Comment on "Sonoluminescence as Quantum Vacuum Radiation"

Recently there have been some attempts to model the phenomenon of single bubble sonoluminescence as arising from the modification of the electromagnetic vacuum [1,2]. Earlier Schwinger had suggested that the origin of sonoluminescence might be in the dynamic Casimir effect generated by the moving bubble-liquid interface [1]. This has inspired many other studies and recently Eberlein [2] has suggested that the radiation in sonoluminescence may be generated due to an effect similar to the Unruh effect, where the acceleration and higher derivatives of velocity of the dielectric interface are responsible for the thermal-like radiation. Though the parameter values needed to fit the general characteristics of a thermal-like spectrum at the observed intensity are unrealistic in these models, they are interesting. But, as we will argue now, there are already enough *experimental facts* available which make these models unrealistic. According to us, any model which invokes only the dynamics and properties of the bubble-liquid interface without regard to the details of the trapped gas and the environmentlike ambient temperature is missing out some very important observations on sonoluminescence and therefore is not viable.

These models seem to ignore the important experimental fact that no sonoluminscence is observed in situations where there is no trace of inert gases in the trapped air [3] or that the intensity drops drastically when the ambient temperature is increased by a mere 5% [4]. Also the spectrum is affected significantly by such temperature changes. The composition of the air in the bubble is an extremely important factor [3,5], and changes in this composition can drastically affect the intensity of radiation. *Lack of noble gases completely stops the emission, and addition of even 1% of argon, xenon, or helium is sufficient for sonoluminescence to occur, though there could be no change in the refractive index or in the dynamics of the interface significant enough to affect the expressions derived in the vacuum radiation models.* This probably is the most crucial test of such models since the difference in refractive indices at the interface is what defines the "moving mirror," and we think that these observations have conclusively ruled out the possibility that the vacuum radiation is the dominant component of sonoluminescence. (We are not contesting the possibility that there may be a small component in the emission coming from such exotic phenomena.)

The field theory calculation has no dependence on the small ambient temperature in the experimental situation, and certainly is not sensitive to the small changes in this temperature. Since the only important feature in these models to generate radiation is the dynamics of the interface, small temperature changes negligible compared to effective temperature of the radiation generated by the moving interface are insignificant in these models. But the experimental results have a sensitive dependence on the ambient temperature and this is a further test of the vacuum radiation models and again the models do not adequately explain the observed features.

The point is that the experiments have shown that there are situations without any detectable radiation, almost as a rule, in which there is a stable bubble with its interface undergoing almost the same dynamics as in the case when there is radiation. The difference is not in the dynamics of the interface, but in the minute details of the composition of the trapped gas or small changes in the ambient temperature. The experimental studies at present are unable to give the details of the bubble dynamics at the sub-picosecond scale. Therefore the change in bubble dynamics at this time scale, due to changes in dissolved inert gas content or due to changes in ambient temperature, is still an open issue.

There may be other such features which are incompatible with vacuum radiation models and it is worth analyzing these models in the light of *all these experimental verified features.* With such an approach, it may be even possible to refine the vacuum radiation models, for example *to incorporate some dependence of the velocity turnaround time on the amount of dissolved gases and ambient temperature* and thereby to obtain some dependence of the emission on such parameters.

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Received 20 May 1996 [S0031-9007(96)01577-3]
PACS numbers: 78.60.Mq, 03.70.+k, 42.50.Lc

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 0031-9007/96/77(22)/4690(1)$10.00