Simulating a gravitational radiation communication system

As part of a long-term project to construct a parametric amplifier and oscillator system for generating and detecting gravitational microwaves we would like to perform computer simulations of numerous components. The system uses a moving, impermeable superconducting membrane as its active element. A configuration of three adjacent, high-Q SRF cylindrical cavities will be constructed, consisting of a single "pump" cavity separated from a double "signal and idler" cavity by means of this membrane, which is impermeable to gravitational waves due to the gravitational Meissner effect. The membrane is driven into sinusoidal motion by the radiation pressure exerted on its left side by electromagnetic microwaves that fill the high-Q "pump" cavity from a pump source. On the right side of the membrane, vacuum fluctuations of the double "signal and idler" cavity with a doublet of high-Q microwave resonances will be exponentially amplified above the threshold for the dynamical Casimir effect, so that signal and idler gravitational waves can be generated out of these fluctuations, in addition to the usual electromagnetic waves. Thus an analog of a laser for generating gravitational waves could be constructed. The REU project would consist of becoming familiar with COMSOL scientific simulation software and simulating one or more components of the system. Components include the vibrational membrane, radio-frequency electromagnetic cavities, and radiation and loss from apertures in cavities.

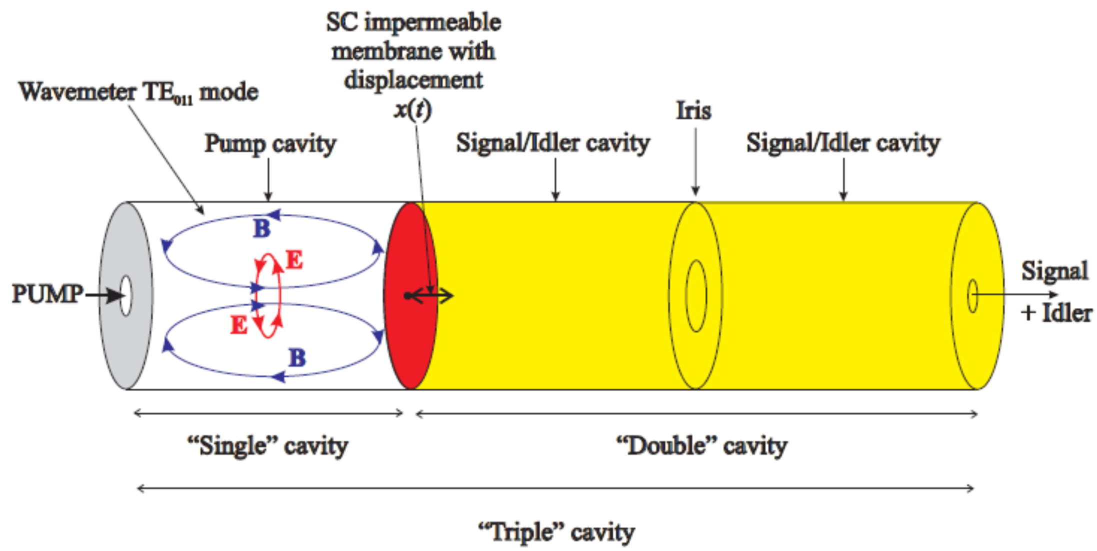

Figure 1: "Triple" cavity paramp is divided into three adjacent cylindrical chambers. The first chamber (i.e., the pump cavity) is separated from the second and third chambers (i.e., the signal and idler cavities) by an impermeable superconducting ("SC") membrane (red), which is the active element of the paramp that can be driven into motion with a displacement of x(t) by a pump wave in the TE011 mode of the "single" cavity, which can exert a radiation pressure force on the left side of the membrane. The initially empty "double cavity" on its right side then fills up with radiation (yellow) that grows exponentially out of vacuum. The iris at the midsection of the "double cavity" splits the TE012 mode of this cavity into a spectral doublet.