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Spherical harmonic analysis of the field radiated by a source embedded in a two-layer coating of a spherical shell

Jerry H. Ginsberg
Georgia Insitute of Technology, G. W. Woodruff School of Mechanical Engineering, Atlanta, GA 30332-0405, USA

The acoustic field generated by a small source embedded in a viscoelastic layer encapsulating a spherical shell was modeled previously by treating each layer as a dissipative fluid [J. H. Ginsberg, JASA, **122**, 3067 (2007)]. Using spherical harmonic series for each layer was shown to lead to profoundly ill-conditioned equations because of the enormous differences of scale of the spherical Bessel functions having complex argument and high order. Mie series is not directly applicable because the present source is embedded in a layer. Scaling of the spherical Bessel functions and the alternatives of using Bessel and Neumann or two Hankel functions are examined for their efficacy in addressing ill-conditioning. The specfic system that is analyzed consists of a soft inner layer that coats the shell, covered by an outer layer that encapsulates the source. The impedance of the outer layer nominally matches the surrounding water, so reflection of the source from the soft inner layer might seem to have the effect of creating a dipole. However, depending on the wavelength in the inner layer, it might seem that the source "sees" the shell, in which case one would expect the behavior to be like a simple source whose strength is doubled.