Abstract Submitted
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Adjoint sensitivity analysis of thermoacoustic instability in a nonlinear Helmholtz solver[1] MATTHEW JUNIPER, LUCA MAGRI, University of Cambridge — Thermoacoustic instability is a persistent problem in aircraft and rocket engines. It occurs when heat release in the combustion chamber synchronizes with acoustic oscillations. It is always noisy and can sometimes result in catastrophic failure of the engine. Typically, the heat release from the flame is assumed to equal the acoustic velocity at a reference point multiplied by a spatially-varying function (the flame envelope) subject to a spatially-varying time delay. This models hydrodynamic perturbations convecting down the flame causing subsequent heat release perturbations. This creates an eigenvalue problem that is linear in the acoustic pressure but nonlinear in the complex frequency, omega. This can be solved as a sequence of linear eigenvalue problems in which the operators are updated with a new value of omega after each iteration. Adjoint methods find the sensitivity of each eigenmode to all the parameters simultaneously and are well suited to thermoacoustic problems because there are a few interesting eigenmodes but many influential parameters. The challenge here is to express the sensitivity of the eigenvalue at the final iteration to an arbitrary change in the parameters of the first iteration. This is a promising new technique for the control of thermoacoustics.

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