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Reduced model for the hydroelastic waves in the cochlea

Hydroelastic waves in the cochlea are studied through modeling a passive basilar membrane as an elastic spring. A rigorous reduction of the three-dimensional equations for the fluid pressure and deflection of the basilar membrane to a one-dimensional ordinary differential equation for the pressure jump across the membrane is derived. The one dimensional reduced model is then critically examined and limits on its validity are discussed. An approximate solution of the reduced equations is in agreement with the experimental Greenwood formula for a proper selection of elastic parameters. The model is used to compute the effect of cochlear implants on the Place Principle governing the spectral decomposition of sound by the cochlea. Numerics are also carried out to see the effect of a cochlear implant on the mechanical response of the cochlea.

This is joint work with Lydia Peres Hari and Jacob Rubinstein