EURYI Awards 2004

Press Information

Dr. Andrea CAVALLERI

– Physics –

Project:

Femtosecond time resolves x-ray studies of critical phenomena in strongly correlated materials

Phase transformation or chemical reactions occur on the timescale of molecular oscillations (10-13) seconds or 100 femtoseconds). The atomic motions that determine such critical phenomena are comparable atomic distances, i.e. below 1 nm or 100,000 times smaller than those accessible with a visible microscope.

By observing the intensity and directions into which x-rays are reflected, one can indeed measure the structure in non-moving matter with atomic resolution, from simple crystals to complex proteins. Symmetrically, the ultrafast timescale of atomic motion can be accessed by taking snapshots with extremely short laser pulses (a billion times faster than the exposure times of a common photographic camera). Yet such ultrafast studies can only be performed with visible light, without the atomic resolution of x-rays.

My experiments are focused at merging the spatial resolution of x-rays with the speed of ultrafast lasers, to investigate phase changes in solids. Following this strategy, I hope to shed new light on the role played by atomic motion in determining the electronic and magnetic properties of some metallic oxides. Some of the phenomena of interest are the "Colossal Magneto-resistance" and "High-temperature superconductivity", processes where the resistance is observed to drastically change or to vanish altogether when a magnetic field is applied or the solid is cooled. This is not only the frontier of our understanding of materials, but also promises revolutionary applications in electronics, optoelectronics and spintronics.

This work will be conducted at the University of Oxford and at Rutherford Appleton Laboratory, a European large-scale facility where ultra-high intensity lasers can be used to generate the necessary short x-ray pulses. X-rays will also be derived from large electron accelerators, or synchrotrons, such as the European Synchrotron Radiation Facility in Grenoble, the Advanced Light Source in Berkeley, or the Diamond synchrotron, under construction at Rutherford Laboratory.

Comments:

The applicant wants to investigate the particular nuclear and electronic dynamics that may be associated with phase changes in solids, exploiting ultra-fast x-ray synchrotron-laser technology.

This is an outstanding young scientist with several top-quality publications (Nature paper last year). His migration from his native country (Italy) via U.S. and back to Europe (England) – will bring back important talent to the physics and chemistry community of Europe.

The proposed fundamental studies for understanding high-temperature superconductivity and giant magneto-resistance could become groundbreaking. The quality of the proposal is excellent, there is even the possibility that the work would lead to revolutionary applications in electronics and opto-electronics.

The Clarendon laboratory is an excellent host institution with nearly optimal equipment to do highly sophisticated experiments.

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Current institution: University of California, Berkeley
New institution: University of Oxford