

**Suggested title of dissertation:**

Electrostatic levitation of ballooning spiders

**Dissertation supervisor:**

Prof Sam Howison

**Description of the proposal:**

While on his famous voyage on the Beagle, Charles Darwin observed ballooning spiders, which travel large distances through the air suspended from a thread of silk. While aerodynamic forces on the thread undoubtedly play an important role, it has recently been suggested that the upwards force (lift) needed to counteract gravity is provided by interaction with the earth's static electric field (approximately 100 V/m vertically). This explanation has received support from recent experiments (see references). The aim of the project is to build a simple model for a ballooning spider subject to electrostatic forces and to establish the key dimensionless parameters that govern its motion.

**Possible avenues of investigation:**

1. Review history and literature of the problem.
2. Calculate electric field around a slender body (representing the thread) placed parallel to a uniform field: requires techniques of perturbation methods and/or exact solution in ellipsoidal coordinates. Use this to calculate the charge distribution and lift force. Repeat when the thread is at an angle and formulate problem for a curved thread. Find conditions for lift-off.
3. More ambitious: combine with simple model of fluid drag to get equation of motion for a free-floating thread, first when vertical and then more generally).
4. Something we haven't thought of yet

**Pre-requisite knowledge:**

The students needs to be comfortable with standard classical electrostatics (electric fields, capacitance) and with perturbation theory (eg Section C course), as well as happy to model unfamiliar situations and perhaps solve the resulting models numerically.

**Further references:**

Electric Fields Elicit Ballooning in Spiders, Erica L. Morley, Daniel Robert Current Biology Published Online: July 05, 2018

Gorham, P.W. (2013). Ballooning spiders: the case for electrostatic flight. <https://arxiv.org/abs/1309.4731>