Nonlinear Bubble Oscillations in Linear Electric Fields

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Bubble oscillation excited by time-periodic linear electric field is studied using method of nonlinear dynamics. If it is assumed that the bubble deformation is small enough ($O(\epsilon)$), the dynamical behavior of bubble surface can be represented by the series expansion of spherical harmonics ($Y_n^m(\theta,\phi)$). The oscillation equations for volume and shape modes based on domain perturbation method are extended to include the effect of the Maxwell stress on bubble surface. The outside fluid medium is assumed to be weakly viscous and perfect dielectric. It is shown that the 3-dimensional bubble deformation by linear electric field can be expressed by a finite number of shape modes ($n, m \leq 4$). The surface area of deformed bubble, which is approximated from the derived oscillation equations with $O(\epsilon^2)$ -accuracy, is also analyzed to optimize the mixing efficiency together with flow field near the bubble surface. Chaotic oscillations of shape modes are investigated systematically as well as their resonances.