1.0 Experiment Background*

This experiment is a follow up to an experiment flown in March of 2002. The apparatus has been redesigned and improved to expand its capabilities and collect a greater quantity of data.

The microgravity environment is ideal for the study of flame behavior because the effect of buoyancy is effectively removed. Buoyancy, being the most dominant influence on a combustion process in a normal gravity environment, hides or masks other important effects such as the Reynolds number of the fuel flow or the size of the fuel exit nozzle.

Laminar flames are characterized by low Reynolds numbers and typically low momentum fluxes, and therefore buoyancy effects are typically very important [1]. This is the case whether acoustically forced or not. In fact, we expect that buoyancy plays a large role in determining the structure of the vortices seen in Figure 1, but the exact nature of this effect cannot be known without studies of equivalent flames under microgravity conditions. Furthermore, a study that is able to determine the affects of buoyancy on the structure of a well-defined flow such as the one considered here would be particularly important to combustion modelers, who prefer to validate their results to relatively simple flows. It is only upon getting good agreement with the simplified case that they make comparisons to more complex cases. A critic of this approach could argue that an alternative means of reducing the effect of buoyancy would be to increase the jet momentum flux, but this also increases the Reynolds number, and thus creates an ambiguity as to whether the differences that are seen are due to buoyancy or Reynolds number effects. This is why the microgravity environment is ideal for studying the effects of buoyancy on unsteady laminar flames; the buoyancy can simply be “turned off,” just as can be done in the numerical models.

To date, there have been several studies of unsteady laminar flames in microgravity, but few of these have dealt specifically with periodically forced non-premixed flames. For example, a few researchers have investigated the interaction of a premixed planar flame with a single vortex [6,7]. In this case, the buoyancy effects have been shown to dominate the structure of the flame under normal-gravity conditions. These microgravity experiments have proven to be exceptionally useful for modelers, because buoyancy-generated turbulence at normal-gravity complicates comparisons between simulations and experiments. We know of only one other successful experiment dealing with periodically forced non-premixed jet flames [8]. In this study, which was undertaken in the Space Shuttle, a laminar propane jet was modulated with a mechanical diaphragm to produce an oscillatory jet flame. The Reynolds number of the jet was 400, the forcing frequencies ranged from 1-10 Hz, and the primary measurements that were made were fluctuating temperature measurements. We believe that this proposed study would complement the forced-flame work of Ref. 8 because our study emphasizes flow visualization rather than single-point temperature measurements.

* This information was taken from our proposal, The Effects of Buoyancy on an Acoustically Pulsed Non-Premixed Laminar Jet Flame, Greenbaum, et al. 2002.