Abstract:

Picture a world where minuscule life forms can use light to move key ingredients across their cell walls. This isn't science fiction; it's the captivating truth about halorhodopsins tiny pumps. These amazing proteins use light energy to move chloride ions, which helps organisms stay alive and work. Our study aims to figure out how these light-powered chloride pumps work.

We know they exist and that microbes need them, but we still have many questions. How do these pumps pick out chloride ions from all the other molecules around them? What exact steps do they take to grab, move, and let go of chloride? Furthermore, how does absorbing light kick off this complex process? Our team will dive into the tiny world of halorhodopsins to find answers. We'll use cutting-edge X-ray Free Electron Laser tech and other advanced methods to catch the super-fast movement of atoms in proteins. This will give us new insights into these active processes and show us how molecules shift during transport.

Our research centers on halorhodopsins proteins driven by light, present in many different microbes. These tiny pumps use light to move chloride ions across cell membranes, which helps these organisms stay alive and work. We want to figure out how these pumps work, how they pick out chloride ions, and how light makes them move. We will create a "molecular movie" that shows each step of how chloride moves through these light-driven pumps. To do this, we'll use X-ray crystallography to see where chloride attaches and how the molecules change shape. We will also use other methods like spectroscopy to watch how these pumps move. This work matters for a few reasons. First, it fills in a significant gap in what we know about how microbes live. Microbes are essential to ecosystems all over the world, so knowing how they move ions helps us understand how they work and act. Second, this research could lead to new ways to control cells with light.

Our group is uniquely positioned to take on this challenging project. We combine our structural biology, biophysics, and microbiology knowledge to approach this tricky issue from several perspectives. We believe our work will reveal more about the amazing world of microbial pumps and contribute to a broader understanding of how ions move and what this means for life on Earth.