

Michael Krieg: "I wish for more bold science at the fascinating intersection between light and biology"

A curious question about how algae find and react to light has become a Nobel-winning tool for controlling the brain. Prof. at ICFO Michael Krieg explains how optogenetics is set to enable new advances in photonics and, additionally, help carry these advances from the lab to patients, starting with restoring sight.

October 09, 2026

A molecular switch for turning neurons on and off with light: that is what this year's Nobel Prize in Physiology or Medicine has recognized. Peter Hegemann and Georg Nagel discovered that channelrhodopsin, a protein in the unicellular alga Chlamydomonas, acts as an ion channel that, when exposed to light, produces an electric signal. Karl Deisseroth then introduced it into nerve cells and used it to characterize and manipulate the activity of neurons in live animals. And just like that, optogenetics, a whole new field at the intersection of genetics, photonics and neuroscience, emerged.

Researchers have since gained important insights into how the brain functions. Memories, feelings, neurological and psychiatric disorders, blindness... All of these are now better understood thanks to light and the protein that once caught the attention of this year's laureates.
ICFO Professor Michael Krieg is one of the many scientists who were deeply drawn to this neuronal switch. After completing a PhD in the lab of Cellular Machines at the Technische Universitat Dresden, and deciding to stay in academia, he began to explore optogenetic techniques, first as a postdoctoral researcher at the Max Planck Institute of Molecular Cell Biology and Genetics, and then at Stanford University School of Medicine. In 2017, he established the Neurophotonics and Mechanical Systems Biology group at ICFO, which he has led ever since. There, researchers use new optogenetic tools to measure mechanical forces inside cells and animals and to visualize their effects as the animals crawl, feel and become old.
Now that optogenetics has been recognized with the Nobel Prize in Physiology or Medicine, Prof. Krieg explains why the laureates' work matters for science as a whole, and how it has shaped, and will likely continue to shape, his own research.

What is the relevance of this Nobel Prize for science?
The prize is obviously highly relevant because it again highlights how curiosity-driven basic research can give rise to an unprecedented discovery with potential clinical implications. As a matter of fact, optogenetics and the use of light-gated ion channels in particular are clinically trialled as we write for the treatment of vision disorders. Even though the translational route to deployment in the brain is a higher hanging fruit, optogenetics provided a unique tool to non-invasively interrogate causal interaction between neuronal activity and the behavior these neurons encode.

Can you specify one important discovery that would not have been possible without the work of this year's Nobel laureates?
One of the most important discoveries and applications is vision restoration in blind people.. But there are many others. For instance, it has enabled causal functional interrogation of brain regions. This is particularly important because before it was barely possible to activate single neurons and interrogate the functions they assume in a complex tissue such as the brain. Optogenetics has been key to changing that.

And in your particular case, what has their discovery enabled? How do you use optogenetics tools in your day-to-day research?
It depends on how narrow your definition of optogenetics is. But if we stick to the definition of the use of light-gated ion channels, we primarily use optogenetics for manipulation of intracellular ion concentrations. This allows us to rewire endogenous neuronal circuits, that

is, networks of nerve cells that already exist naturally in the brain. Or to suppress pain and fears, or attract animals to otherwise unpleasant smells by modifying how signals are integrated at specific synapses between two neurons. Currently we are interested in inward proton pumps, and ultra-sensitive, red-shifted ion channels with the aim to increase the versatility of our synaptic engineering techniques.
For mechanobiology, one of the main interests in my group, optogenetics is less important than for neuroscience, but it provides a toolbox that allows cell-specific manipulation using light within an organism. For example, through specialize optogenetic tools, protein localization can be altered, or enzyme-kinetics can be halted, resulting in precise manipulation of force-bearing and force-producing motor proteins.

You have been working in optogenetics for more than 10 years. What first drew you to the field? Did the laureates' research influence that decision?
I got exposed to the field as a postdoc, while working next door to Karl Deisseroth's lab. Then I primarily used optogenetics as a tool to interrogate functional neuronal activity-behavior relationships. I wanted to understand if my genetic perturbations on the animal left neuronal excitability and synaptic transmission unchanged. I really took a step forward when I started my own lab, as I wanted to establish non-invasive and autonomous ways to activate channelrhodopsins (the protein that Peter Hegemann and Georg Nagel discovered) using bioluminescent light emission.

How did you feel when the Nobel prize was announced?
I was very happy to see the long and hard work being acknowledged by this important prize. I was waiting for it to happen already long ago, and congratulate the recipients obviously for getting the prize, but more importantly for making this discovery and founding a new field.

How might this prize influence the field's evolution in the coming years?
There is always a draw into the field after a Nobel Prize. We have seen this after piezo and trp channels received it, and we will see a similar increase in attention and acceptance - drawing in more talent and creativity. Combined with other photonic technology and protein engineering, we will witness non-invasive neuromodulation, eventually bridging optogenetic from the bench to the clinic. I wish for more bold science and for more funding to explore the different facets of this fascinating intersection between light and matter, in the clinical but most importantly also in the basic research activities. At the end, we would not be here and talk about this, if basic research would not have informed us about these possibilities.