Initial-value problem for stability of detonations rehabilitated
ANATOLI TUMIN, The University of Arizona — Erpenbeck (1962) formulated the
hydrodynamic stability of detonations as an initial-value problem. Unfortunately,
instead of directly solving the dispersion relation numerically, Erpenbeck used the
principle of the argument utilizing both analytical and numerical approaches to
establish the existence of the poles in the Laplace variable plane for the case of
idealized one-reaction detonations (1964). The numerical implementation was so
daunting that it is still believed that the method is “hard to implement and it does
not give a computationally direct way to determine the stability boundaries or the
dispersion relation that defines the unstable modes.” As a result, the normal mode
approach was suggested in 1990. In the present work, we revisited the stability
problem of idealized one-reaction detonations, and showed that the spectrum of
the normal mode approach is equivalent to the discrete spectrum stemming from
Erpenbeck’s dispersion relation. The dispersion relation requires solving the homo-
genous ODEs for the adjoint system (instead of inhomogeneous equations in the
normal mode formulation), and evaluating an integral through the reaction zone.
The solution of the initial-value problem also leads to a method of expansion of
the perturbation field into modes of discrete and continuous spectra. In addition,
it gives a convenient tool for getting the receptivity problem solution. It is neces-
sary to explore the receptivity coefficients together with the conventional eigenvalue
analysis in order to understand the flow dynamics.