Contribution ID: **254** Type: **Oral Presentation**

Fluid dynamics of nematocyst prey capture

Tuesday, 10 July 2018 11:30 (30 minutes)

A nematocyst is a specialized organelle within cells of jellyfish and other Cnidarians that sting. Nematocysts are also present in some single celled protists. They contain a barbed, venomous thread that accelerates faster than almost anything else in the animal kingdom. Here we simulate the fluid-structure interaction of the barbed thread accelerating through water to puncture its prey using the immersed boundary method. For simplicity, our model describes the discharge of a single barb harpooning a single celled organism, as in the case of dinoflagellates. One aspect of this project that is particularly interesting is that the micron-sized barbed thread reaches Reynolds numbers above one, where inertial effects become important. At this scale, even small changes in speed and shape can have dramatic effects on the local flow field. This suggests that the large variety of sizes and shapes of nematocyst may have important fluid dynamic consequences. We find that reaching the inertial regime is critical for hitting prey over short distances since the large boundary layers surrounding the barb characteristic of viscous dominated flows effectively push the prey out of the way.

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Session Classification: Women advancing mathematical biology

Track Classification: Minisymposium: Women Advancing Mathematical Biology