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Present Status and Aims of Quantum Electrodynamics

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Foreword

Since the first measurements of the Lamb shift and the anomalous magnetic moment of the electron,tests of quantum electrodynamics have become a continuous challenge for many experimental physicists. Several times during these years discrepancies between the predictions of the theory and the experimental data have been published, stimulating intense discussions about the physical grounds and mathematical methods of QED. Further improvements of experimental accuracy combined with more careful analysis of the experiments and calculation of higher-order contributions have led again and again to an agreement between the experimental data and the predictions of QED. From the small discrepancies still present at this time, nobody would deduce a breakdown of QED theory. However, regarding the fundamental importance and the model character of QED, further tests with larger momentum transfers and higher precision that check on the validity of higher-order contributions seem highly desirable. Therefore we felt that the time has come for a discussion of the following topics:

- physical ground and mathematical methods of QED,
- mutual relations between theory and experiment,
- analysis of experimental data as being presented today,
- possible improvements of tests of QED regarding experimental aspects and
- contributions of other interactions.

We were very pleased that so many experts actively engaged in this field supported our suggestion to hold a Symposion on the Present Status and Aims of Quantum Electrodynamics at Mainz.

As far as the theory is concerned, the contributions discuss fundamental problems of QED, aspects of unified field theories, relations between theory and experiment, and examples of numerical calculations of QED interactions at large momentum transfer and corrections of higher order in α and $Z\alpha$. However, the major part of the contributions assesses the QED tests at high energies and represents the current status of precision experiments on bound systems and free particles at low energies. Of course, within the time allotted the total spectrum of QED could not be covered. Several important topics, such as the interactions with real photons or macroscopic QED, had to be omitted.

As a result, the symposion revealed some general trends and problems. At high energies new experiments with an even larger momentum transfer may be realised in the future. In contrast, however, further improvement of accuracy in precision experiments is now often limited by the finite lifetime of the system under investigation (e.g., positronium); also the comparison between experimental data and theory is becoming more difficult due to the not precisely predictable contribution of other interactions (consider, e.g., the anomalous magnetic moment of the muon). Therefore the general trend is characterised by the measurement of the QED properties of stabile systems (electron, positron), by investigations of (n'S - nS) transitions, or by the exploration of systems with high Z values, especially hydrogen-like ions and muonic atoms. The reader will find these trends in several articles.

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