

Joel M. Kralj, PhD

Work Address

KRALJ Lab
BioFrontiers Institute
Univ. of Colorado, Boulder
3415 Colorado Ave.
JSC Biotech Bldg.
Boulder, CO 80303-1904

Phone: (303) 492-2642
Cell: (617) 610-3683
joel.kralj@colorado.edu

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 Aug 2014 – present
Assistant Professor of Molecular, Cellular and Developmental Biology
BioFrontiers Institute

Q-STATE BIOSCIENCES INC, Cambridge, MA Jul 2013 – Aug 2014
Chief Technical Officer and Co-founder

HARVARD UNIVERSITY, Cambridge, MA Feb 2009 – Jun 2013
Postdoctoral Researcher in Chemistry and Chemical Biology
Advisor: Prof. Adam E. Cohen

Education

BOSTON UNIVERSITY, Boston, MA Sep 2002 – Jan 2009
Ph.D. Physics (Jan 2009)
Advisor: Prof. Kenneth J. Rothschild

SANTA CLARA UNIVERSITY, Santa Clara, CA Sep 1998 – Jun 2002
B.S. Engineering Physics (June 2002)
Advisor: Prof. John Birmingham

Publications

1. Kiskinis E.*, **Kralj, Joel M.***, Zou, P*, Weinstein, E*, Eggan, K., Cohen, AE. “Alterations in neuronal excitability in ALS probed through optical electrophysiology studies of human iPSC-derived neurons.” *Submitted*
2. Dodd, BJT, **Kralj, Joel M.** “Live cell imaging reveals pH oscillations in *Saccharomyces cerevisiae* during metabolic transitions.” *Scientific Reports*, 7, 13922 (2017)
3. Bruni, GN., Weekley, RA., Dodd, BJ., **Kralj, Joel M.** “Voltage induced calcium flux mediates mechanosensation in *Escherichia coli*.” *PNAS*, 114,35 (2017).
4. Werley, CA., Chien, MP., Gaublomme, J., Shekhar, K., Yi, BA., **Kralj, Joel M.**, Bloxham, W., Regev, A., Cohen, AE. “Geometry-dependent functional changes in iPSC-derived cardiomyocytes probed by functional imaging and RNA sequencing.” *Plos One* (2017)

5. Dempsey GT, Chaudhary KW, Atwater N, Nguyen C, Brown BS, McNeish JD, Cohen AE, **Kralj, Joel M.** “Cardiotoxicity screening with simultaneous optogenetic pacing, voltage imaging, and calcium imaging.” *Journal of Pharmacological and Toxicological Methods*, (2016)
6. 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)
7. 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)
8. 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)
9. 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.
10. 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)
11. 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)
12. **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)
13. **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)
14. 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.
15. 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)
16. 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., Hoeplich, 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)
17. 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)
18. **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)
19. **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).
20. 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).
21. 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).
22. 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 9,057,734
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 9,207,237
3. **J. M. Kralj**, G. Dempsey, C. Werley, A. E. Cohen, “Cardiotoxicity Screening Methods.” U.S. Patent Pending
4. A. E. Cohen, K. C. Eggen, **J. M. Kralj**, D. R. Hochbaum, G. D. Dempsey. “Systems and Methods for Assessing Inter-cellular communication.” U.S. Patent 20,170,292,961.
5. K. C. Eggen, A. E. Cohen, **J. M. Kralj**, E. Kiskinis, “Models for Parkinson’s disease studies.” U.S. Patent Pending
6. K. C. Eggen, A. E. Cohen, **J. M. Kralj**, E. Kiskinis, “Analysis of compounds for pain and sensory disorders.” U.S. Patent Pending
7. K. C. Eggen, A. E. Cohen, **J. M. Kralj**, E. Kiskinis, “Diagnostic methods for neural disorders.” U.S. Patent 9,594,075

Awards

NIH New Innovator	2016 - 2021
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

CU-BOULDER, Boulder, MA <i>Quantitative Optical Imaging – Course developed</i> Course designed to teach advanced undergraduates and graduate students the basics of optical imaging in biology. This course contains four subsections: (i) nature of light, (ii) contrast mechanisms, (iii) biological imaging, and (iv) data processing.	Fall 2015 -
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------

BOSTON UNIVERSITY, Boston, MA <i>Graduate Teaching Fellow</i> American Association of Physics Teachers Distinguished Teaching Fellow (2003) Courses: <ul style="list-style-type: none">• Intro to Modern Physics• Physics I for non-Scientists <i>Independent Tutor</i>	Sep 2002 – May 2004
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------

Professional Societies

- Biophysical Society
- Society of Applied Spectroscopists
- Society for Neuroscience

- American Society for Cell Biology