

## Joel M. Kralj, PhD

### Work Address

KRALJ Lab  
BioFrontiers Institute  
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### Research Statement

Research in the Kralj lab focuses on creating new tools to study functions of molecules, cells, and organisms. We combine techniques from biochemistry, molecular engineering, optics, microfluidics, image processing, and machine learning and apply them to diverse model systems including bacteria, yeast, cardiomyocytes, and neurons. We aim to uncover biology at unexplored scales with high throughput.

### Employment

UNIVERSITY OF COLORADO BOULDER, Boulder, CO Assistant Professor of Molecular, Cellular and Developmental Biology BioFrontiers Institute	Aug 2014 – present
Q-STATE BIOSCIENCES INC, Cambridge, MA Chief Technical Officer and Co-founder	Jul 2013 – Aug 2014
HARVARD UNIVERSITY, Cambridge, MA Postdoctoral Researcher in Chemistry and Chemical Biology Advisor: Prof. Adam E. Cohen	Feb 2009 – Jun 2013

### Education

BOSTON UNIVERSITY, Boston, MA Ph.D. Physics (Jan 2009) Advisor: Prof. Kenneth J. Rothschild	Sep 2002 – Jan 2009
SANTA CLARA UNIVERSITY, Santa Clara, CA B.S. Engineering Physics (June 2002) Advisor: Prof. John Birmingham	Sep 1998 – Jun 2002

### Publications

- Hou, JH., **Kralj, Joel M.**, Douglass, AD., Engert, F., Cohen, AE. “Simultaneous mapping of membrane voltage and calcium in zebrafish heart *in vivo* reveals chamber-specific developmental transitions in ionic currents.” *Frontiers in Physiology* (2014)
- Hochbaum, DR., Zhao, Y., Farhi, SL., Klapoetke, N., Werley, CA., Kapoor, V., Zou, P., **Kralj, Joel M.**, Maclaurin, D., Smedemark-Margulies, N., Saulnier, JL., Boulting, GL., Sraub, C., Cho, YK., Melkonian, M., Wong, GK., Harrison, DJ., Murthy, VN., Sabatini, BL., Boyden, ES., Campbell, RE., Cohen, AE. “All-optical Electrophysiology in Mammalian Neurons Using Engineered Microbial Rhodopsins.” *Nature Methods* (2014)
- Venkatachalam V, Brinks D, Maclaurin D, Hochbaum D, **Kralj, Joel M.**, Cohen AE. “Flash Memory: Photochemical Imprinting of Neuronal Action Potentials Onto a Microbial Rhodopsin.” *Journal of the American Chemical Society*, 136(6):2529. (2013)

4. Park J, Werley CA, Venkatachalam V, **Kralj, Joel M.**, Dib-Hajj SD, Waxman SG, Cohen AE. "Screening Fluorescent Voltage Indicators with Spontaneously Spiking HEK Cells." *PLOS One*, 8(12):e85221.
5. Clair EC, Ogren JI, Mamaev S, **Kralj, Joel M.**, Rothschild KJ. "Conformational Changes in the Archaeorhodopsin-3 Proton Pump: Detection of Conserved Strongly Hydrogen Bonded Water Networks." *Journal of Biological Chemistry* 38(1):153. (2012)
6. St. Clair, EC., Ogren, JI., Russano, D., Mamaev, S., **Kralj, Joel M.**, Rothschild, KJ. "Near-IR Resonance Raman Spectroscopy of Archaeorhodopsin-3: Effects of Transmembrane Potential." *Journal of Physical Chemistry B*, 116(50):14592. (2012)
7. **Kralj, Joel M.\*.**, Douglass, AD\*., Hochbaum, DR\*., Cohen, AE. "Optical Recording of Action Potentials in Mammalian Neurons with a Voltage Indicating Protein." *Nature Methods*, 9(1):90-95. (2012)
8. **Kralj, Joel M.**, Hochbaum, DR., Douglass AD., Cohen AE. "Electrical Spiking in *Escherichia Coli* Probed with a Fluorescent Voltage Indicating Protein." *Science*, 333(6040):345-348 (2011)
9. Bayraktar H, Fields AP, **Kralj, Joel M.**, Spudich JL, Rothschild KJ, Cohen AE. "Ultrasensitive Measurements of Microbial Rhodopsin Photocycles Using Photochromic FRET." *Photochemistry Photobiology*, 88(1):90.
10. Bergo, VB., Partha, R., **Kralj, Joel M.**, Sineshchekov, OA., Spudich, EN., Spudich, JL., Rothschild, KJ. "Evidence for Interaction of a Protonated Histidine with the Schiff Base Counterion in Proteorhodopsin." *Journal of Biological Chemistry*, 284(5):2836-43 (2009)
11. Cappuccio, JA., Blanchette, CD., Sulchek, T., Arroyo, ES., **Kralj, Joel M.**, Hinz, AK., Kuhn, EA., Chromy, BA., Rothschild, KJ., Fletcher, J., Katzen, F., Peterson, TC., Kudlicki, WA., Bench G., Hoepflich, PD., Coleman, MA. "Cell-free Co-expression of Functional Membrane Proteins Supported in Soluble Nanolipoprotein Particles." *Molecular and Cellular Proteomics*, 7(11):2246-53 (2008)
12. Amsden, JJ., **Kralj, Joel M.**, Bergo, VB., Spudich, EN., Spudich, JL., Rothschild, KJ., "Initial structural changes upon photoisomerization of a blue absorbing proteorhodopsin." *Biochemistry*, 47(44):11490-8 (2008)
13. **Kralj, Joel M.**, Amsden, JJ., Spudich, EN., Spudich, JL., Rothschild, KJ. "Protein-Chromophore interactions in the blue and green proteorhodopsins." *Journal of Physical Chemistry B*, 112(37): 11770-76 (2008)
14. **Kralj, Joel M.**, Bergo, VB., Spudich, EN., Spudich, JL., Rothschild, KJ. "The Protonation State of Glu142 differs in the green and blue absorbing variants of proteorhodopsin." *Biochemistry*. 47 (11): 3447-53 (2008).
15. Amsden JJ., **Kralj, Joel M.**, Chieffo, L., Wang, X., Erramilli, S., Spudich E., Spudich, J., Ziegler, L., Rothschild, K. "Subpicosecond Protein Backbone Changes Detected During the Proteorhodopsin Primary Photoreaction." *Journal of Physical Chemistry B*. 111 (40): 11824 (2007).
16. Bergo, VB., Ntefidou, M., Trivedi, VD., Amsden, JJ., **Kralj, Joel M.**, Rothshild, KJ., Spudich., JL. "Conformational changes in the photocycle of Anabaena sensory rhodopsin; absence of the Schiff base counterion protonation signal" *Journal of Biological Chemistry* 281(22): 15208 (2006).
17. Khare, BN., Meyyappan, M., **Kralj, Joel M.**, Wilhite, P., Sisay, M., Imanaka, H., Koehne, J., Baushchlicher, CW., "A glow discharge approach for functionalization of carbon nanotubes." *Applied Physics Letters* 81(27): 5237 (2002).

\*Denotes equal contribution

## Patents

1. A. E. Cohen, **J. M. Kralj**, A. D. Douglass, "Optogenetic probes of membrane potential." U.S. Patent pending
2. A. E. Cohen, **J. M. Kralj**, D. R. Hochbaum, D. MacLaurin, "Systems and methods for imaging at high spatial and/or temporal precision." U.S. Patent pending
3. A. E. Cohen, Eggan K, **J. M. Kralj**, E Kiskinis, "Diagnostic methods for neuronal disorders." U.S. Patent Pending

## Awards

Searle Scholar

2015 - 2018

IC Postdoc Fellowship

2009 - 2011

Boston University Photonics Fellow	2007 – 2008
Biophysical Society Travel Grant	2008
American Association of Physics Teachers Distinguished Teaching Fellow	2003

### **Additional Work Experience**

NASA AMES RESEARCH CENTER, Mountain View, CA <i>Undergraduate Researcher</i>	Apr 2001 – Jul 2002
MICROSYSTEMS ENGINEERING, INC, Portland, OR <i>Verification and Validation Engineer</i>	Summers 2000, 2001

### **Teaching Experience**

BOSTON UNIVERSITY, Boston, MA <i>Graduate Teaching Fellow</i>	Sep 2002 – May 2004
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American Association of Physics Teachers Distinguished Teaching Fellow (2003)

Courses:

- Intro to Modern Physics
- Physics I for non-Scientists

*Independent Tutor*

### **Professional Societies**

- Biophysical Society
- Society of Applied Spectroscopists
- Society for Neuroscience
- American Society for Cell Biology