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## "Monarch Butterflies Migrate up to 4,500km across North America every Year to Escape the Cold Winter"

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### **Faculty or Research Mentor**

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### **Summary**

Monarch butterflies migrate up to 4,500 km across North America every year to escape the cold winter. During migration, they can fly at altitudes of 1,300 m where the ambient pressure and density reduce to about 70% and 75% of the sea-level values, respectively. Their overwintering sites are all located in the high mountains in Central Mexico at 3,000 m. Moreover, the air density is about 70% of that at the sea level. The effects of density on the flight performance of butterfly and how these butterflies fly at the high-altitudes are unknown. In this project, we will measure freely-flying butterfly flight using high-resolution motion-tracking camera. Implications of flight dynamics and flapping wing aerodynamics will be discussed. The density and pressure inside the vacuum chamber will be adjusted to simulate a high-altitude environment. Experimental methods will be improved to enhance the accuracy and resolution of the measurements. Female and minority students are encouraged to apply.

### **Student Prerequisites**

None. Biology majors are encouraged to apply.

### **Student duties**

The student will be expected to work closely with a graduate student to perform following duties:

- Measuring the morphological parameters (wing area, span, etc.) of the butterflies before the testing
- Acquiring motion-capture data involving calibration of the cameras, placement of markers on the butterfly wings, operating the motion-capture system, operating the motion-capture system in the PRC vacuum chamber
- Postprocessing the data from the experiments
- Assessing the accuracy of the measured data

Main benefits to the students are

- Unique opportunity to operate a state-of-the-art motion tracking system and PRC vacuum chamber
- Working with live butterflies
- Opportunity to contribute to a journal or conference paper, depending on the progress

Experimental data are expect in June/July, which will be postprocessed and analyzed at the end of the summer semester.

### **Mentor Supervision and Interaction**

A graduate (PhD) student will provide a daily supervision to the student. In addition, the student is expected to update the mentor with a weekly progress update report and during a bi-weekly update meetings. The followings are the specifics.

- Weekly progress update report
  - Written together with the graduate student
  - To discuss the results, any issues, and plans for the following week
  - Evaluation: the mentor will provide feedback to all reports. The mentor will assess the writing, scientific progress, and quality of the analysis. Suggestions will be provided
- Bi-weekly progress update meetings
  - Together with the graduate student.
  - To discuss the results and any issues in person.
  - Frequency of the meeting will increased as needed.
  - Evaluation: the mentor will provide detailed instruction for the on-going work and offer suggestions for improvement.