EMULATION OF BALL LIGHTNING FOR THZ STAND-OFF DETECTION OF BIO-CHEMICAL AGENTS

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As shown in a companion paper here [1], the author's maser-soliton theory of ball lightning (BL) explains BL as a localized nonlinear vibrating plasma caviton, locally trapping the electromagnetic field generated by a large spiking atmospheric maser created by the electric field pulse of lightning in several cubic miles of moist air over flat areas. This is a new type of discharge. It can be used [2] to send in a 800 nm laser beam and its second harmonic (SH) for local THz generation and for detection in a second BL.

The basic experiment planned as shown in Fig. 1 uses a 10-20KW klystron amplifier with negative feedback, trying to simulate the behavior of the atmospheric maser. The klystron is connected through a directional coupler to a tuned resonator that serves as discharge chamber. From there, a waveguide completes the loop, as shown in Fig. 1. An optical feedback strengthens the natural tendency of the klystron to spike almost instantaneously when the load decreases. The discharge sought is seen as a vibrating glow at atmospheric pressure, at much lower temperature than the lowest temperature arch discharge obtained so far at normal pressure.

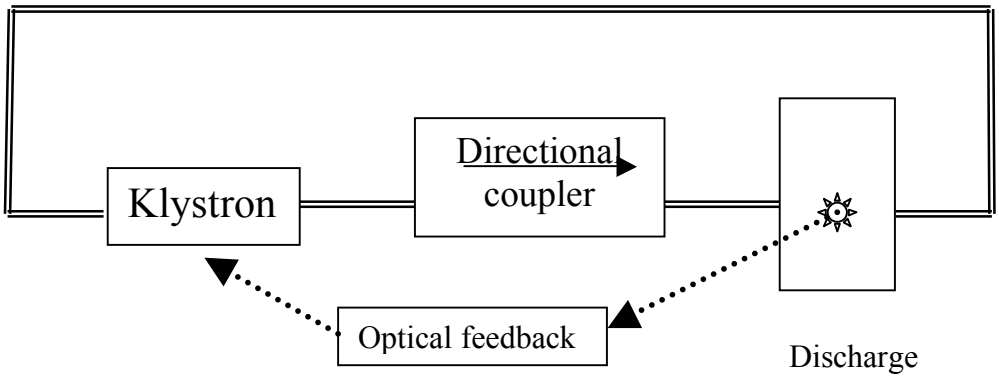

Fig. 1.: Scheme of laboratory ball lightning generation, emulating an atmospheric maser with a klystron

At these low temperatures, there are no electrons that could sustain the discharge. However, right when the discharge is dying, a powerful klystron spike is automatically caused by the sudden decrease of the load. This extracts electrons through cold (Fowler) emission, also known as field ionization, and rekindles the discharge. The optical feedback is responsible in part for the fast reaction. Then the spiking cycle repeats itself, causing the BL to vibrate with a continuous sequence of death and re-birth cycles.

To create a system of BL solitons at points P given by $x=x_i$ at a stand-off distance of the order of 1 km, a coherent superposition of klystron-generated waves $E=\Sigma_i E_i \delta(x-x_i)=\Sigma_i E_i \int \exp[i\mathbf{k}(\mathbf{x}-\mathbf{x}_i)d^3x$ is needed, schematized in Fig. 2. The integral can be approximated by a finite coherent superposition of Klystron states.

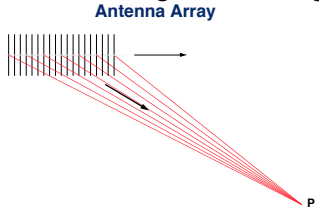

Fig. 2: To iterate the scheme shown in Fig. 1 and produce a system of cold, stable, vibrating BL solitons in mid air at a large distance, a coherent system of spiking power klystrons is needed, with well-defined phase relations, and with feedback, that is obtained from the detected SH carrying the THz waveform, coming from the next BL. The antennas shown are focalizing parabolic antennas in fact.

[1] P.H. Handel, "Use of ball lightning for THz stand-off detection of bio-chemical agents," this volume.
[2] Jianming Dai, Xu Xie, and X.-C. Zhang, *Physical Review Letters*, **97**, 103903 (2006).