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***Attosecond Science and the Laser Control of
Electrons in Molecules***

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Advances in modern laser technology allow for the generation of ultrashort (few cycles) intense ($>10^{14}$ W/cm²) laser pulses. Interaction for such intense pulses with molecules leads to MHOHG, Molecular High Order Harmonic Generation, [1], MATI, Molecular Above Threshold Ionization, [2], through the highly nonlinear nonperturbative response of electrons. The resulting harmonics are in fact the only current source of coherent attosecond (asec) pulses [3]. Since the electron orbit period in the hydrogen atom is 152 asec, such pulses are the preferred future tools for imaging, visualizing and controlling electron motion in molecules [4]. Numerical solutions of multidimensional molecular Time-Dependent Schroedinger equations, TDSEs, coupled to the photon Maxwell equation on multiprocessor parallel supercomputers are the essential mathematical tools for modeling and simulating the generation of asec pulses [5]. These asec pulses are then used through molecular TDSE simulations to create Molecular Electron-Wavepackets, MEWPs. The generation of MEWPs, the study of their intrinsic properties and their manipulation are therefore the source of a new science - Attosecond Science, i.e., the ultimate control of electrons in matter.

[1]. A.D. Bandrauk, S. Barmaki, G.K. Lagmago, chapt. 5 in "Ultrafast Intense Laser Science", edit K. Yamanouchi et al, vol III, (Springer, Berlin, Tokyo, 2008). [2]. A.D. Bandrauk, S. Chelkowski, I. Kawata, Phys. Rev. A 67, 013407 (2003). [3]. A.D. Bandrauk, F. Krausz, A. Starace, New J Phys. 10, 025004 (2008). [4]. S. Chelkowski, G.L. Yudin, A.D. Bandrauk, J Phys. B 39, S409 (2006). [5]. E. Lorin, S. Chelkowski, A.D. Bandrauk, New J Phys. 10, 025033 (2008).



André D. Bandrauk, Ph.D., FRSC, FAAAS, born in Berlin, B.Sc. (Hon. Chem.) from l'Université de Montréal, M.Sc. in theoretical chemistry from M.I.T. and Ph.D. in Chemical Physics from McMaster University (Hamilton, Canada), NATO Fellow at Oxford University's Mathematical Institute (1968-70), assistant at the Technische Hochschule Munchen (1970) before being appointed as an assistant professor of theoretical chemistry at l'Université de Sherbrooke. In 1982, he was awarded a Killam Research Fellowship by the Canada Council, and was elected as a Fellow to the Royal Society of Canada in 1992. In 1989, he received the **Herzberg** prize from the Canadian Spectroscopy Society for his theoretical work on molecules in intense laser fields, and was awarded the prestigious **John Polanyi** (Nobel Prize 1986) Award by the Chemical Society of Canada in 2001. He is currently a **CANADA RESEARCH CHAIR** in Computational Chemistry & Molecular Photonics and a new **Fellow of the American Association for the Advancement of Science, AAAS** (2003). He became Chair of the Department of Chemistry in 2005 and in **2007 received an award from the Humboldt Foundation (Berlin, Germany)**. He was awarded the NSERC – **J. C. Polanyi Prize for Attosecond Science** (with P. B. Corkum, NRC) in 2008 (NSERC'S highest scientific prize).