BAGWELL X
TENTH HONORARY LECTURE

Fri Nov. 17, 11^{am} – 12^{noon} Burton Morgan 121

Lecture Series held in fond memory of Philip F. Bagwell, former Professor in Electrical and Computer Engineering, to celebrate his spirit of deep thinking across disciplines.

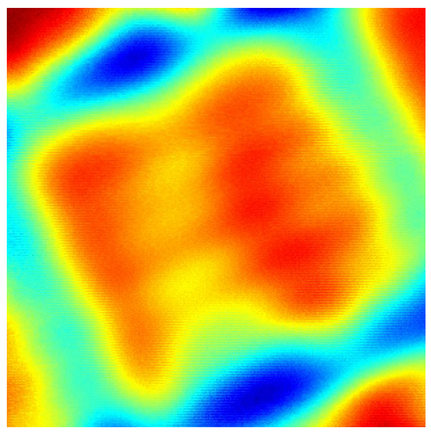
PREVIOUS SPEAKERS
John Rogers › Federico Capasso › Wilfried Haensch
Zhores Alferov › Eugene Fitzgerald › Steve Hillenius
Jeff Hawkins › Albert Overhauser › Herb Kroemer

Michael Shur
Rensselaer Polytechnic Institute

PROFESSOR MICHAEL S. SHUR obtained an MS degree in Electrical Engineering from the St. Petersburg Electrotechnical University in 1965, and a Ph.D. in Physics from the Ioffe Institute of Physics and Technology in 1967. He worked as a Junior Scientist at the Ioffe Institute and subsequently held research or faculty positions at Wayne State University (MI), Cornell University (NY), Oakland University (MI), the University of Minnesota, and the University of Virginia. In 1996 he joined the Rensselaer Polytechnic Institute (Troy, NY) as the Patricia W. and C. Shelden Roberts Professor of Solid State Electronics in the Departments of Electrical, Computer and Systems Engineering and Physics, Applied Physics and Astronomy. He additionally serves as the Director of the Broadband Center since 2006, and previously presided over the Center for Integrated Electronics and the RPI site of 'Connection One'. Shur has founded and co-founded four companies and worked as Jefferson Science Fellow in the US Department of State. He provides consulting and technical expertise to a wide array of multinational corporations and patent law firms, and is an Editorial Board member for several scientific journals. His research has been recognized by a series of awards and prizes, garnered over 50,000 publication citations with h-index of 103, and featured in numerous keynote presentations and invited lectures. Shur is a Fellow of the National Academy of Inventors, the Optical Society of America, MRS, IET, the Electrochemical Society, the World Innovation Foundation, AAAS, and the Electromagnetic Academy; a Life Fellow of IEEE and the American Physical Society; and a Fellow and Life Member of SPIE. He received Honorary Doctorates from the St. Petersburg Electrotechnical University and the University of Vilnius, in 1994 and 2016 respectively.

Counter-Intuitive Physics of Ballistic Transport in State of the Art Electronic Devices

THE ELECTRON MEAN FREE PATH IN SILICON (about 30 nm at room temperature) greatly exceeds the 10–12 nm CMOS feature size used, for example, in the recent generations of iPhones or Android phones. Electrons therefore leave the active device region before they experience scattering. The current-voltage characteristics in this collisionless 'ballistic' transport regime look similar to those of much longer transistors. However, the physics behind this misleading similarity are very different and counter-intuitive, and have important qualitative consequences for the design of advanced transistors and integrated circuits. One new concept is that the so called 'ballistic mobility', being the coefficient of proportionality between the effective drift velocity and applied electric field, is proportional to the device length. This effect, confirmed by numerous experiments, arises because electrons hit contacts more often in short channel devices. At high frequencies, the electron inertia and phase delays of the opposing electron fluxes start playing an important or even dominant role in the channel impedance. Electron density (plasma) waves enable the device response well into the THz operational range, and transform into shock waves at high excitation levels. The rectification and instabilities of the plasma waves enable a new generation of sub-THz and THz plasmonic devices. Application examples of these novel technologies include ultra-wide band wifi, advanced homeland security, VLSI testing, and cancer detection.



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