Similarity laws in disordered condensed systems

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Usp. Fiz. Nauk **158**, 749–750 (August 1989)

Universalities in Condensed Matter: Proceedings of the Workshop, Les Houches, France, March 15–25, 1988/Eds. R. Jullien, L. Peliti, R. Rammal, and N. Boccara. Springer-Verlag, Berlin; Heidelberg; New York; London; Paris; Tokyo, 1988.—270pp. (Springer Proceedings in Physics. V. 32).

The book is a collection of the results of the work of the seminar on "Universalities in Condensed Matter" the aim of which was to organize contacts and to unify the efforts of scientists of different fields of physics working on similar fundamental problems, and also to provide an analysis of different physics objects from unified positions. Physical systems that possess the property of similarity and that admit scaling are examined. It is precisely the change in the scale of a system that leads to a corresponding change in some of its parameters.

The book consists of five parts. The first small part is devoted to some geometrical systems. Here, for example, the hierarchy of line defects in structures, the elements of the Fibonacci chain quasicrystal, the scaling properties of a Fourier spectrum, etc. are examined. The set of topics being treated has a random character.

The second part of the book deals with scaling in critical phenomena. The papers presented here investigate similarity laws in sol-gel transitions, properties of polymer and percolation clusters and also smectic crystals in the domain of disruption of crystal structure. Similarity laws are studied in superconducting glasses, in magnetic phase transitions, etc. Here also one should note the random selection and nature of the papers presented.

The third part of the book investigates ramified and fractal systems. It presents a selection of original papers on individual processes and methods of their analysis, which refer to percolation systems and the process of growth of aggregates.

The fourth part, entitled "Anomalous scaling laws" includes a number of papers on the analysis of systems where scaling assumes a complex form. We shall demonstrate these problems on the example of a DLA-cluster which corresponds to the model of the cluster-particle aggregation that is diffusion-limited. In this case the cluster grows as a result of individual particles that perform a Brownian motion in space sticking to it. This cluster is characterized by a definite fractal dimensionality, and if one takes a piece of the cluster then the index of the power in the dependence of its mass on size will be a fractal dimensionality. It might appear that this index should characterize also other similarity laws, for example the dependence of its perimeter on size. However modeling shows that scaling for the higher moments as a function of size of the DLA-cluster would require new characteristics which are not expressible in terms of the fractal dimensionality of the cluster. Problems of this kind arise in the detailed investigation of appropriate systems and are being developed.

The last part entitled "Dynamical systems and turbulence" deserves special attention. Here results are presented on scaling in problems of gas dynamics, physics of chaos and turbulence. A number of problems is analyzed and an attempt is made to utilize methods which gave good results in one class of phenomena for other systems and phenomena.

Although the book is a set of individual original papers, it reflects the modern state of physics of disordered systems with strong interaction. The book will be useful for physicists working in different fields, who are interested in such problems.

Translated by G. M. Volkoff