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Casimir Physics

Springer

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Preface

In 1948 Hendrik Casimir published a paper showing that the existence of electromagnetic zero-point energy implies that there is an attractive force between two uncharged, perfectly conducting, parallel plates. Evgeny Lifshitz in 1955 generalized this theory to the case of dielectric media and finite temperatures. Over the next forty years experiments demonstrated the reality of Casimir forces, while a relatively small number of theoretical papers extended the analyses of Casimir and Lifshitz and explored other aspects of zero-point energies and fluctuations of quantum fields. It was not until the 1990s, however, that these forces were measured unambiguously and found to be in good agreement with predicted values. There followed a rapid growth of interest and research in Casimir physics.

Casimir effects serve as primary examples of directly observable manifestations of the nontrivial properties of quantum fields, and as such are attracting increasing interest from quantum field theorists, particle physicists, and cosmologists. Though very weak except at short distances, Casimir forces are universal in the sense that all material objects are subject to them. They are an increasingly important part of the physics of atom-surface interactions, while in nanotechnology they are being investigated not only as contributors to stiction but also as potential mechanisms for the actuation of micro-electromechanical devices. Analyses of such effects and their potential applications involve theoretical and computational electromagnetism, atomic, molecular and optical physics, and material science, among other specialties.

While the field of Casimir physics is expanding rapidly, it appears to have reached a certain level of maturity in some important respects. This is especially true on the experimental side, where it seems that the main sources of imprecision in force measurements have been identified. Another important achievement has been the development of semi-analytical and numerical methods for the computation of Casimir forces between bodies of practically arbitrary shape. There has also been significant progress in the basic theory of Casimir and related effects, including quantum levitation, quantum friction, and dynamical Casimir effects.

In light of these developments, and with no end yet in sight to the broad-based interest in Casimir physics, we felt that a book consisting of chapters written by internationally recognized leaders in the field would be both timely and of lasting value. The seed idea for this book was a workshop on *New Frontiers in Casimir Force Control* organized by us in Santa Fe, New Mexico, in September 2009. The chapters that follow are approximately evenly divided with regard to theory and experiment and deal mainly, though not exclusively, with surface-surface and atom-surface Casimir effects. Most chapters include a review of a particular aspect of Casimir physics in addition to a detailed presentation of the authors' current research and their perspective on possible future developments in the field. All the chapters include extensive bibliographies.

This volume is not intended to be a unified textbook, but rather a collection of mainly independent chapters written by prominent experts in the field. The ordering of chapters is only by topic and not by degree of depth or specialization. Therefore, the reading order is not at all prescribed by the ordering of the chapters.

We thank all the authors for taking valuable time from their research in order to present detailed and carefully written articles in a style that should appeal to other researchers in the field as well as to a broader audience. Thanks also go to Christian Caron and Gabriele Hakuba at Springer for their editorial support.

Las Alamos, May 2011

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