

obtain a general idea of time measurement. It is a good reference to have on one's personal bookshelf.

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The Casimir Effect: Physical Manifestations of Zero-Point Energy

K. A. Milton
World Scientific, River Edge, N.J.,
2001. \$87.00 (301 pp.).
ISBN 981-02-4397-9

In 1946, Hendrik Casimir and Dik Polder calculated, for large separations, the van der Waals interaction between two atoms and between an atom and a conducting plate. Casimir was intrigued by the simplicity of the results and mentioned them during a walk with Niels Bohr. As Casimir reported to me in a letter dated 12 March 1992 "[Bohr] mumbled something about zero-point energy. That was all, but it put me on a new track. I found that calculating changes of zero-point energy really leads to the same results as the calculations of Polder and myself." Further thinking about zero-point field energy led Casimir in 1948 to predict the most famous Casimir effect—the tiny attractive force between two parallel conducting plates, interpretable in terms of the change, due to the plates, in electromagnetic zero-point energy. At about the same time, the Lamb shift was observed and interpreted as the change in zero-point energy due to the presence of the atom. Perhaps Bohr's remark reflected an awareness of this other work, but Casimir himself had no knowledge of it. As Casimir told me in the 1992 letter, "I was not at all familiar with [that work]. I went my own, somewhat clumsy way. . . I do not think there were outside influences. . ."

After many years of relative dormancy, the study of Casimir forces is an active field. Although the recrudescence owes much to recent experiments that unambiguously confirm Casimir's predictions, it also signifies a growing recognition of the fundamental importance of the Casimir effect, defined as "the stress on the bounding surfaces when a quantum field is confined to a finite volume of space," in *The Casimir Effect: Physical Manifestations of Zero-Point Energy*, by Kimball Milton.

Wading through the murky details of Casimir effects for different

quantum fields and geometries is no small task. Milton's attractively slim book will guide the serious beginner around the shoals, and its analytical rigor should also attract experienced theorists. It is appealing also in its unified approach, based mainly on Green's function methods that Milton and others developed in collaboration with Julian Schwinger. These techniques are employed in the first few chapters to treat various examples including the electromagnetic force between parallel conducting and dielectric plates, the fermionic Casimir force for parallel surfaces, the electromagnetic and fermionic Casimir forces for spherical boundary surfaces, and the electromagnetic Casimir effect for dielectric balls. Finite temperature and conductivity corrections are analyzed in detail where appropriate. The remaining two-thirds of the book deals among other things with cylindrical geometries, D-dimensional spheres, applications to hadronic physics and the bag model, Chern–Simons electrodynamics, and cosmology (including, briefly, the cosmological constant problem).

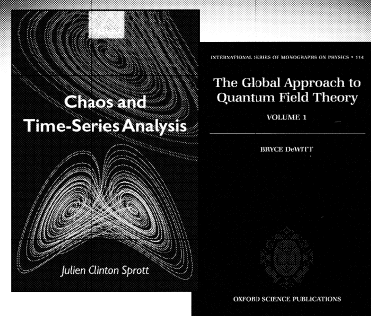
One need not be expert in all these areas to follow the calculations. However, many readers might welcome a bit more discussion of things like the bag-model boundary condition, which is introduced formally with no mention of its simple physical basis. The primary emphasis throughout is not on physical motivations but on how to calculate Casimir effects and how to handle divergences.

Milton does, however, invoke physical arguments in a chapter on "Sonoluminescence and the Dynamical Casimir Effect." Here he casts serious doubt on the worth of a series of papers by Schwinger that suggested the Casimir effect as the origin of sonoluminescence. Although not ruling out entirely the possibility that the dynamical Casimir effect may be at work in sonoluminescence, Milton gives compelling arguments that it simply cannot generate anything like the energies observed.

I have only two minor complaints. First, I feel that Milton's tone is sometimes too harsh in disagreeing with other workers, though other readers might feel that this makes for livelier reading.

My second complaint has to do with history. Much of the older literature on the Casimir effect for dielectrics describes the effect as a macroscopic manifestation of van der Waals forces. What complicates the theory is the nonadditivity of van der

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Waals forces: The force between macroscopic objects is not simply the sum of pairwise van der Waals forces. (The force can be repulsive or attractive, and intuition is no guide as to which it should be in different geometries. The same is true for conductors; Casimir thought that a conducting spherical shell would have an attractive force, whereas Timothy Boyer in 1968 found that the force is actually repulsive.) In the limit of dilute media, however, the nonadditive effects are small and the pairwise approximation is accurate. I thought that was well known—albeit subject to divergence issues—but the author credits recent work for the demonstration that “for tenuous media the Casimir effect and the sum of molecular van der Waals forces are identical.”

Milton concludes that “remarkably little” has been learned about Casimir effects “in the more than 50 years since Casimir’s brilliant observation.” His book, however, proves that this has not been for lack of first-rate theoretical work.

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Laser Remote Sensing of the Ocean: Methods and Applications

Alexei Bunkin
 and Konstantin Voliak
Wiley, New York, 2001. \$99.95
(244 pp.). ISBN 0-471-38927-7

Although hydrographic applications are the focus of Alexei Bunkin and Konstantin Voliak’s *Laser Remote Sensing of the Ocean*, the title belies the book’s breadth: nearly half of the text is devoted to general, nonmarine techniques in laser remote sensing. The diverse range of topics covered includes airborne terrain mapping, Doppler measurement of wind speed, and the measurement of atmospheric composition, thermodynamic states, aerosol concentrations, and gaseous pollutants.

The book does not cover the most recent developments in the fast-moving area of ice and vegetation canopy-mapping lidars, made possible by advanced detector arrays and digitizers. It does, however, provide a review of much of the earlier literature, both Soviet and American. It also acts as a bridge between the hydrographic

work through the 1980s of the General Physics Institute (GPI) of the Russian Academy of Sciences and US airborne laser practices at NASA’s Wallops Flight Facility in Virginia. This kind of remote-sensing research has many implications for remote environmental monitoring from aircraft.

Airborne and orbital lidars typically direct more than 10^{18} photons toward Earth’s surface each second. Some photons are scattered elastically at their original wavelength from the ground, and by Rayleigh and Mie scattering from water and clouds. A handful may be detected at the receiver. Time of signal arrival is the primary interest for mappers, whose spectral window is intentionally restricted to the transmitted frequency. In the visible spectrum—using doubled neodymium yttrium aluminum garnet (Nd:YAG) lasers at 532 nm—laser bathymetry can reach up to ten times the characteristic optical attenuation range, 50 m or more, before the signal is lost. Such penetration also makes possible the mapping of photosynthetic pigments and suspended particles in depth, through scattering and induced emission. For inland and coastal mapping, aircraft lidar mapping with satellite navigation provides

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