Microscopic Particle Image Velocimetry of Fast Cytoplasmic Streaming during *Drosophila* Oogenesis

Cytoplasmic streaming is a biological phenomenon that was first reported in late 1700s and is present in a wide array of organisms. In most animal cells, streaming typically occurs in early development, and during oogenesis of the fruit fly *Drosophila*, two types of cytoplasmic streaming occur: fast and slow. Cytoplasmic streaming is a complex three-dimensional flow; despite having been extensively studied over the past two centuries, its causes have been identified only recently. Most early studies compared and contrasted flow characteristics of wild-type and mutant flies using average values without providing a statistical view of the variety of flow morphologies that can occur during fast streaming. While this approach was initially very useful, recent efforts have been focused on extracting and comparing more quantitative information that details the complex flow, albeit only for certain limited stages of development of *Drosophila* prior to those associated with fast streaming. By contrast, we focus on statistically characterizing fast cytoplasmic streaming, particularly during stage 10b. First, we show a novel analytical approach on individual particle tracking of injected tracers, which consequently highlights major challenges to this system. Next, we demonstrate that microscopic particle image velocimetry (µPIV) on naturally occurring autofluorescent protein vesicles can be used to create a statistical view of the naturally occurring flow characteristics of fast cytoplasmic streaming in wild-type *Drosophila* oocytes. Finally, we use this µPIV approach to compare wild-type with *spir1* mutant oocytes and show differences in their fast streaming behavior. Together, these experiments provide a new quantitative statistical picture of this complex biological phenomenon.