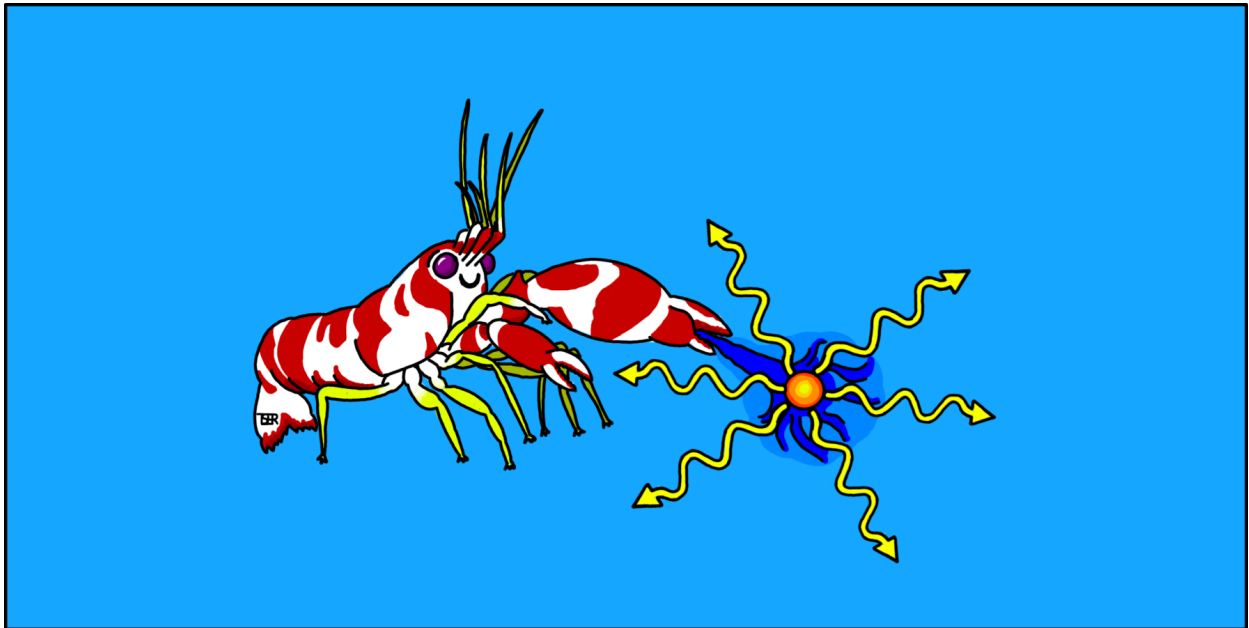


On the Origin of Shrimpluminescence

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DETAILS...

Pistol shrimp, like the red-banded pistol shrimp shown on the cover, are capable of generating a jet of water with high enough velocity that a cavitation bubble forms in its wake. When the bubble collapses, a powerful shock-wave is produced that can kill the shrimp's prey [1]. If the shrimp's prey had very sensitive eyes (and also weren't dead) they might notice a flash of light is also produced through an effect referred to as "shrimpluminescence" in the case of the pistol shrimp [2], but more generally known as *sonoluminescence*.

Sonoluminescence can be more precisely defined as the effect in which light is produced when an ultrasonically driven bubble collapses [3]. Unlike the shrimp's violent method, laboratory techniques can produce stable, single bubbles that can be driven and collapsed with high precision. As such, quite a bit of effort has been spent studying *single-bubble sonoluminescence* (SBSL) [4, 5]. Yet the physical origin of the light production has eluded understanding. There are two prevailing theories: (i) the effect is of a thermal origin and (ii) it is an electrical effect [3]. The thermal argument is based on the observation that the temperature of the gas trapped in the bubble when light is emitted is ~ 10000 K! [4, 6] (for reference, the surface of the Sun is about 6000 K). It is believed that thermal radiation (among other mechanisms) could be the source of the light. The electrical arguments are instead based on the belief that the fluid *fractures* around the bubble leading to dielectric break-down across the crack and producing "sparks" that emit the light [7, 8].

On the other hand, I can't ignore an alternative theory quite far from the others: a phenomenological model based on quantum electrodynamics. This subject will get us pretty far afield but I will try to spend some time on this too because it's neat! In short, Schwinger [9] and subsequently others [10, 11] showed that changes in the Casimir energy due to shrinking the volume of a dielectric sphere can lead to production of photons. This effect has been called *vacuum radiation* [11].

Inspired by our shrimp friends, I propose to review some of the attempts to explain SBSL using the three theories mentioned above: (i) it is a thermal effect, (ii) it is an electric electrical effect, and (iii) SBSL is vacuum radiation. There have been *many* attempts to explain SBSL, so to keep the scope limited, I will only focus on the most recent and most successful ones.

About me: I work for Dmitry Reznik. Besides some time working with industrial robots as an undergrad, all of my research experience has been centered around lattice dynamics and other condensed matter stuff. I will be surprised if this topic is deemed to be too close to my research to be admissible. I plan to have fun writing this paper and I hope you will have fun reading it!

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