"The Rijke Tube: Observing, Identifying and Modeling Thermoacoustic Instabilities"

The Rijke Tube is a very simple experiment: a slender tube is set upright and a heating element is placed in the lower half. After a short transient, the tube emits a loud and steady hum. The humming is a manifestation of the complex phenomenon of Thermoacoustic Instability. Such instabilities occur whenever heat is released into an underdamped acoustic cavity and the coupling between gas and heat transfer dynamics becomes unstable. If the heat release is due to combustion, e.g. as in solid fuel rockets or ram jets, they are also known as combustion instabilities and are highly undesirable due to large mechanical stresses on the components caused by the pressure fluctuations.

In this talk I will first demonstrate the Rijke Tube experiment and describe the stabilization and closed-loop identification of the acoustic dynamics. A linear infinite-dimensional model derived from first principles will then be introduced and an analysis with basic root locus techniques will show that the humming is indeed the result of the heat transfer process acting as a destabilizing feedback on the gas dynamics.