The pioneering work of Edwin T. Jaynes in the fields of statistical physics, quantum optics, and probability theory has had a significant and lasting effect on the study of many physical problems, ranging from fundamental theoretical questions through to practical applications such as optical image restoration. *Physics and Probability* is a collection of papers in these areas by some of his many colleagues and former students, based largely on lectures given at a symposium celebrating Jaynes' contributions, on the occasion of his seventieth birthday and retirement as Wayman Crow Professor of Physics at Washington University.

The collection contains several authoritative overviews of current research on maximum entropy and quantum optics, where Jaynes' work has been particularly influential, as well as reports on a number of related topics. In the concluding paper, Jaynes looks back over his career, and gives encouragement and sound advice to young scientists.

All those engaged in research on any of the topics discussed in these papers will find this a useful and fascinating collection, and a fitting tribute to an outstanding and innovative scientist.

Physics and Probability

Essays in honor of Edwin T. Jaynes

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CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York NY 10011–4211, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

First published 1993
First paperback edition 2004

A catalogue record for this book is available from the British Library

ISBN 0 521 43471 8 hardback
ISBN 0 521 61710 3 paperback

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PREFACE

Most physicists, most of the time, are engaged in what Thomas Kuhn calls "normal science," the process of solving problems under a prevailing paradigm. Part of Edwin Jaynes' career has been profitably devoted to this enterprise, but his best known work may aptly be called "abnormal" in this sense. We organized the Symposium on Physics and Probability not only to recognize Jaynes' accomplishments, but also to celebrate the scientific style and integrity that have been an inspiration to so many of his students and colleagues.

The articles in this volume are based, with a few exceptions, on lectures given at the Symposium, which was held 15-16 May 1992 at the University of Wyoming. The occasion for the Symposium was Jaynes' official retirement from his position as Wayman Crow Professor of Physics at Washington University — as well as to commemorate his seventieth birthday. The authors are former graduate students of Professor Jaynes, or colleagues, or people whose work has been so directly influenced by Jaynes that it was deemed appropriate to invite them to speak at the Symposium.

Jaynes is best known for his work in statistical physics and quantum optics. His seminal papers on information theory and statistical mechanics formulated the latter (in the spirit of Gibbs) without an ergodic hypothesis, relying instead on the maximum entropy principle to assign probabilities in a manner least biased with respect to the available information. The "Maxent" principle, along with Jaynes' broader work in Bayesian statistics, has more recently been gainfully applied to a growing number of practical problems including optical image restoration, radar target identification, model selection in economics, and others described in this volume. The evolution of these applications from Jaynes' original, purely academic motivations nicely illustrates the truth in Richard Feynman's remark that "no matter how small a thing is, if it has physical interest and is thought about carefully enough, you're bound to think of something that's good for something else."

Jaynes' work in quantum optics, on the other hand, seems to have evolved from a practical concern with maser problems to fundamental questions about field quantization. The Jaynes-Cummings paper showed that semiclassical radiation theory could be an excellent approximation even under conditions where the average number of photons is small. This result led to Jaynes' neoclassical theory, where even spontaneous emission and the Lamb shift were approached without quantization of the field. The aim of this theory was to see just how far one could take semiclassical theory without running into conflict with experiment; although it has not yet proved a viable substitute for quantum electrodynamics, it certainly resulted in a much better understanding of semiclassical theory and field quantization in quantum optics. After three decades the Jaynes-Cummings model, to borrow a phrase from Pierre Meystre, remains alive and well, as the papers in this volume amply demonstrate.

Over the years Jaynes has remained true to his conviction that "progress in science goes forward on the shoulders of doubters, not believers." In the final article of this volume

we are reminded again just why it is he feels so strongly about this and other matters of concern to the academic community. His unhappiness with the conventional interpretation of quantum theory — a way of reasoning that would be considered a "psychiatric disorder" in any other field — is here reiterated succinctly, illustrating once more the generating force behind much of the work discussed in this volume.

We wish to thank all the contributors to this volume for their enthusiastic response that made the Symposium a very pleasurable and memorable occasion. Thanks also go to other people, including Freeman Dyson, Erwin Hahn, Peter Knight, and John Toll, who could not attend owing to prior commitments but nevertheless took the time to express encouragement and their admiration for Edwin Jaynes. Finally we are grateful to the Department of Physics and Astronomy of the University of Wyoming for the excellent facilities and services provided during the Symposium, to Ms. Kim Bella for her efficient polishing of the various manuscripts, and to Cambridge University Press for their enthusiastic willingness to publish this collection.

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