

## Ivan P. Christov

### List of publications

#### Journal articles

1. I.P.Christov, I.V.Tomov, S.M.Saltiel, "Self-heating Effects in Electro-optic Light Modulators", *Optical and Quantum Electron.*, 15, (1983), pp. 289-295
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5. I.P.Christov, I.V.Tomov, "Growth of Raman-Stokes Waves in Focused Pump Beams", *Optical and Quantum Electron.*, 17, (1985), pp. 207-213
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7. I.P.Christov, "Propagation of Partially Coherent Light Pulses", *Optica Acta*, 33, (1986), pp. 63-72
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15. M.B.Danailov, I.P.Christov and N.Michailov, "Image Transfer by Modulation of Short Light Pulses", *Appl.Phys.B*, 49, (1989), pp. 371-375
16. M.B.Danailov and I.P.Christov, "A Novel Method of Ultrabroadband Laser Generation", *Optics Commun.*, 73, (1989), pp. 235-238
17. I.P.Christov, "On the Production of Time-orthogonal Pulse Shapes", *Opt.Comm.*, 77, (1990), pp. 253-255
18. I.P.Christov, "Theory of Time Telescope", *Optical and Quantum Electron.*, 22, (1990), pp. 473-480
19. M.B.Danailov and I.P.Christov, "Ultrabroadband Laser Using Prism-based Spatially Dispersive Resonator", *Appl. Phys. B* 51, (1990), pp. 300-302
20. M.B.Danailov and I.P.Christov, "Spectrum-preserving Amplification of Ultrabroadband Optical Pulses", *J.Mod.Opt.*, 38, (1991), pp. 413-416
21. M.B.Danailov and I.P.Christov, "Amplification of Spatially-dispersed Ultrabroadband Laser Pulses", *Opt.Comm.*, 77, (1990), pp. 397-401
22. N.I.Michailov, I.P.Christov and I.V.Tomov, "Two-wavelength Operation of a Femtosecond Dye Laser", *Appl.Phys. B*, 51, (1990), pp. 171-176
23. N.I.Michailov, T.Deligeorgiev, I.P.Christov and I.V.Tomov, "Performance of a Rhodamine 6G Dye Laser Passively Mode-Locked by a New Styryl Dye", *Optical and Quantum Electron*, 22, (1990), pp. 293-296
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37. I.P.Christov, V.D.Stoev, M.Murnane and H.Kapteyn, "Sub-10fs operation of Kerr-lens mode-locked laser", Opt.Lett., 21,(1996), pp. 1493-1495
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39. I.P.Christov, M.Murnane and H.Kapteyn, "High-harmonic generation of attosecond pulses in the single-cycle regime", Phys.Rev.Lett., 78,(1997), pp. 1251-1263
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46. I.P.Christov, M.Murnane and H.Kapteyn, "Generation and propagation of attosecond x-ray pulses in gaseous medium", Phys.Rev. A 57, (1998), pp. R2285-R2288.
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56. I. P. Christov, H. Kapteyn, and M. Murnane “Quasi-phase matching of high-harmonic and attosecond pulses in modulated waveguides”, *Opt. Express* 7, 362-367 (2000)
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81. I. P. Christov, "Dynamic correlations with time-dependent quantum Monte Carlo", *J. Chem. Phys.* 128, 244106 (2008)
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91. I. P. Christov, "Time dependent spatial entanglement in atom-field interaction", Phys. Scr. 94, 045401 (2019).
92. I. P. Christov, "Phase-locking mechanism in non-sequential double ionization", Appl. Phys. B 125, 1 (2019).
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96. I. P. Christov, "Local Entanglement of Electrons in 1D Hydrogen Molecule", Entropy 25, 1308 (2023).

### **Book chapters**

1. I. P. Christov, "Generation and Propagation of Ultrashort Optical Pulses", in Progress in Optics, ed. by Emil Wolf, vol. XXIX, (1991), pp. 201-284
2. E. A. Gibson, I. P. Christov, M. M. Murnane, and H. C. Kapteyn, "Quantum control of high harmonic generation: Applied attosecond science," in Femtosecond Optical Frequency Comb: Principle, Operation, and Applications, J. Ye, Ed.: Kluwer Publishing Company, 2005, pp 314-332.
3. P. Salieres and I. Christov, "Macroscopic Effects in High-Order Harmonic Generation", in Strong Field Laser Physics, Springer Series in Optical Sciences , Vol. 134, ed. T. Brabec, 2009, pp.261-280.

### **Research overviews**



1. R. Bartels, S. Backus, G. Vdovin, I. P. Christov, M. M. Murnane, and H. C. Kapteyn, "Subopticalcycle coherent control in nonlinear optics," *Optics and Photonics News* 11, 23 (2000).
2. H. Kapteyn, M. Murnane, I.P. Christov, "Extreme nonlinear optics: Coherent x-rays from lasers", *Physics Today*, 39, March (2005)
3. N. L. Wagner, A. Wuest, I. P. Christov, T. Popmintchev, X. Zhou, M. M. Murnane, H. C. Kapteyn, "High-order X-ray Raman scattering using coherent electrons from high harmonic generation", *Optics and Photonics News* 17, 43 (2006).

### **Published conference proceedings**

1. J. Zhou, G. Taft, C. P. Huang, M. M. Murnane, H. C. Kapteyn, and I. Christov, "Sub-10 fs pulse generation from Ti:sapphire laser: Capabilities and ultimate limits," *Ultrafast Phenomena IX* (Springer-Verlag, 1994) pp. 39-40.
2. A. Rundquist, G. Taft, M. M. Murnane, H. C. Kapteyn, K. DeLong, R. Trebino, and I. Christov, "Measurements of ultrafast optical waveforms using FROG," *Proceedings of the SPIE*, Vol. 2377 (SPIE, Bellingham, WA, 1995) p. 201-206.
3. M. M. Murnane, H. C. Kapteyn, I. Christov, G. Taft, J. Zhou, A. Rundquist, and C. P. Huang, "Recent advances in femtosecond laser technology: Capabilities and limits," *Proceedings of the SPIE*, Vol. 2524 (SPIE, Bellingham, WA, 1995) p. 2-10.
4. J. Peatross, J. Zhou, A. Rundquist, M. M. Murnane, H. C. Kapteyn, and I. P. Christov, "High-order harmonic generation with a 25 femtosecond laser pulse," *Proceedings for International Conference on Super-Intense Laser Atomic Physics, SILAP 95* (1996).
5. J. Zhou, A. Rundquist, Z. Chang, J. Peatross, I. P. Christov, M. M. Murnane, and H. C. Kapteyn, "Enhanced high-harmonic generation with ultrashort 25 fs pulses," *Ultrafast Phenomena X* (Springer-Verlag, 1996), p. 120.
6. A. Rundquist, Z. Chang, H. Wang, I. Christov, H. C. Kapteyn, and M. M. Murnane, "Coherent x-ray generation at 2.7 nm using 25 fs laser pulses," *First International Conference on Superstrong Fields in Plasmas, Varenna, Italy, AIP Proceedings*, Vol. 426, (1998) p. 296.
7. H. C. Kapteyn, M. M. Murnane, and I. P. Christov, "Extreme nonlinear optics: Phase-matching of ultraviolet and soft x-ray generation," *Proc. of the 6th International Conference on X-Ray Lasers*, Y. Kato, H. Takuma, and H. Daido Eds., *Institute of Physics Conference Series*, Vol. 159 (IOP Publishing, Bristol, UK, 1999), p. 17.

8. Randy Bartels, Sterling Backus, Ivan Christov, Lino Misoguti, Gleb Vdovin, Erik Zeek, Margaret M. Murnane, and Henry C. Kapteyn, "Coherent control of XUV radiation," in *Ultrafast Phenomena XII* (T. Elsaesser, S. Mukamel, M. M. Murnane and N.F. Scherer, Eds., Springer Series in Chemical Physics, 2001), pp. 42-44.
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10. R. A. Bartels, S. Backus, C. Lei, A. Paul, I. P. Christov, M. M. Murnane, and H. C. Kepteyn, "Small-scale coherent EUV light sources from high-harmonic generation," in *X-Ray Lasers 2002: 8th International Conference on X-Ray Lasers* (J. J. Rocca , Ed., AIP Conf. Proceedings Vol. 641, (2002), pp. 401-405.
11. E. A. Gibson, A. Paul, N. L. Wagner, R. Tobey, E. Gagnon, D. Gaudiosi, M. M. Murnane, H. C. Kapteyn, and I. P. Christov, "Quasi-phase-matching of high harmonic EUV generation at very high ionization levels," in *Ultrafast Optics IV* (F. Krausz, G. Korn, P. Corkum, and I.A. Walmsley, Eds., Springer Series in Optical Sciences, 2003), p. 217-221.
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17. I. P. Christov, "Time-Dependent Quantum Monte Carlo-Principles and Perspectives", in "Light at extreme intensities", ed. by D. Dumitras, AIP Conference Proceedings 1228, p. 379, (2010)
18. I. P. Christov, "Principles of Time Dependent Quantum Monte Carlo", in "Quantum trajectories", K. Hughes and G. Parlant (eds.), p. 49 (2010)

### **Presentations and talks**

1. **Invited**, I. P. Christov, "Novel phase-matching techniques for high-harmonic generation," Gordon Conference on Nonlinear Optics and Lasers, New London, NH, July 2001.
2. **Postdeadline**, E. Gibson, A. Paul, D. Gaudiosi, E. Gagnon, M. Murnane, H. Kapteyn, I. Christov, "Generation of coherent "water window" soft x-rays using quasi-phasesmatching," CLEO/QELS Conference, Baltimore, MD, June 2003.
3. **Colloquium**, H. C. Kapteyn, E. Gibson, A. Paul, R. Tobey, N. Wagner, T. Lei, I. Christov, J. Gland, T. Feurer, K. Nelson, and M. Murnane, "Compact coherent EUV sources and applications," National Institutes of Health, Bethesda, MD, May 2004.
4. **Invited**, H. C. Kapteyn, E. Gibson, A. Paul, T. Lei, X. Zhang, A. Libertun, D. Raymondson, M. M. Murnane, I. Christov, D. Attwood, and Y. Liu, "High-harmonic generation: Technology and applications," 26th International Congress on High-Speed Photography and Photonics 2004, Arlington, VA, September 2004.
5. **Contributed**, A. Paul, E. Gibson, S. Backus, R. Tobey, M. M. Murnane, H. C. Kapteyn, and I. Christov, "Quasi-phase matching of high harmonic generation in the water window at 100% ionization levels," OSA Topical Conference on Nonlinear Optics: Materials, Fundamentals and Applications, Waikoloa, HI, August 2004.
6. **Poster**, N. Wagner, I. Christov, M. Murnane, H. Kapteyn, and E. Gibson, "Self-compression of high power laser pulses in an atomic gas," American Physical Society Division of Atomic, Molecular, and Optical Physics Annual Meeting (DAMOP), Boulder, CO, May 2004.

**7. Poster**, R. A. Bartels, I. P. Christov, M. M. Murnane, and H. C. Kapteyn, “Statistical study of attosecond dynamics from learning control of extreme nonlinear optics,” Conference on Lasers and Electro-optics / Quantum Electronics and Laser Science Conference (CLEO/QELS), San Francisco, CA, May 2004.

**8. Contributed talk**, E. A. Gibson, A. Paul, R. Tobey, N. Wagner, M. Murnane, H. Kapteyn, and I. P. Christov, “High-order harmonic generation from argon ions up to 250 eV,” Conference on Lasers and Electro-optics / Quantum Electronics and Laser Science Conference (CLEO/QELS), San Francisco, CA, May 2004.

**9. Invited talk**, H. C. Kapteyn, R. A. Bartels, S. J. Backus, M. M. Murnane, I. P. Christov, and H. Rabitz, “Ultrafast pulse shaping for control and automated learning in quantum systems,” ATTO-network symposium: “Attosecond generation, metrology and applications,” Ringberg Castle, Bavaria, Germany, April 2004.

**10. Invited talk**, Emily Gibson, Ariel Paul, Isabell Thomann, Amy Lytle, Etienne Gagnon, Xiaoshi Zhang, Ariel Libertun, Daisy Raymondson, Margaret Murnane, Henry C. Kapteyn, Ivan Christov, David Attwood, and Yanwei Liu, “EUV “Photonics” of high-harmonic generation and applications,” X-ray Driver for FELs Meeting, Berkeley CA, April 2005. Presented by H. Kapteyn.

**11. Contributed talk**, Xiaoshi Zhang, Amy Lytle, Tenio Popminchev, Ariel Paul, Nick Wagner, Oren Cohen, Ivan Christov, Margaret Murnane, and Henry Kapteyn, “Phase matching, quasi phase matching and pulse compression in a single waveguide for enhanced high harmonic generation,” Talk JTuD6, OSA Conference on Lasers and Electro-optics/ Quantum Electronics and Laser Science (CLEO/QELS), Baltimore, MD, May 2005. Presented by X. Zhang.

**12. Invited talk**, Emily Gibson, Xiaoshi Zhang, Ariel Paul, Amy Lytle, Arvinder Sandhu, Isabell Thomann, Etienne Gagnon, Henry Kapteyn, Margaret Murnane, and Ivan Christov, “Extreme nonlinear optics for coherent X-ray generation: applied attosecond science,” Gordon Research Conference on Atomic Physics, Tilton, New Hampshire, June 2005. Presented by Margaret Murnane.

**13. Invited talk**, Ron Tobey, Mark Siemens, Luis Avrila, Guido, Emily Gibson, Xiaoshi Zhang, Ariel Paul, Amy Lytle, Arvinder Sandhu, Isabell Thomann, Etienne Gagnon, Ivan Christov, Keith Nelson, Martin Aeschliman, John Gland, David Attwood, Henry Kapteyn, and Margaret Murnane, “Extreme nonlinear optics for coherent X-ray generation: applied attosecond science,” Femtochemistry VII, Washington DC, July 2005. Presented by M. Murnane.

**14. Invited Talk**, Etienne Gagnon, Isabelle Thomann, Nick Wagner, Amy Lytle, Dr. Arvinder Sandhu, Dr. Andrea Wüest, Prof. Margaret M. Murnane, Prof. Henry C. Kapteyn, Prof. Ivan Christov, Mark Baertschy, Chris Greene, Jun Ye, Jason Jones, and Tamar Seidemann, “Two topics relevant to QC,” 2005 Gordon Conference on Quantum

Control Of Light And Matter, Waterville, Maine, August 2005. Presented by Henry Kapteyn.

**15. Invited talk**, Ivan Christov, Jorge Rocca, Barry Walker, Keith Nelson, John Gland, Chris Greene, Tamar Sideman, Henry Kapteyn, and Margaret Murnane, “Extreme nonlinear optics for coherent Xray generation,” Workshop on Opportunities for an ultrafast laser-based x-ray light source facility, Gatlinberg TN, October 2005. Presented by Margaret Murnane.

**16. Seminar**, Nick Wagner, Dr. Andrea Wüest, Amy Lytle, Dr. Arvinder Sandhu, Etienne Gagnon, Isabelle Thomann, Prof. Margaret M. Murnane, Prof. Henry C. Kapteyn, Ivan Christov (Sofia), Mark Baertschy, Chris Greene, and Tamar Seidemann (NW), “HHG in molecular systems,” Seminar for JILA NSF Group Grant, October 2005. Presented by H. Kapteyn.

**17. Invited Presentation**, Prof. Henry C. Kapteyn, David Gaudiosi , Emily Gibson, Mike Grisham, Amy Lytle, Ariel Paul, Tenio Popmintchev, Brandon Reagan, Nick Wagner, Xiaoshi Zhang, Randy Bartels, Sterling Backus, Tom Weinacht, Andrea Wuest, Prof. Margaret M. Murnane, Prof. Ivan Christov, Prof. Jorge Rocca, and Prof. Barry Walker, “Coherent x-rays from lasers: applied attosecond science,” Army Research Office Attosecond Optics Workshop, Durham, NC, November 2005. Presented by H. Kapteyn.

**18. Research Update Presentation**, Xiaoshi Zhang, Amy Lytle, Ariel Paul, Oren Cohen, Ivan Christov, Margaret Murnane, Henry Kapteyn, and Barry Walker, “Extreme nonlinear optics for coherent EUV generation,” NSF Engineering Research Center for Extreme Ultraviolet Science and Technology Annual Retreat, Winter Park, CO, January 2006. Presented by H. Kapteyn.

**19. Physics Colloquium**, Emily Gibson, Randy Bartels, Nick Wagner, Dr. Andrea Wüest, Margaret Murnane and Henry Kapteyn, Ivan Christov (Sofia), Chris Greene (JILA), and Tamar Seidemann (NW), “Extreme nonlinear optics for coherent X-ray generation,” University of California at Santa Barbara, February 2006. Presented by M. Murnane.

**20. Physics Colloquium**, Emily Gibson, Randy Bartels, Nick Wagner, Dr. Andrea Wüest, Margaret Murnane, Henry Kapteyn, Ivan Christov, Chris Greene, and Tamar Seidemann, “Coherent x-rays from lasers,” College of Charleston, Charleston SC, February 2006. Presented by H. Kapteyn.

**21. Invited Presentation**, Xiaoshi Zhang, Amy Lytle, Ariel Paul, Oren Cohen, Jorge Rocca, Barry Walker, Carmen Menoni, David Attwood, Eric Anderson, Ivan Christov, Margaret Murnane, and Henry Kapteyn, “Extreme nonlinear optics for coherent EUV generation,” ESF network meeting on: Future Advanced Light Sources (FALS), Daresbury Laboratory, Warrington, Cheshire, United Kingdom, March 2006. Presented by M. Murnane.

**22. Invited Presentation,** Xiaoshi Zhang, Amy Lytle, Ariel Paul, Oren Cohen, Jorge Rocca, Barry Walker, Carmen Menoni, David Attwood, Eric Anderson, Ivan Christov, Margaret Murnane, and Henry Kapteyn, “Extreme nonlinear optics for coherent EUV generation,” ESF network meeting on: Future Advanced Light Sources (FALS), Daresbury Laboratory, Warrington, Cheshire, United Kingdom, March 2006. Presented by M. Murnane.

**23. Research Update Presentation,** Henry Kapteyn, Elliot Bernstein, Steve Leone, Dan Dessau, John Gland, Chris Greene, Tamar Seideman, Martin Aeschlimann, Ronggui Yang, Keith Nelson, Ivan Christov, Barry Walker, Tom Silva, and Rich Mirin, “Novel linear and nonlinear spectroscopies using small-scale EUV light sources,” NSF Engineering Research Center for Extreme Ultraviolet Science and Technology Annual Site Visit, May 2006. Presented by H. Kapteyn.

**24. Contributed presentation,** Arvinder Sandhu, Etienne Gagnon, Ariel Paul, Isabell Thomann, Amy Lytle, Margaret Murnane, Henry Kapteyn, and Ivan Christov, “Sub-femtosecond XUV pulses via energy selective non-linear stabilization in a waveguide,” OSA Conference on Lasers and Electrooptics/Quantum Electronics and Laser Science (CLEO/QELS), Long Beach, CA, May 2006. Paper JTUE4. Presented by Arvinder Sandhu.

**25. Short Course,** Henry Kapteyn, Margaret Murnane, and Ivan Christov, “Extreme nonlinear optics of coherent X-ray generation,” Optical Society of America IFSC Student Chapter School in Optics and Photonics, Physics Institute of São Carlos, University of São Paulo, São Carlos, Brazil, June 2006. Presented by M. Murnane.

**26. Invited Presentation,** N. Wagner, A. Wüest, R. Tobey, M. Siemens, I. Christov, T. Popmintchev, X. Zhou, M.M. Murnane, and H.C. Kapteyn, “Ultrafast coherent X-ray spectroscopies of molecules and materials,” 15th International Laser Physics Workshop, Lausanne, Switzerland, July 2006. Presented by M. Murnane.

**27. Poster Presentation,** Arvinder Sandhu, Etienne Gagnon, Ariel Paul, Isabell Thomann, Amy Lytle, Tracey Keep, Margaret Murnane, Henry Kapteyn, and Ivan Christov, “Isolated EUV pulses via CEP-insensitive nonlinear stabilization in a waveguide,” 15th International Conference on Ultrafast Phenomena, Pacific Grove, CA, July 2006. Paper TuG16. Presented by A. Sandhu.

**28. Invited Presentation,** X. Zhang, A. Lytle, O. Cohen, I.P. Christov, M.M. Murnane, and H.C. Kapteyn, “Attosecond technology: quantum control of high harmonic generation for phase matching,” Kavli Institute of Theoretical Physics Attosecond Science Workshop, Santa Barbara, CA, September 2006. Presented by H. Kapteyn.

**29. Invited Presentation,** Margaret Murnane, Henry C. Kapteyn, Nicholas L. Wagner, Andrea Wuest, and Ivan P. Christov, “Observation of intra-molecular vibrational dynamics using high-harmonic generation as a probe,” Frontiers in Optics/ Optical

Society of America Annual Meeting, Rochester, NY, October 2006. Presented by M. Murnane.

**30. Invited talk,** Tenio Popmintchev, Ming-Chang Chen, Alon Bahabad, Michael Gerrity, Ivan P. Christov, Margaret M. Murnane, and Henry C. Kapteyn, “Phase matching of high harmonic generation in the soft and hard X-ray regions of the spectrum,” Ultrafast Nonlinear Optics Conference (UFNO), Burgas, Bulgaria, September 2009. Presented by Tenio Popmintchev.

**31. Seminar,** Tenio Popmintchev, Ming-Chang Chen, Alon Bahabad, Ivan P. Christov, Margaret M. Murnane, Henry C. Kapteyn, “Tunable coherent ultrafast light in the soft and hard X-ray regions of the spectrum,” Photonics Institute, Vienna University of Technology, Vienna, Austria, September 2009. Presented by Tenio Popmintchev.

**32. Contributed talk,** T. Popmintchev, M.-C. Chen, A. Bahabad, M. Gerrity, P. Arpin, P. Sidorenko, O. Cohen, M. Seaberg, R. Sandberg, S. Backus, X. Zhang, G. Taft, I. P. Christov, M. M. Murnane, and H. C. Kapteyn, “Phase Matching of High Harmonic Generation in the Soft and Hard X-ray Regions of the Spectrum,” OSA Conference on Nonlinear Optics, Honolulu, HI, July 2009. Paper NThC3 in *Nonlinear Optics: Materials, Fundamentals and Applications*, OSA Technical Digest (CD) (Optical Society of America, 2009). Presented by Tenio Popmintchev.

**33. Contributed talk,** Tenio Popmintchev, Ming-Chang Chen, Alon Bahabad, Michael Gerrity, Paul Arpin, Pavel Sidorenko, Oren Cohen, Matthew Seaberg, Richard Sandberg, Sterling Backus, Xiaoshi Zhang, Greg Taft, Ivan P. Christov, Margaret M. Murnane, Henry C. Kapteyn, “Phase Matching of High Harmonic Generation in the Water Window and Beyond at High Pressures Using Mid-IR Lasers,” OSA Conference on Lasers and Electro-optics/ International Quantum Electronics Conference CLEO/IQEC), Baltimore, MD, June 2009. Paper JThG1. Presented by Tenio Popmintchev.

**34. Poster presentation,** Tenio Popmintchev, Ming-Chang Chen, Alon Bahabad, Michael Gerrity, Bosheng Zhang, Ivan P. Christov, Henry C. Kapteyn, and Margaret M. Murnane, “Phase matching of extreme high-order harmonic generation in the soft and hard X-ray regions of the spectrum,” Annual Site Visit of the NSF Engineering Research Center in EUV Science and Technology, Ft Collins, CO, May 2009. Presented by Tenio Popmintchev.

**35. Invited talk,** I P. Christov, “Time dependent quantum Monte Carlo: Principles and perspectives”, Control of Quantum Dynamics of Atoms, Molecules and Ensembles by Light Workshop, Nesebar, Bulgaria, 23-28 June, 2009.

**36. Invited talk,** I P. Christov, “Correlated electron dynamics with time dependent quantum Monte Carlo”, Control of Quantum Dynamics of Atoms, Molecules and Ensembles by Light Workshop, Nesebar, Bulgaria, 3-9 July, 2011.

**37. Poster Presentation**, N. Dimitrov, I. Stefanov, A. Dreischuh, I. Christov, "Generation of coherent laser radiation in the vacuum ultraviolet", Second National Congress in Physical Sciences, Sofia, 27 Sept-1 Oct, 2013.