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Continuum breakdown of the acoustic field generated by a pulsating micro-sphere[1] YARON BEN-AMI, AVSHALOM MANELA, Technion - Israel Institute of Technology — The flow field of a pulsating sphere is a canonical problem in acoustics. We consider the counterpart problem at small length scales of the sphere, where its radius is comparable with the gas mean free path. Such small scales are often encountered in the process of time-resolved spectroscopy of micro-particles. At these conditions, the gas rarefaction effects become important and the continuum description breaks down. The acoustic field is analyzed in the entire range of sphere length-scales. Numerical calculations are carried out via the direct simulation Monte Carlo method; analytical predictions are obtained in the free-molecular and near-continuum regimes. In the latter, the regularized thirteen moments model is applied, to capture the system response at states where the Navier-Stokes-Fourier equations break down. The results quantitate the dampening effect of gas rarefaction on the acoustic field. At near-continuum conditions, the acoustic field is composed of exponentially decaying 'compression', 'thermal' and 'Knudsen-layer' modes, reflecting thermoviscous and higher-order rarefaction effects. Stronger attenuation is obtained in the free-molecular regime, where boundary sphericity results in a geometric reduction of the molecular layer affected by the source.

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