Wave Processes at Interfaces

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Summary. We investigate the interaction of shock waves in a heavy gas with embedded light gas bubbles next to a rigid wall. This may give insight regarding cavitation processes in water. Due to the highly dynamical, unsteady processes under consideration we use an adaptive FV scheme for the computations to resolve accurately all physically relevant effects. The results are validated by comparison with tube experiments.

1 Introduction

The formation and collapse of vapor bubbles in a liquid is called cavitation. Lord Rayleigh discovered that pressure waves emitted during the process of cavitation [Ray17] may damage solids, e.g., marine screw propellers. Since then, the mechanism of cavitation damaging has been subject of experimental [Lau76, LH85] and analytical research. However, it is still unclear whether the shock and rarefaction waves or the liquid jet onto the solid is the main reason for the erosion of the material. The loading on an elastic-plastic solid exposed to shock and rarefaction waves in water was investigated by Specht in [ASB00]. Hanke and Ballmann showed one-dimensional results for a bubble collapse in water in [HB98].

Cavitation is induced by a pressure drop in the liquid below vapor pressure. Such a pressure decrease may occur due to local acceleration of the liquid flow caused by geometrical constraints, e.g., if the liquid flows through a narrow orifice or around an obstacle. In case the pressure drops below vapor pressure, the liquid bursts and creates a free surface filled with gas and vapor – the bubble. Due to changes in the flow field, the pressure in the liquid may increase afterwards causing the bubble to collapse. The collapse is accompanied by strong shock and rarefaction waves running into the bubble and the surrounding liquid. The shock wave focuses in the center of the bubble. This leads to extreme physical states in the interior. In addition, the shrinking of