointed out by several experts asked for their opinion about the interest of such a conference back in March 1978. In order to arrive at a program which was internally "at equilibrium", the borderline was drawn by limitation to physical systems, thus excluding endeavours into chemistry, or even further, into life and social sciences.

The vicinity in time of several meetings of a similar kind presented a certain danger for CDC 79, as signaled by a number of the experts contacted for advice. These meetings are listed below because some of them are referred to in the contributions to CDC 79 and have produced proceedings of interest :

- The "International Symposium on Nonlinear Nonequilibrium Statistical Mechanics" held in Kyoto, Japan, on July 10-14, 1978, and chaired by H. Mori;
- the 17th International Solvay Conference on Physics on "Order and Fluctuations in Equilibrium and Non-Equilibrium Statistical Mechanics" held in Brussels, Belgium, on November 20-23, 1978, and directed by I. Prigogine;
- the 1979 Midwinter Solid State Research Conference on "Non-Linear and Non-Equilibrium Phenomena in Condensed Matter" held in Laguna Beach, California, on January 15-19, 1979, and chaired by G. Ahlers and B. Huberman;
- the "6th International Seminar on Phase Transitions and Critical Phenomena in Solids and Liquids" held in Trieste, Italy, on March 26-28, 1979, and chaired by C. Di Castro;
- the "International Symposium on Synergetics" held in Elmau Castle, Bavaria, on April 30 - May 5, 1979, and directed by H. Haken.

If these meetings had at all been dangerous to CDC 79, it may have been with regard to participation but certainly not with regard to quality. In fact, while many of the experts in the field unfortunately did not attend, the CDC 79 community turned out to be a motivated, coherent, enthousiastic and surprisingly young group, as was evident from the quality of the discussions.

These discussions would actually have merited publication, as would have the contributed papers. However, reasonable size and quick publication of the proceedings were considered of primary importance, and I believe that the final product fully justifies this reasoning. Still, in order to retain some information about the contributed papers, the list of contents of the Abstract-Handbook (which contained the abstracts of all contributions and was handed to each participant at CDC 79) is reproduced here with only minor modifications, in place of a simple list of contents. In this *list of contributions* all invited lectures, which alone are printed in this

volume, figure with their paper numbers while the contributed papers are only listed by title and have no page numbers attached.

All contributions are grouped into the *seven topics* which formed the underlying structure of the program. Making use of the *address list of participants* included as an appendix, it will be possible to obtain more ample information directly from the authors of the contributed papers. In this way it is hoped that these proceedings will offer maximum information at minimum cost both in volume and in time delay.

The first topic of the program was a review of the theoretical methods and was meant as an introduction to the conference. In his comparison of mode-coupling theory and the dynamical renormalization group method, Prof. Gunton clearly showed the extent and limits of the equivalence between the two approaches. Prof. Janssen gave a review of the elegant field-theoretic method, which had been introduced into critical dynamics by himself and by De Dominicis, and also pointed to new applications, some of which were discussed in contributed papers. The particularities and difficulties of critical dynamics in the ordered phase and the role of Goldstone modes were discussed by Prof. Szépfalusy.

Although not truely separated from the first topic, the real space dynamical renormalization group methods have assumed a quite distinct importance in present-day research, mainly because of their applicability to low-dimensional systems. While Prof. Suzuki's lecture, as well as the other contributions, gave an impressive view of the problems still ahead, the beautiful report by Prof. Mazenko took up the question at a more fundamental level and was full of promise.

In view of the very recent break-through in the understanding of critical damping of second sound in liquid Helium, a full day was devoted to this substance. The latest measurements of the second sound damping and other effects of critical dynamics obtained with powerful light scattering techniques were the subject of an illuminating report by Prof. Greytak. Dr. Peliti reviewed the theory by De Dominicis and himself, which for the first time had exhibited the discrepancy between theory and experiment. The final explanation of this discrepancy by Prof. Ferrell and his collaborators Dr. Bhattacharjee and Dr. Dohm was reported for the first time at CDC 79 by these three authors. The abundant experimental data obtained near the tricritical point of He^3-He^4 mixtures were reviewed by Prof. Meyer while the theoretical aspect was also contained in Prof. Gunton's and Dr. Peliti's talks.

In view of the still controversal question of whether the central peak is an intrinsic feature of critical dynamics near structural phase transitions, a panel was organized on this subject. The very latest experimental and theoretical developments together with an extensive historic overview was presented by Prof. Müller. A second panel discussion devoted to the problems left open by this conference was directed by Prof. Mazenko.

Two other important topics of critical dynamics could only be touched, namely low-dimensional systems and systems with random parameters. Concerning the first topic, Prof. Sjölander reported on exact results obtained for the one-dimensional Heisenberg chain, which was supplemented by some results for two dimensions by Dr. Reiter. Unfortunately, it had not been possible to have a report on the exciting new results for two-dimensional two-component systems (Helium films). But instead, there was an expert report by Prof. De Dominicis on the sophisticated theoretical methods developed for systems with randomness.

Much emphasis was also given to the experimental aspect in the following topic concerning hydrodynamic instabilities. Here, Prof. Bergé and his group reported their imaginative light scattering work, most of which was communicated for the first time

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at CDC 79. Bergé also discussed the transition to turbulence, emphasizing the importance of the aspect ratio of the system. The formidable theoretical problems related with both hydrodynamic instabilities and turbulence were discussed respectively by Prof. Velarde and Dr. Fournier, the latter reporting also on some attempts to apply renormalization group methods to turbulence.

The last topic was devoted to critical dynamics far away from equilibrium. Here again CDC 79 witnessed a first report, namely the break-through achieved by Prof. Kawasaki and his collaborator Dr. Onuki in the problem of a shear flow of a liquid near its critical point. It was a remarkable coincidence that the experimental verification of one of Kawasaki's predictions was also first reported at CDC 79 by Beysens and Gbadamassi from Prof. Bergé's group.

Prof. Kawasaki also reviewed other systems which are far away from equilibrium and which may be analyzed by his new theory. One was non-equilibrium superconductivity which, due to its importance, would have deserved an independent account. Instead, the classic far-away-from-equilibrium system , namely the laser, was brilliantly reviewed by Prof. Arecchi, and many contributed papers on non-equilibrium problems were to follow.

Having mentioned some missing topics, it is worth adding that the program of CDC 79 was probably a major cause for a stimulating conference. This program grew out of a collaboration with Michel Droz for which I am most grateful to him. I also thank Michel and my other associates, as well as the secretaries, accountants and printers for their unassuming but efficient presence whenever it was needed.

But if CDC 79 succeeded with only a local staff of three, it was also due to its third member, Mrs. Christine Baly. She was not only the helpful and efficient Conference secretary but contributed significantly to the shaping of the social program : the excursion to CERN and to the famous Bodmer collection of ancient manuscripts and art objects, as well as the high-spirited banquet in the castle of the historic Madame de Staël at Coppet with the authentic Swiss folklore.

A particular word of thanks is due to the authorities of the Canton and the City of Geneva who so graciously offered the cocktail at the elegant Palais Eynard but, more indirectly, are also at the origin of the excellent facilities at the new Sciences II building.

Obviously, without the sponsors, there would have been no CDC 79. Therefore, I here reiterate my thanks to them in the name of the participants, above all to the Swiss National Science Foundation, but also to the Fond General of Geneva University, to the International Union of Pure and Applied Physics and to the Faculté des Sciences, the Section de Physique and the Département de Physique Théorique of Geneva University. I think, the present proceedings are the best proof for the good use made of their funds.

Charles P. Enz

Geneva, May 6, 1979

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