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A single-fluid multiphase formulation for diffuse-interface modeling of high-pressure liquid-fueled transcritical mixing layers[1] LLUIS JOFRE, JAVIER URZAY, ALI MANI, PARVIZ MOIN, Center for Turbulence Research, Stanford University — Liquid propellants are often used in propulsion systems. In subcritical conditions, atomization involves the rupture of the liquid volume through the competition between aerodynamic shearing and surface tension. In contrast, the classic atomization description becomes inadequate at supercritical conditions when the characteristic temperature and pressure of the gas environment are above the corresponding critical values. In that limit, the latent heat of vaporization vanishes and there is virtually no surface tension that prevents rupture of the liquid core and diffusive mixing with the gas environment. In particular, in high-pressure gas turbines the liquid fuel is seldom preheated to supercritical temperatures before injection, and the presence of both subcritical and supercritical conditions in the combustion chamber is warranted. Consideration of the liquid phase is therefore required in addition to the gas phase and the supercritical mixture. A single-fluid multiphase formulation of this problem is presented to investigate mixing and combustion in fuel-air transcritical mixing layers. The formulation makes use of diffuse-interface concepts facilitated by the relatively larger interface thicknesses at these high pressures.

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Javier Urzay
Center for Turbulence Research, Stanford University

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