

Open Questions in Quantum Physics

Fundamental Theories of Physics

A New International Book Series on The Fundamental Theories of Physics: Their Clarification, Development and Application

Editor: ALWYN VAN DER MERWE

University of Denver, U.S.A.

Editorial Advisory Board:

ASIM BARUT, *University of Colorado, U.S.A.*

HERMANN BONDI, *Natural Environment Research Council, U.K.*

BRIAN D. JOSEPHSON, *University of Cambridge, U.K.*

CLIVE KILMISTER, *University of London, U.K.*

GÜNTER LUDWIG, *Philipps-Universität, Marburg, F.R.G.*

NATHAN ROSEN, *Israel Institute of Technology, Israel*

MENDEL SACHS, *State University of New York at Buffalo, U.S.A.*

ABDUS SALAM, *International Centre for Theoretical Physics, Trieste, Italy*

HANS-JÜRGEN TREDER, *Zentralinstitut für Astrophysik der Akademie der Wissenschaften, G.D.R.*

Open Questions in Quantum Physics

*Invited Papers on
the Foundations of Microphysics*

edited by

Gino Tarozzi

*Departments of Philosophy and Mathematics,
University of Bologna, Italy*

and

Alwyn van der Merwe

Department of Physics, University of Denver, U.S.A.

D. Reidel Publishing Company

A MEMBER OF THE KLUWER ACADEMIC PUBLISHERS GROUP



Dordrecht / Boston / Lancaster

Library of Congress Cataloging in Publication Data

Main entry under title:

CIP

Open questions in quantum physics.

(Fundamental theories of physics)

Proceedings from a workshop, held in Bari, Italy, in the Dept.
of Physics of the University, during May 1983.

Includes index.

1. Quantum theory--Congresses. 2. Physics--Philosophy--
Congresses. 3. Stochastic processes--Congresses. 4. Wave-particle
duality--Congresses. I. Tarozzi, G. II. Van der Merwe, Alwyn.
III. Title: Microphysics. IV. Series.

QC173.96.064 1984 530.1'2 84-18009

ISBN-13: 978-94-010-8816-9 e-ISBN-13: 978-94-009-5245-4

DOI: 10.1007/978-94-009-5245-4

Published by D. Reidel Publishing Company
P.O. Box 17, 3300 AA Dordrecht, Holland

Sold and distributed in the U.S.A. and Canada
by Kluwer Academic Publishers,
190 Old Derby Street, Hingham, MA 02043, U.S.A.

In all other countries, sold and distributed
by Kluwer Academic Publishers Group,
P.O. Box 322, 3300 AH Dordrecht, Holland

All Rights Reserved

© 1985 by D. Reidel Publishing Company, Dordrecht, Holland
and copyright holders as specified on appropriate pages within.
Softcover reprint of the hardcover 1st edition 1985

No part of the material protected by this copyright notice may be reproduced or utilized
in any form or by any means, electronic or mechanical, including photocopying,
recording or by any information storage and retrieval system,
without written permission from the copyright owner

CONTENTS.

PREFACE	ix
PART 1. QUANTUM MECHANICS, REALITY AND SEPARABILITY: PHYSICAL DEVELOPMENTS OF THE EINSTEIN-PODOLSKY-ROSEN ARGUMENT	
K.R. POPPER: Realism in Quantum Mechanics and a New Version of the EPR Experiment	3
Discussion: M. CINI, F. DE MARTINI, K. KRAUS, T.W. MARSHALL, K.R. POPPER, H. RAUCH, M.C. ROBINSON, F. SELLERI, J. SIX, G. TAROZZI, J.-P. VIGIER.	26
D. AERTS: The Physical Origin of the Einstein-Podolsky-Rosen Paradox	33
T.D. ANGELIDIS: Does the Bell Inequality Hold for All Local Theories?	51
E. BITSAKIS: Is it Possible to Save Causality and Locality in Quantum Mechanics?	63
K. KRAUS: Einstein-Podolsky-Rosen Experiments and Macroscopic Locality	75
T.W. MARSHALL, E. SANTOS and F. SELLERI: On the Compatibility of Local Realism with Atomic Cascade Experiments	87
O. PICCIONI, P. BOWLES, C. ENSCOE, R. GARLAND and V. MELHOP: Is the Einstein-Podolsky-Rosen Paradox Demanded by Quantum Mechanics?	103
R. PROSSER: Infinite Wave Resolution of the EPR Paradox	119
W. RIETDIJK: On Non Local Influences	129

F. SELLERI: Einstein Locality for Individual Systems and for Statistical Ensembles	153
J. SIX: Can Nondetected Photons Simulate Nonlocal Effects in Two-Photon Polarization Correlation Experiments?	171
PART 2. THE STOCHASTIC INTERPRETATION OF QUANTUM PROCESSES	
M. CINI: Quantum Theory of Measurement without Wave Packet Collapse	185
N. CUFARO PETRONI: A Causal Fluidodynamical Model for the Relativistic Quantum Mechanics	199
A.B. DATZEFF: On the Nonlinear Schrödinger Equation	215
P. GUERET: Recent Developments in de Broglie Nonlinear Wave Mechanics	225
B.J. HILEY: The Role of the Quantum Potential in Deter- mining Particle Trajectories and the Resolution of the Measurement Problem	237
T.W. MARSHALL: When is Statistical Theory Causal?.	257
M.C. ROBINSON: Radiation Damping and Nonlinearity in the Pilot Wave Interpretation of Quantum Mechanics	271
E. SANTOS: Stochastic Electrodynamics and the Bell Inequalities	283
J.-P. VIGIER: Nonlocal Quantum-Potential Interpretation of Relativistic Actions at a Distance in Many-Body Problems	297
PART 3. THE REALISTIC INTERPRETATION OF THE WAVE FUNCTION: EXPERIMENTAL TESTS ON THE WAVE-PARTICLE DUALISM	
A. GARUCCIO: Third Kind Measurements and Wave-Particle Dualism	325
L. MANDEL: Quantum Effects in the Interference of Light	333

CONTENTS	vii
H. RAUCH: Tests of Quantum Mechanics by Neutron Interferometry	345
G. TAROZZI: A Unified Experiment for Testing both the Interpretation and the Reduction Postulate of the Quantum Mechanical Wave Function	377
EPILOGUE	391
K.R. POPPER: Evolutionary Epistemology	395
SUBJECT INDEX	415

PREFACE

Due to its extraordinary predictive power and the great generality of its mathematical structure, quantum theory is able, at least in principle, to describe all the microscopic and macroscopic properties of the physical world, from the subatomic to the cosmological level. Nevertheless, ever since the Copenhagen and Göttingen schools in 1927 gave it the definitive formulation, now commonly known as the orthodox interpretation, the theory has suffered from very serious logical and epistemological problems. These shortcomings were immediately pointed out by some of the principal founders themselves of quantum theory, to wit, Planck, Einstein, Ehrenfest, Schrödinger, and de Broglie, and by the philosopher Karl Popper, who assumed a position of radical criticism with regard to the standard formulation of the theory.

The aim of the participants in the workshop on *Open Questions in Quantum Physics*, which was held in Bari (Italy), in the Department of Physics of the University, during May 1983 and whose Proceedings are collected in the present volume, accordingly was to discuss the formal, the physical and the epistemological difficulties of quantum theory in the light of recent crucial developments and to propose some possible resolutions of three basic conceptual dilemmas, which are posed respectively by:

- (a) the physical developments of the Einstein-Podolsky-Rosen argument and Bell's theorem, i.e., the problem of the logical and empirical contrast between local realism and quantum mechanics, with special reference to a simplified new experiment presented by Popper in his opening lecture;
- (b) the stochastic interpretation of quantum processes, both according to the de Broglie school and to the approaches of Bohm and Vigier and its implications for the theory of measurement;
- (c) the wave-particle duality and the testability of the physical properties of quantum waves on the basis of the experimental proposals advanced by Selleri and others.

The Università' degli Studi di Bari, the Istituto Nazionale di Fisica Nucleare (I.N.F.N.), the Regione Puglia, and the Comune

and the Provincia di Bari made possible the organization of the workshop through their financial support, while expenses incurred in the editing of the present Proceedings were partially covered by a faculty research grant from the University of Denver.

Our thanks are expressed here to all these institutions and in particular to Professor Luigi Ambrosi, Rector of the Bari University and to Professor Antonino Zichichi, President of I.N.F.N.

Gino Tarozzi
Alwyn van der Merwe