In this chapter we shall pursue our study of the possible experimental tests of the dynamical Casimir effect. In particular we shall focus our attention on the phenomenon of Sonoluminescence. We shall develop an original model for explaining the origin of the radiation emitted in this process, based on dynamical particle production from the quantum vacuum driven by a time varying refractive index (which acts as an external field perturbing the QED vacuum). Although the model developed could be greatly improved if further information about the realistic dynamics of the refractive index could be gained from condensed matter studies, it has to be stressed that it is already able to propose some tests amenable to observations.

The contents of this chapter are original and represent an extract from a “corpus” of works Qed0, PRL, SnPr, Qed1, Qed2, dedicated to the subject. All of these have been done in collaboration with Francesco Belgiorno, Matt Visser and Dennis Sciama without the enthusiasm and guidance of whom they would never have appeared.

Sonoluminescence (SL) is the phenomenon of light emission by a sound-driven gas bubble in a fluid. In SL experiments, the intensity of a standing sound wave is increased until the pulsations of a bubble of gas trapped at a velocity node have sufficient amplitude to emit brief flashes of light having a “quasi-thermal” spectrum with a “temperature” of several tens of thousands of Kelvin. The basic mechanism of light production in this phenomenon is still highly controversial. We first present a brief summary of the main experimental data (as currently understood) and of their sensitivities to external and internal conditions. For a more detailed discussion see Physics-Reports.

SL experiments usually deal with bubbles of air in water, with ambient radius $R_{\text{ambient}} \approx 4.5 \, \mu m$. The bubble is driven by a sound wave of frequency of 20–30 kHz. (Audible frequencies can also be used, at the cost of inducing deafness in the experimental staff.) During the expansion phase, the bubble radius reaches a maximum of order $R_{\text{max}} \approx 45 \, \mu m$, followed by a rapid collapse down to a minimum radius of order $R_{\text{min}} \approx 0.5 \, \mu m$. Figure 1.00bounce.epsf

[Radius of sonoluminescent bubble as a function of time] Typical variation of the bubble radius as a function of time and in relation to the sound wave cycle (dotted line). Note the peculiar oscillatory behaviour after the collapse. The picture is taken from ref. Physics-Reports. F:bounce