Surface Tension and Thermodynamic Effects with the Material Point Method

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Abstract: We will present the results of several recent works on incorporating surface tension and thermodynamic effects into the material point method. On both fronts, a key innovation is a novel boundary quadrature method for MPM surfaces. We will explain how these methods can be made conservative (e.g., for momentum and heat), and we will demonstrate a number of interesting examples from both computational physics and computer graphics. Our methods are able to simulate a dynamic range of phenomena—from thermocapillary effects like Marangoni convection, to high-surface tension fluids like liquid metals, to thin-film effects similar to tears of wine—that are typically quite difficult to achieve with other numerical methods. We will conclude with some thoughts on generalizing these ideas to other MPM simulation problems.