

Final Technical Report

Sponsoring Agency: Department of Energy

Award no.: DE-SC0019730

Project Title: Student Support for the “Frontiers in Attosecond & Ultrafast X-ray Science”
School

Institution: The Ohio State University

Principal Investigator: Louis F. DiMauro

Project Period: 03/01/2019 through 07/31/2023

Final Report DOE Award DE-SC0019730: Student Support for the “Frontiers in Attosecond & Ultrafast X-ray Science” School

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1.1 Introduction

The new millennium witnessed two revolutionary breakthroughs in ultrafast x-ray science: table-top XUV sources based on high harmonic generation in gases ushered in the attosecond era while facility-based x-ray free-electron lasers opened the path for intense, femtosecond hard x-rays. This award requested scholarship funds for a 2019 and 2023 School whose prime objective was the training of young scientists in these emerging complementary areas both relevant to DOE BES mission. The school entitled the “Frontiers of Attosecond and Ultrafast X-ray Science (FAXS)” (<http://www.erice-attosecond.it/>) was the second and fourth in a series, which began in 2017. The two Schools were held during March 10-16, 2019 and March 26-31, 2023 at the Ettore Majorana Foundation and Centre for Scientific Culture (<http://www.ccsem.infn.it/>) in Erice, Sicily. The DOE funds supported the registration fee for young scientists (graduate students and postdocs) from US institutions. The registration fees included School participation, lodging and meals over the duration of the School. Note, the third addition of the School was held in 2022 as a virtual event due to the pandemic, DOE funds were not necessary for this event. The FAXS School is a course of the 62th and 63rd International School of Quantum Electronics under the directorship of Prof. Diederik Wiersma (University of Florence). The Directors for the FAXS School are Louis DiMauro (The Ohio State University, USA) and Mauro Nisoli (Politecnico di Milano, Italy).

The FAXS School program consisted of approximately 10 lectures by leading experts in attosecond and x-ray science (see attached list). Most lecturers delivered a series of three 1-hour lectures. The lecturers were required to spend the full 5 days at the school so to promote interaction with the students. The Erice Majorana Center venue accommodated ~75 young scientists. The registration fee covered the cost of participating in the school, lodging and meals for the entire duration of the school. The schedule consisted of lectures every morning and afternoon except for one afternoon that was reserved for an archaeological excursion. Every evening had a student/postdoc poster session and social gatherings at the Majorana Center to encourage further interaction of all participants and lecturers.

The two FAXS Schools attracted an international group of young scientists. The DOE funds supported the registration fee for 11 students/postdocs from US institutions (5 supported in 2019 and 6 supported in 2023). The management of the DOE fellowships were administered through the Research Foundation of The Ohio State University. FAXS scholarships for European students/postdocs were provided by European funding sources administered by co-Director, Prof. Nisoli. All students/postdocs were encouraged to present a poster. Travel expenses to the FAXS School were the responsibility of the student/postdoc home institution.

Young Researcher Selection Process: The Co-Directors adopted a student evaluation process similar to that used for the Inaugural FAXS School in 2017. Each student applied through the FAXS School registration webpage, <http://www.erice-attosecond.it/registration/>. Each application was screened based on the submitted statement of research, publication list and a letter of support from their advisor/supervisor. The FAXS co-Directors evaluated each application and awards were chosen based on scientific relevance, qualifications and diversity. Students/postdocs were notified of their selection by the co-Directors two months prior to the school. The registration fees were handled as reimbursements. The DOE funds only supported young scientist from US institutions (universities or national laboratories).

2. FAXS School lecturers and topics

2019 Lecturers and topics

Lecturer	Topic
Anne L'Huillier (Lund University, Sweden)	Atomic physics with attosecond pulses (theory and experiments)
Louis DiMauro (Ohio State University, USA)	Strong-field atomic physics
Olga Smirnova (Max Born Institut – Berlin, Germany)	Strong-field physics
Mauro Nisoli (Politecnico di Milano, Italy)	Fundamentals of high-order harmonic generation and attosecond metrology. Molecular physics with attosecond pulses (experiments)
Fernando Martín (Universidad Autonoma de Madrid, Spain)	Molecular physics with attosecond pulses (theory)
Robert Baker (Ohio State University, USA)	Transient absorption/reflectivity attosecond spectroscopy
David Reis (Stanford University, USA)	High-order harmonic generation in solids / NL x-ray physics
Yann Mairesse (CELIA, Bordeaux, France)	High-order harmonic spectroscopy; In-situ attosecond techniques
Dimitris Charalambidis (FORTH-IESL, Greece)	Nonlinear optics in the XUV
Luca Poletto (IFN-CNR Padova, Italy)	XUV optics for attosecond technology
Philip Bucksbaum (Stanford University, USA)	Free Electron Lasers and attosecond pulses
Pascal Salieres (CEA-Saclay, France)	Attosecond metrology: RABBITT, Rainbow RABBITT, attosecond streaking, molecular tomography

2023 Lecturers and topics

Lecturer	Topic
Lukas Gallmann (ETH –Zurich, Switzerland)	Laser Technology for Attosecond Science
Mikhail Ivanov (Max Born Institute Berlin, Germany)	Fundamentals of strong field physics

Anne L'Huillier (Lund University, Sweden)	Attosecond atomic physics
Matteo Lucchini (Politecnico di Milano, Italy)	Attosecond solid state physics
Agostino Marinelli (SLAC National Accelerator Laboratory, USA)	XFELs General theory. Attosecond FELs and applications
Fernando Martín (Universidad Autonoma de Madrid, Spain)	Attosecond molecular physics – Theory
Luca Poletto (IFN-CNR, Italy)	X-ray optics
Pascal Salieres (CEA-Saclay, France)	Attosecond metrology
Marc Vrakking (Max Born Institute Berlin, Germany)	Attosecond molecular physics – Experiments

3. Students and their institutions supported by DOE funds

2019 FAXS school

Name	Institution
Dan Tuthill	Ohio State
Jay Rutledge	Stony Brook
Andrew Piper	Ohio State
Erice Moore	Ohio State
Anna Wang	Stanford

2023 FAX school

Name	Institution
Dina Eissa	Ohio State
Harshad Gajapathy	Ohio State
Emily Hruska	Ohio State
Brian Kaufman	Stony Brook University
Ananya Patnaik	Ohio State
Andrew Short	University of Central Florida

