



Lateral Stability Analysis of Hypersonic Vehicle under Pressure Fluctuation by Solving Mathieu Differential Equation

[Qingkai Wei](#), [Xun Huang](#)

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Two recent test failures of Hypersonic Technology Vehicle 2 impose a strike to the increasingly growing enthusiasm, not only on the United States side. It is important to find out the exact failure reason, otherwise a solution is impossible. In this Note, we propose a potential failure reason from the perspective of lateral stability analysis. We argue that the time variant pressure fluctuations, which are normally omitted in classical aircraft dynamics analysis, could not be neglected in dynamic analysis of hypersonic vehicles. To demonstrate the idea, a hypersonic model is imagined in this work and its aerodynamic parameters are estimated using fundamental fluid principles. Pressure fluctuations are thereafter estimated by an empirical formula. A lateral dynamic equation is set up, taking those time variant fluctuations into account. The resulted equation is a Mathieu differential equation. Numerical solutions of this equation show that the inclusion of fluctuation terms generates more complicated dynamics and should be considered in flight controller design.

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