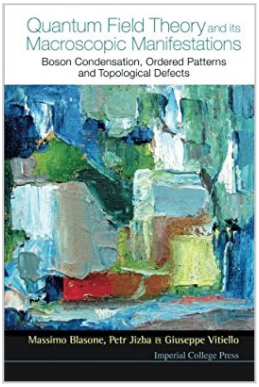

Quantum Field Theory And Its Macroscopic Manifestations: Boson Condensation, Ordered Patterns And Topological Defects

By Massimo Blasone

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Quantum dynamics underlies macroscopic systems exhibiting some kind of ordering, such as superconductors, ferromagnets and crystals. Even large scale structures in the Universe and ordering in biological systems appear to be the manifestation of microscopic dynamics ruling their elementary components. The scope of this book is to answer questions such as: how it happens that the mesoscopic/macroscopic scale and stability characterizing those systems are dynamically generated out of the microscopic scale of fluctuating quantum components; how quantum particles coexist and interact with classically behaving macroscopic objects, e.g. vortices, magnetic domains and other topological defects. The quantum origin of topological defects and their interaction with quanta is a crucial issue for the understanding of symmetry breaking phase transitions and structure formation in a wide range of systems from condensed matter to cosmology. Deliberately not discussing other important problems, primarily renormalization problems, this book provides answers to such questions in a unitary, self-consistent physical and mathematical framework, which makes it unique in the panorama of existing texts on a similar subject. Crystals, ferromagnets and superconductors appear to be macroscopic quantum systems, i.e. their macroscopic properties cannot be explained without recourse to the underlying quantum dynamics. Recognizing that quantum field dynamics is not confined to the microscopic world is one of the achievements of this book, also marking its difference from other texts. The combined use of algebraic methods, and operator and functional formalism constitutes another distinctive, valuable feature.

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Editorial Review

Review

"Physicists believe quantum fields to be the true protagonists of Nature in the full variety of its wonderful, manifold manifestations: from the fascinating appearance of colorful disclinations in nematic liquid crystals, to the awing pattern of cosmic strings in the Universe; from the unexpected quantum features of macroscopic superfluids, to the surprising dynamics of solitons, to the mysterious process of generation of virtual particles when symmetry after symmetry is broken. Quantum field theory is the tool they created to fulfill their visionary dream of describing with a universal, unique language all of nature, be it single particles or condensed matter, fields or many-body objects, in a way that can be made consistent with the other hard and deep constraint they have to call to account: relativistic covariance. This is perhaps the first book on quantum field theory whose aim is to grasp and describe with rigor and completeness, but at the same time in a compelling, fascinating way, all the facets of the complex challenge it faces scientists with. It is a book that presents solutions but poses questions as well; hard, demanding yet fascinating; a book that can at the same time be used as a textbook and as a book of dreams that any scientist would like to make come true."
-- Mario Rasetti, Dipartimento di Fisica, Politecnico di Torino, Torino, Italy

"This remarkable book dispels the common misconception that quantum field theory is 'just quantum mechanics with an infinite number of degrees of freedom', revealing vast new mathematical terrains, and new ways of understanding physical phenomena in both commonplace and exotic systems. Uniquely valuable, and covering material difficult or impossible to find coherently assembled elsewhere, it will be welcomed by students and researchers in all fields of physics and mathematics."
-- John Swain, Physics Department, Northeastern University, Boston, MA, USA

"The book by Massimo Blasone, Petr Jizba and Giuseppe Vitiello gives an overall presentation of the most important aspects of quantum field theory, leading to its macroscopic manifestations, as in the formation of ordered structures. The list of topics, all covered in full detail and easy-to-follow steps, is really impressive. It includes the general structure of quantum mechanics and quantum field theory, the role of the inequivalent representations of the commutation relations, the spontaneous breakdown of symmetry with the consequent phenomenon of dynamical rearrangement of symmetry, quantum field theory at nonzero temperature, boson condensation and topological defects, dissipative quantum systems. The main features of the presentation rely on very simple and powerful unifying principles, given by the intermixing of symmetry and dynamics, under the general texture of quantum coherence.
Most of the chapters share the typical flavor of the very intense personal research carried by the authors during the years, but the style of presentation is always perfectly coherent, and all topics are presented in a mature and well-organized way. I think that the book will be most useful for graduate students who are willing to be engaged in the fascinating task of exploring the full potentiality of quantum field theory in explaining the emergence of ordering at the macroscopic level, from the large-scale structure of the universe, to the ordering of biological systems. Of course, active researchers in all formation stages, but even mature scientists, will appreciate the intellectual depth and the scientific efficacy that the authors have transfused in their work."
-- Francesco Guerra, Department of Physics, Sapienza University of Rome, Italy --

"This book gives a very thorough treatment of a range of topics that are of increasing importance, from a

rather unusual, and very instructive, point of view." ---- Tom W Kibble, Theoretical Physics, Imperial College London, London, UK

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