Stability of expanding bubbles in the Sound Shell Model (SSM)

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Gravitational waves is a subject of many current research projects and The Laser Interferometer Space Antenna (LISA) is scheduled to launch in 2034 with the primary goal of detecting gravitational waves. Among the waves that LISA may observe are those originating from the early universe. These gravitational waves contribute to what is known as the gravitational wave background.

The gravitational waves can arise from various sources, one of which is first-order phase transitions that occurred in the early universe. In first-order phase transitions, the change occurs through a process called nucleation. This process can generate gravitational waves, providing a potential source for the signals LISA aims to detect.

During the phase transition, the bubble may experience perturbations, which could lead to instability and to the end of the bubble expansion. So far, the stability of the bubbles has only been calculated for very large bubbles, for which the bubble wall can be approximated as a straight line. The results of this approximation predicts the bubbles grow larger than simulations of the same subject. The reason for this contradiction might be the approximation.

In order to calculate more precise results for the stability of the bubbles, one has to use methods differing from those of the approximation. Like finding a coordinate system in which the equation is separable and to reduce the equations into a spherically symmetric form, from which the equations can be solved. This work focuses on getting the perturbed equations to a form which can be used to solve for the stability of the bubbles and the analysis of those equations. The solving of these equations is not part of this work.