Introduction: Combustion instability, where unsteady heat release couples with acoustic modes, has long been an area of concern in liquid rocket engines. Accurate modeling of the acoustic normal modes of the combustion chamber is important to understanding and preventing combustion instability. The injector resistance can have a significant influence on the chamber normal mode shape, and hence on the system stability.

Results: A larger pressure drop/velocity across the orifice leads to higher acoustical resistance. Although there is only a 5% difference in pressure drop between the two cases, there is a significant impact on the acoustic mode shape of the system. For the low resistance case, the manifold/injector boundary behaves as an acoustically open boundary, while for the high resistance case it behaves as acoustically closed. Additionally, increasing the resistance across the injector leads to a change in both the real and imaginary components of the complex eigenfrequencies, as shown in Figure 4.

Conclusions: The knowledge gained through this model can be used during future design cycles to favorably shape the combustion chamber mode shape, and to determine the complex eigenfrequencies in an effort to predict which modes are susceptible to instability.

References: