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Book Review: *The Casimir Effect and its Applications*

The Casimir Effect and its Applications. V. M. Mostepanko and N. N. Trunov, Clarendon Press, Oxford, 1997.

This monograph deals with the beauty and intricacies of the Casimir effect, which is the source of the forces between bodies at short distances that are due to electromagnetic fluctuations. The authors are from that part of the world that has been especially active in both theory and experiment, as evidenced by the Lifshitz theory of van der Waals forces as well as the first accurate measurement of the these forces. Russian scientists have remained on the forefront of the Casimir effect research ever since Lifshitz's first contributions to the subject. It is, however, not a book for the fainthearted. It seeks a readership that has already been exposed to the fundamentals of the Casimir effect and is looking for a summary of modern developments in the subject. It deals with the Casimir effect in a very general and fundamental way, addressing the topic of van der Waals forces almost as a footnote to more general developments. I am sure that readers with a strong background and interests in field theory will find the book rather appealing. As for the rest of us, maybe a feeling that the monograph is overly brief will prevail. Nevertheless, I believe anybody working in this broad and varied area of physics will find its collection of topics quite appropriate, making it almost a handbook for the methods and concepts in this field of research.

The Casimir effect is introduced in the first chapter for a scalar field in a bounded one- dimensional domain in a standard way by comparing zero point energies at different separations. The authors then proceed to a more consistent formulation of the Casimir effect in terms of the energy-momentum tensor of fluctuating fields. This part could be done in a bit more user-friendly way since it is basic for many of the further developments. Also I wonder why the authors did not include the surface mode approach that has proved to be of great value especially in many van der Waals force calculations in the literature. Other fundamentals introduced in this chapter are zero point energy regularization, semi-permeable

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boundaries and topologically non-trivially connected spaces which are later dealt with in all the gory details.

The second chapter is a somewhat eclectic compendium of different problems. Regularization methods of the energy-momentum tensor are followed by calculations of the Casimir effect in a wedge, in rectangularly bounded volumes and in the presence of a conducting sphere for scalar and electromagnetic fields. The Casimir effect for a spinor field and a scalar field with moving boundaries are treated separately.

The next chapter I consider to be the core of the book. It deals with the Casimir effect in bounded spaces with realistic boundary properties. The term refers to boundary conditions for electromagnetic field between dielectric plates that are not, in general, approximated by Neumann or Dirichlet boundary conditions. A compendium of formulas is given for van der Waals (i.e. electromagnetic Casimir effect) forces in a slab geometry as well as a derivation of the equivalence between the surface mode summation (van Kampen) and other canonic approaches to the Casimir effect. In general, because of the preeminent value of the surface mode approach in the van der Waals force theory, I would expect a bit more detailed discussion of the equivalence, along the lines of the Barash–Ginzburg work, but I am also aware that this could be just my personal predilection. The discussion of the Casimir effect in bounded spaces is followed by an analysis of van der Waals torques for either bodies of anisotropic shapes or anisotropic dielectric properties. A description of the effects of imperfect domain geometry as well as the interactions between bodies of complex shape follows. The treatment of the forces between slightly imperfect parallel planes is particularly interesting especially for understanding van der Waals forces in soft condensed matter. The authors' discussion of the thermal dependence of Casimir forces and their exposition of the experimental results leave much to be desired. Both could well be expanded into separate chapters. Fortunately, at least for the latter, there were many other books available to educate oneself in this subject area. It is not really a drawback of this one as it was conceived from the start as being a theoretical exposition. Another serious flaw of this chapter is that the authors fail to mention recent developments on the (pseudo) Casimir effects in general elastic media where deformation vectors play the role of the fluctuating fields. I believe we will see more on the Casimir effect coming in the future from soft condensed matter especially from confined liquid crystalline materials.

In the next two chapters we progress inevitably towards more field-theoretic and cosmological aspects of the Casimir effect. Non-Euclidean spaces with twisted and interacting fields together with effective vacuum temperature are introduced in the context of the Casimir effect. The last

chapter gives a final excursion into the applications of the Casimir effect to elementary particle physics through the hadron bag model and multi-dimensional Kaluza–Klein theories, inevitably coming close "au bout de mon Latin" for this reviewer.

On a last note, there appears to be a pronounced bias towards the Russian-language literature in the reference list. Despite the undeniably essential contributions of Russian speaking and publishing authors, this emphasis really does not in my humble opinion mirror the factual situation.

In spite of several reservations on my part, the most important one being the brevity of the exposition and, in some cases, enumeration of results without any meaningful derivation, I do recommend the book to advanced research workers in this field. It contains a wealth of different methods and results that would be difficult to assemble from the original literature and has, in this respect, a definitive handbook feel to it.

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