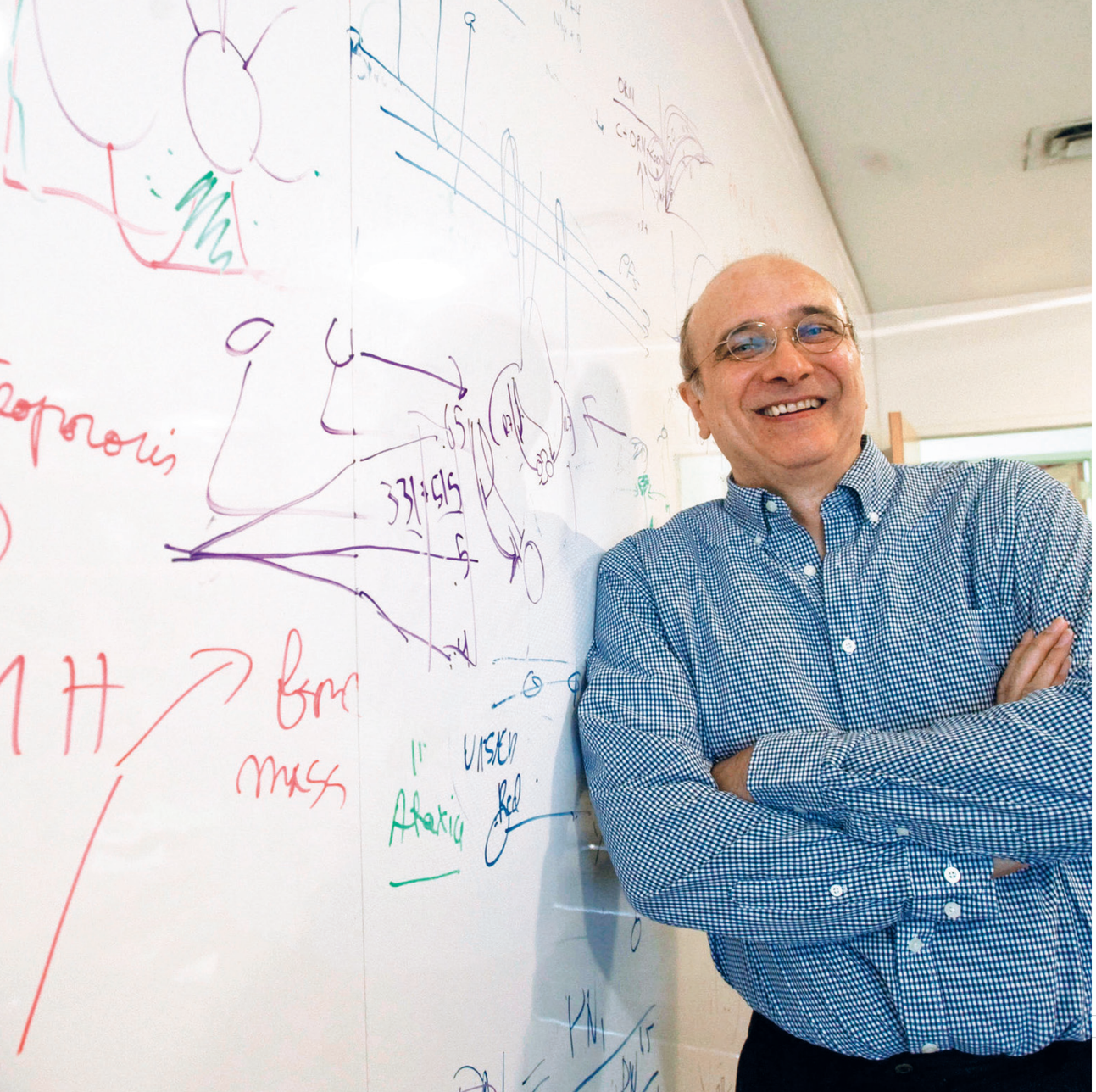

Understanding How Flies' Brains Identify Odors

AUREL A. LAZAR

Professor of Electrical Engineering

Working with fruit flies, Aurel A. Lazar and his team are trying to understand how insects' brains discriminate one smell from another. The brain gets information as "spike trains"—brief electrical pulses that respond to a stimulus, such as a smell. Lazar is working on how a fruit fly's brain acquires and processes such smells.

Building on a well-developed genetic understanding of the anatomy of its olfactory system, he uses time encoding machines—computer models of olfactory sensory systems—to represent odors as "spike trains." He is investigating the sense of smell as a memory-based, odor-object recognition system.

Lazar is the founder and leader of the Bionet Group of the Department of Electrical Engineering. The group is an interdisciplinary research team bringing together faculty and students from the biological and engineering sciences to address questions that arise in the field of computational neuroscience. The group is an active and integral part of the world class Columbia neuroscience community.

Lazar's team has developed a novel in vivo experimental setup with precise and reproducible delivery of airborne stimuli to fruit flies that has enabled them to map out the process of odor encoding in olfactory sensory neurons. This research is performed in collaboration with Richard Axel, University Professor, in The Axel Laboratory.

In addition, the team is pursuing the implementation of massively parallel models of sensory systems in vision and hearing. The team has demonstrated for the first time the faithful recovery of natural video (movies, animation) and auditory scenes (speech, sounds) encoded with neural circuits. This has the potential to enhance next-generation artificial retinal and cochlear implants.

Lazar describes his research interests as being "at the intersection of computational, theoretical, and systems neuroscience. The computational/theoretical work builds on methods of communications/networking, information theory, machine learning, nonlinear dynamical systems, signal processing, and systems identification. The experimental work employs methods of genetics, neurophysiology, and systems biology."

Lazar teaches Computational Neuroscience: Circuits in the Brain, an advanced undergraduate/graduate introductory-level course, along with follow-up graduate-level courses. He joined Columbia Engineering in 1980.

B.S., Bucharest Polytechnical Institute, 1971; M.S., Darmstadt Institute of Technology, 1976; Ph.D., Princeton, 1980