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Abstract

The interaction of closely spaced bubbles is relevant for a variety of geophysical, industrial, and medical applications. The present study fills a research gap in that it is concerned theoretically with the volume pulsations of bubbles at small distances compared with their sizes. It was shown that the bi-spherical coordinates provide separation of variables and are more suitable for analysis of this problem. A coupled oscillator method is used to describe collective acoustic resonances from closely spaced bubbles in water. Explicit formulas have been derived that describe the dependence of the bubbles natural frequencies and damping coefficients on their sizes and the separation distance.

Keywords: bubbles, multiphase flow, coupled oscillations, bi-spherical coordinates, radiation damping

1. Introduction

Gas bubbles play an important role in the generation, scattering and absorption of sound in a liquid [1]. Applications include performance prediction for search sonar or underwater telemetry, acoustical oceanography, medical and industrial ultrasound. In industry, bubble monitoring is required for electrochemical processes, the production of paints, pharmaceuticals and foodstuffs [2]. The use of the backscatter signal of an acoustic pulse from bubbles makes it possible to tackle the inverse problem – determination of

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