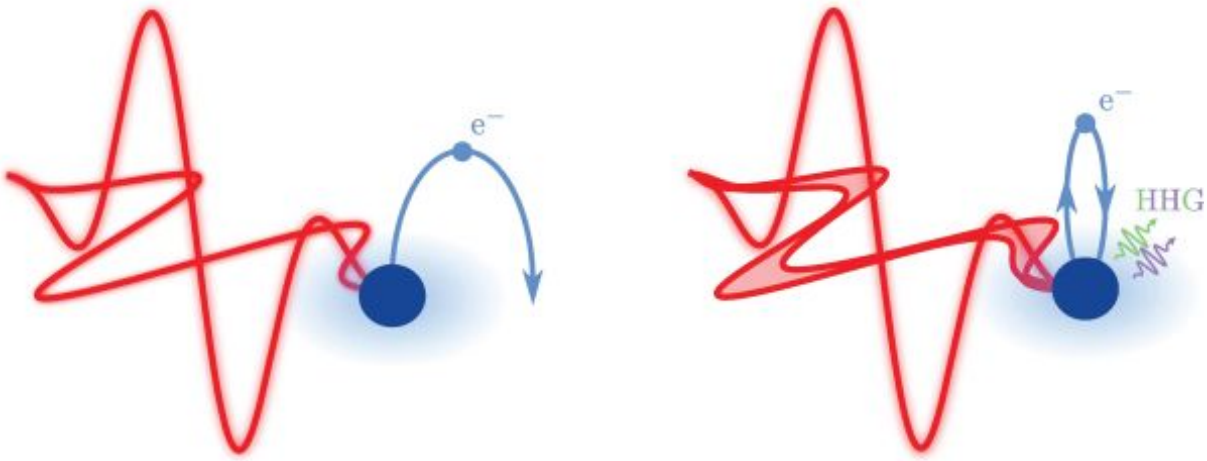


Circular polarization is no longer a barrier for High Harmonic Generation

Contrary to long-standing scientific belief, ICFO researchers have demonstrated that circularly polarized light can, in fact, generate high harmonics -provided that the light contains sufficiently strong fluctuations.

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High harmonic generation (HHG) is a process where an intense laser interacts with a material to produce new light at much higher frequencies -the harmonics of the incoming laser's frequency. This light only lasts a few attoseconds (10-18 seconds), making it an invaluable tool for observing electronic and nuclear motions within atoms and molecules, which typically occur on timescales too fast for longer light pulses to capture.

Despite extensive research aimed at understanding HHG, some open questions remain. For instance, it has been observed that when the incoming laser field is a coherent, classical light source, its polarization plays a crucial role in the outcome. In particular, when the light is circularly polarized-meaning its electric field rotates as it propagates- this typically suppresses the generation of high harmonics in atoms.

ICFO researchers **Dr. Javier Rivera-Dean**, **Philipp Stammer**, led by **ICREA Prof. Maciej Lewenstein**, in collaboration with Prof. Dr. Marcelo Ciappina from Guangdong Technion - Israel Institute of Technology, have overcome this limitation, overturning the long-standing belief that circularly polarized light cannot produce high harmonics. After working for months, they have theoretically shown that high harmonics can indeed re-emerge by introducing strong enough fluctuations into the laser light. The results were published today in Physical Review Letters.

Specifically, the team considered light with engineered quantum fluctuations that cannot be described by classical physics alone, caused by a quantum phenomenon known as squeezing. Not only did they show the emission of high harmonics, but they also found that their frequency and intensity depend sensitively on the quantum properties of light, particularly on the type of squeezing applied. Finally, they linked these observations to how the underlying behavior of electrons changes during the process.

The researchers remark that non-classical light is not strictly required to enable HHG with circular polarization; instead, strong fluctuations, regardless of their origin, are the key. However, according to Dr. Javier Rivera-Dean, lead author of the paper: i¿½Our work ope s the exciting possibility of using structured quantum fluctuations in the light to modify t e HHG process, and therefore ask questions about both its nature and the consequences t could have in more involved attosecond science applications.i¿½ Therefore, this c uld provide powerful new methods for controlling and studying ultrafast electron dynamic in complex systems, and further advance the emerging field of attosecond quantum opt

Reference:

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