UNIMORE Dipartimento di Scienze Fisiche, Informatiche e Matematiche
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

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## FIM-S3 SEMINAR

# Ultrafast coherent manipulation of a free-electron wave function *via* electron-light quantum interaction

## Wednesday May 26th, 2021 – 15.30

Online streaming using Google Meet
Link: https://meet.google.com/yud-upbp-mno

## Speaker

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### Abstract

The interaction between light and electrons can be exploited for generating radiation, such as in synchrotrons and FEL, or for controlling electron beams for dynamical investigation of materials. Using electromagnetic fields, the coherent control of an electron wave function can be pushed to unexplored timescales, enabling new applications in light-assisted quantum devices and diagnostics at extremely small timescales.

In this contribution, I will describe an innovative method for coherent longitudinal and transverse phase manipulation of a free-electron wave function. Using appropriately synthesized light fields I will demonstrate how to modulate the energy, linear momentum and orbital angular momentum (vorticity) of the electron wave function with sub-fs precision [1-3]. The experiments have been performed in an ultrafast-TEM, where a relativistic pulsed electron beam was made to interact with properly shaped near-field. The energy-momentum exchange resulting from such interaction was directly mapped via momentum-resolved ultrafast electron energy-loss spectroscopy.

Our approach for longitudinal and transverse electron phase modulation at the sub-fs timescale would pave the way to achieve unprecedented insights into non-equilibrium phenomena in advanced quantum materials [4], playing a decisive role in the rational design and engineering of future photonics and electronics applications [5].

[1] G. M. Vanacore et al., *Nature Communication* **9**, 2694 (2018).
[2] G. M. Vanacore et al., *Nature Materials* **18**, 573-579 (2019).
[3] I. Madan*, G. M. Vanacore* et al., *Science Advances* **5**, eaav8358 (2019).
[4] I. Madan*, G. M. Vanacore* et al., *Appl. Phys. Lett.* **116**, 230502 (2020).
[5] G. M. Vanacore et al., *La Rivista del Nuovo Cimento* **43**, 567–597(2020).

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