A Method to Design Mechanical Transducers for Resonant Mass Gravitational Wave Detectors

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Methodology

In this work a method to design two mechanical modes transducers for spherical resonant mass gravitational wave detectors is presented. Applied for SCHENBERG detector that uses microwave multiparametric sensors. The detector has 17 mechanical modes and more 6 electromagnetic modes for the microwave cavities. Here these aspects of the mechanical design that should allow amplification in amplitude around 10000 times. For this to be possible, these transducers, when placed on the spherical surface of the detector, must meet conditions that involve: size limitations, can be manufactured with a high mechanical and electrical Q, have an effective mass ratio between their modes to provide the intended amplification and compose a resonant system that has characteristics necessary for the detection of gravitational waves (GW). To meet this last aspect, the transducers must form a resonant system with the sphere around the quadrupole frequencies of the sphere. This work describes how these transducers were designed to be able to meet all these conditions. In this project, the use of simulations using the finite element method (FEM) was essential.

Results

The proposal method to design two mechanicals modes transducers for spherical resonant mass gravitational was applied for the SCHENBERG detector. The 17 mechanical modes for this detector whit the six mechanicals transducers was obbtained in according who were expected.

The figure below show two graphs that summarize the results achieved. The graphs are displayed for 6 transducers of two modes connected to the sphere with the central hole. It is possible to notice in the figure that the modes has assumed

an increasingly symmetrical and less spread distribution and the total band decreased. The red bars indicate the frequencies corresponding to the singlets.