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NUMERICAL SIMULATIONS ON THE STABILITY OF PREMIXED SPHERICAL FLAMES UNDER MICRO-GRAVITY CONDITIONS

Abstract

We present numerical simulations of spherical flames in a premixed lean hydrogen-air atmosphere under micro-gravity conditions. The mathematical model is based on the thermo-diffusive approximation with one-step finite rate chemical reaction. Radiative heat loss is modeled under optically thin conditions. Fully three-dimensional simulations allow the investigation of the nonlinear transient behavior of spherical flames with respect to three-dimensional perturbations. Different scenarios of their evolution can be observed, like extinction of the flame, spherical growth, and splitting of the flame into smaller spherical structures. In addition we show computations of steady flame balls. We also study the interaction of such spherical flames with adiabatic walls, a behavior which presents similarities with capillarity effects in fluid mechanics when a droplet hits a wall. Relations to available experimental observations, performed in the SOFBALL experiments on different STS missions, as well as to theoretical analyses, will be discussed. The numerical scheme is based on an adaptive multiresolution discretization which allows self-adaptive grid refinement in regions of the thin reaction zone. Local scale dependent time stepping strategies allow for further speed-up. The efficiency and accuracy of the computations at a reduced computational cost will be illustrated.

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