| Berkley: | SHIUN-JR YANG | Energy transfer dynamics in natural photosynthetic systems of photosystem 2 using ultrafast spectroscopy

| Cambridge: | TIMOTHY LAMBDEN | Cryogenic scanning transmission electron microscopy

# Research Proposal: Investigation of Nanoscale Structures in Beam-Sensitive Materials and Energy Transfer Dynamics in Natural Photosynthetic Systems

## Abstract:

This research proposal aims to combine two distinct areas of study, namely the investigation of nanoscale structures in beam-sensitive materials using cryogenic scanning transmission electron microscopy (CryoSTEM) and the analysis of energy transfer dynamics in natural photosynthetic systems using ultrafast spectroscopy and theoretical simulations. Both areas hold significant potential for advancing our understanding of materials and biological systems and have implications for various fields, including renewable energy and materials science. This proposal outlines the methodology, expected results, and potential sustainable impact of the study.

## Introduction:

The development of advanced electron microscopy techniques, such as CryoSTEM, has revolutionized our ability to investigate the nanoscale structure of beam-sensitive materials previously inaccessible for examination. This research proposal seeks to optimize acquisition strategies to maximize data quality without causing significant damage to the sample. Additionally, the proposal aims to study the energy transfer dynamics in natural photosynthetic systems, specifically focusing on Photosystem II (PSII) and its ability to maintain a delicate balance between photoprotection and energy conversion efficiency.

## Methods:

The research will be conducted by two Ph.D. students, Timothy Lambden, and Shiun-Jr Yang, who specialize in different areas. Timothy Lambden's work will utilize CryoSTEM to investigate a wide range of beam-sensitive materials, including perovskites for photovoltaics, biological macromolecules, and bioelectronic polymers. This research will involve developing ice-free cryo holders and optimizing smart scanning and in-painting techniques. On the other hand, Shiun-Jr Yang will employ ultrafast spectroscopy and theoretical simulations to study the energy transfer network in Photosystem II, aiming to understand its ability to balance photoprotection and energy conversion efficiency under varying light conditions.

## Expected Results:

Through the application of CryoSTEM, Timothy Lambden's research is expected to provide high-resolution insights into the nanoscale structures of beam-sensitive materials, contributing to the development of new materials for various applications. Meanwhile, Shiun-Jr Yang's research on energy transfer dynamics in Photosystem II is expected to uncover the design principles that enable efficient and durable solar devices. This understanding could inspire advancements in renewable energy technologies.

## Sustainable Impact:

The sustainable impact of this research proposal lies in its potential implications for various fields. Timothy Lambden's research on CryoSTEM has the potential to revolutionize materials science by providing valuable insights into the nanoscale structure of beam-sensitive materials. Such discoveries could lead to the development of more efficient and sustainable materials for applications such as photovoltaics and biotechnology. Similarly, Shiun-Jr Yang's research on energy transfer dynamics in Photosystem II could inspire the design of efficient and durable solar devices, advancing the field of renewable energy.

## Conclusion:

This research proposal combines the use of CryoSTEM for investigating nanoscale structures in beam-sensitive materials and ultrafast spectroscopy for studying energy transfer dynamics in natural photosynthetic systems. The expected results have the potential to significantly impact various fields, including materials science and renewable energy. By gaining a deeper understanding of these fundamental processes, this research aims to contribute to the development of more sustainable and efficient technologies for future applications.