



Radlab Seminar



Professor Roberto D. Merlin

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4:30 PM – 5:30 PM

Roberto Merlin received the Licenciado en Ciencias Físicas (M.Sc.) degree from the University of Buenos Aires, Argentina, in 1973 and the Dr. rer. nat. (Ph.D.) degree from the University of Stuttgart, Germany, in 1978. After a postdoctoral position at the University of Illinois at Urbana-Champaign, he joined the faculty of the University of Michigan where he is currently the Director of the Optical Physics Interdisciplinary Laboratory.

Merlin's research specialty is experimental condensed matter physics. His areas of expertise include various optical techniques and, in particular, spontaneous and impulsive (stimulated) Raman spectroscopy. His current interests focus on the generation and control of coherent vibrational and electronic fields using ultrafast laser and x-ray pulses, and negative refraction.

Merlin is a Fellow of the American Physical Society, the Optical Society of America, the von Humboldt Foundation and the Guggenheim Memorial Foundation. Other honors include the 2006 Frank Isakson Prize of the American Physical Society and Lannin Lecturer at the Department of Physics, Pennsylvania State University. His service record includes Chair of the APS Forum on International Physics and General Chair of the Quantum Electronics and Laser Science Conference. He is also a member of the Editorial Board of the Springer Series in Solid State Sciences and the journal Solid State Communications.

Negative Refraction, Radiationless Interference and Subwavelength Focusing: The Quest for the Superlens

Ernst Abbe published in 1873 a ground-breaking paper on the limit of resolution of an optical instrument, which was later rederived by Lord Rayleigh using Fourier analysis. The famous expression $d = \lambda/nsin\alpha$ relates d , the smallest separation that can be resolved, to the light wavelength λ , the refractive index n and the angle of the cone of light that can enter the objective, 2α . The first part of the talk will take us from the late 1800's to the turn of the 20th century, when the field of near-field (or subwavelength) optics experienced a tremendous growth, emphasizing recent developments motivated by the work of John Pendry on negative-index superlenses. We will also discuss how Abbe's result is related to Heisenberg's uncertainty principle and how the diffraction limit can be bypassed without violating any physical law.

In the second part of the talk, we will introduce the concept of near-field plates. These are grating-like planar structures which rely on a hitherto unrecognized property of Maxwell's equations to provide focusing well beyond the diffraction limit, at arbitrary frequencies. The subwavelength electromagnetic-field distributions closely resemble those of slabs of negative-index material. The structures' design is related to that of the Fresnel plates in that diffraction forces the input field to converge to a spot on the focal plane. Unlike the conventional zone plates, for which focusing results from interference of traveling waves, the subwavelength plates control the near field and, as such, their superlensing properties originate from a static form of interference. Practical implementations of these plates hold promise for near-field data storage, non-contact sensing, imaging and nanolithography applications. Experimental results on a microwave near-field plate will be presented, which demonstrate focusing of 1 GHz radiation at a resolution of $\lambda/20$.