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**"Evaporative Tear-Film Instability: The Origin of Dry Eye"**

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**Abstract:** Dry eye, a burny, itchy feeling of dryness and discomfort, is a common malady that infects up to 30 % of the global population. It is especially prevalent in the elderly and women, and in arid, windy climates. During an interblink, randomly distributed ruptures can occur in the tear film. So-called "black spots" and/or "black streaks" appear in 15 to 40 s for normal individuals. For people who suffer from dry eye, tear-film breakup time can be less than a few seconds. Rapid tear breakup is widely believed a signature of dry-eye syndrome. In spite of decades of effort, there currently is no satisfactory explanation for how tear rupture gives rise to dry-eye symptoms nor is there a physically consistent explanation for the origin of tear rupture.

We propose local evaporative-driven tear rupture. Increased evaporation drives a hole in the tear film. As the hole deepens, local salinity increases. The growing hole is suppressed by curvature-driven healing flow and by osmotic-suction due to the local salinity increase. Rupture occurs only when the locally high evaporative flux outweighs the two healing flows. Quantitative evaluation of the evaporative-driven tear-breakup mechanism leads to significant increased salinities at the bottom of the rupture spot (or streak) that we coin salinity "hot spots". Predicted roles of environmental conditions such as wind speed and relative humidity on tear-film stability agree with clinical observations. Most importantly, locally elevated evaporation leads to hyperosmolar spots in the tear film and, hence, vulnerability to epithelial inflammation and dry-eye symptoms. Tear-film rupture is more likely with contact-lens wear because initial tear-film thickness is reduced.

We provide the first (and only) physically consistent, quantitative explanation for black streaks and/or spots in the human tear film during interblink. Importantly, we explain the formation of "hot spots" of locally high concentration of solutes in the tear film. A tear film peppered with salinity hot spots activates corneal afferent nerve receptors (cold) causing pain sensation and eventually leading to dry eye.

**Biography:** Clayton (Clay) J. Radke received his B.S. degree in chemical engineering at the University of Washington in 1966 and his Ph.D. in 1971 at the University California under the mentorship of J. M. Prausnitz. He spent 18 months as an NSF Postdoctoral Fellow at the University of Bristol studying colloid chemistry under Professors Douglas Everett and Ron Ottewill. In 1973, he joined the chemical-engineering faculty at the Pennsylvania State University returning to the faculty at the University of California in 1976. He rose to full Professor in 1984 and was appointed Professor of Vision Science in 2003. Dr. Radke has held a number of visiting professorships including the Universite de Poitiers, University of Minnesota, Massachusetts Institute of Technology, and Stanford University, and was

Benjamin Maeker Distinguished Professor at the University of Bristol in 2007. He won the Proctor & Gamble Colloid Chemistry Award of the American Chemistry Society in 2003, the John Franklin Carl Award of the Society of Petroleum Engineering in 2011, the Chemstations Research Lectureship Award of the American Society for Engineering Education in 2013, and University of Washington Alumnus of the Year in 2015. He was elected to the National Academy of Engineering also in 2015. Dr. Radke has lectured at well over 100 university and industrial laboratories. His lectures are appreciated for clear presentation of new technical advances sprinkled with humor and illustrative anecdotes. He currently serves on the editorial boards of 4 technical journals, several company technical boards, and is Chair of the Board of Trustees of New College in the Graduate Theological Union at Berkeley.

Dr. Radke's research focuses on interfacial and colloidal technologies where phenomena at phase boundaries influence overall behavior. His research is rigorous and quantitative, blending fundamental theory with experiment. He tackles important problems that have large impact on practical application in industry. Professor Radke is known for constructing innovative apparatus to elucidate physical phenomena including a continuous-flow tensiometer, an internal reflection fluorescence oil/water interfacial spectrometer, an in-situ streaming-potential optical reflectometer, a single-lens polarographic oxygen permeameter, and most recently, a hand-held in-vivo evaporimeter for the human eye. He has published over 270 research monographs, coauthored one book, three patents, and delivered over 700 technical papers. Dr. Radke is devoted to teaching. He served as department vice chair for undergraduate education over almost two decades. For many years, he taught, and continues to teach, the introductory course for undergraduate chemical-engineering students. In addition, Dr. Radke teaches undergraduate courses in transport, fluid mechanics, kinetics, and interfacial phenomena, as well as graduate courses in applied mathematics, transport, and colloid science. He won the physical sciences Donald Sterling Noyce Prize for Excellence in Teaching in 1993, the campus Distinguished Teaching Award in 1994, and the department teaching award 9 times. In addition, Dr. Radke is a much-beloved mentor and advisor including over 60 PhD students, over 30 MS students, and enumerable undergraduate honors research students.

**When: Tuesday, January 24th, 2017 at 11 am**
**Where: CB#204W**