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Hydrodynamic backreaction forces in expanding bubbles

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In first-order cosmological phase transitions, it is commonly accepted that subluminal bubble expansion requires out-of-equilibrium interactions with the plasma which are captured by friction terms in the equations of motion for the scalar field. This has been disputed in works pointing out subluminal velocities in local equilibrium arising either from hydrodynamic effects in deflagrations or from the entropy change across the bubble wall in general situations. In this talk it will be argued that both effects are related and can be understood from the conservation of the entropy of the degrees of freedom in local equilibrium. Despite the lack of an explicit friction term in the equation of motion for the scalar field undergoing the phase transition, the friction effect arises from temperature gradients across the bubble wall, which are enforced by the background field dependence of the conserved entropy current in the plasma. This can lead to subluminal speeds for both deflagrations and detonations. The effects can be accounted for by simply imposing local conservation of stress-energy and including field-dependent thermal contributions to the effective potential. Although one can apply the "bag model" parameterization of the energy-momentum tensor of the plasma, determining the correct parameters still requires solving for the field profiles across the wall.

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