Phys 250 Quantum Optics, Homework #4

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Due Thurs. Oct 29 at 6PM

Read *Introductory Quantum Optics*, Sections 3.5-3.8 and 4.1-4.4, as well as the material on Casimir Forces (p 32-33).

1. Essential for deriving the Casimir force is the Euler-Maclaurin formula that expresses the difference between a sum (needed for incorporating modes between mirrors) and an integral (needed for incorporating the modes between mirrors infinitely far apart). First describe the origin of the Casimir force qualitatively, but in some detail (without relying on the Euler-Maclaurin formula). Second make a brief study of the Euler-Maclaurin formula (e.g Wikipedia and other websites) to get a better understanding of this important formula (you dont have to hand-in anything for this second part).

2. Derive an expression for the Casimir force between a plane and a sphere of radius R, separated by some distance a, in the limit $a \ll R$. To do this make use of the Proximity Theorem, wherein you treat the two surfaces as nearly flat and assume the force from each region is given by the Casimir pressure, P, between two planes (2.182), or in other words: $dF = P\,(\mathrm{d}(\vec{\mathrm{x}}))\,dA$. You should expand the separation between the surfaces, $\mathrm{d}(\vec{\mathrm{x}})$, to second order. (These approximations actually produce extremely accurate results for the Casimir force because the distance dependence is so steep.) Also derive the Casimir force for two spheres of radius R, again separated by a.

3. Problem 3.12

4. Problem 3.13

5. Problem 4.1

6. Problem 4.2

You may hand in the homework in groups of 2 or 3.