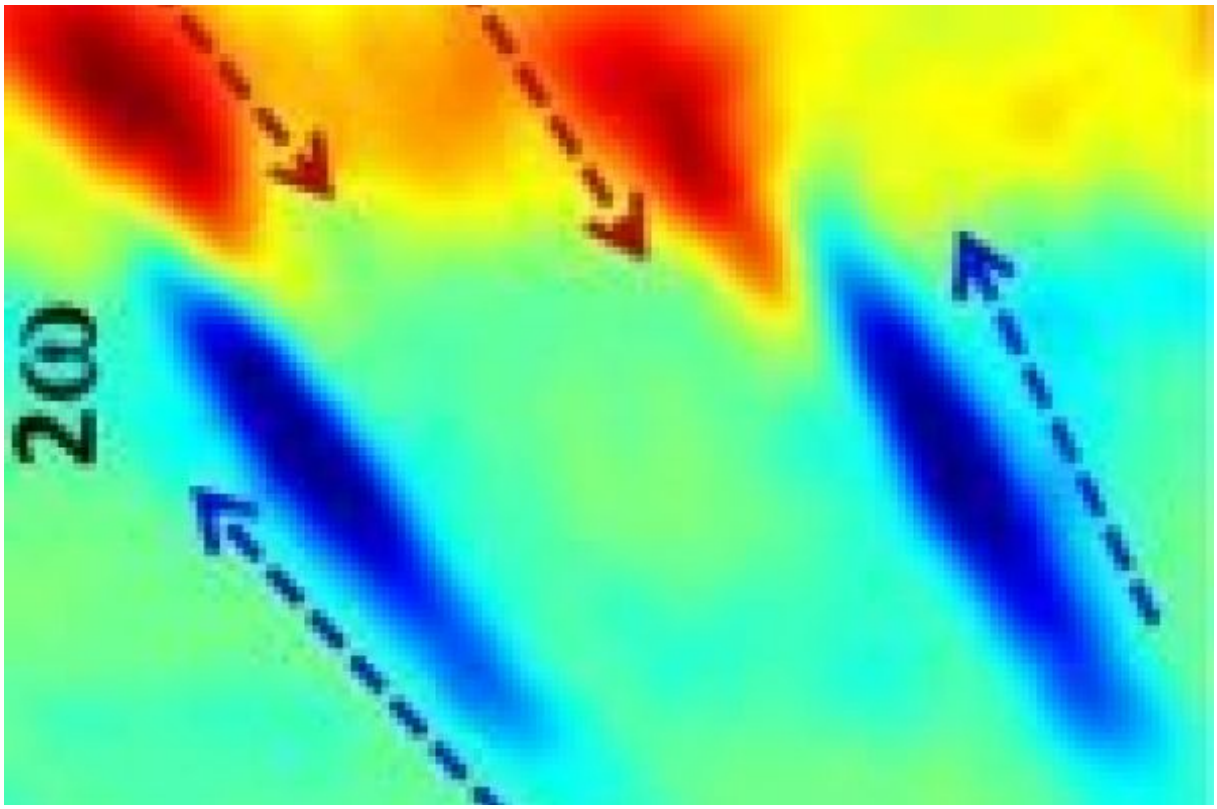

Phase matters

Capturing the optical phase of nanoantennas by coherent second-harmonic microscopy

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In a recent study carried out by Nicolo Accanto, Lukasz Piatkowski and Jan Renger in the Molecular NanoPhotonics group led by ICREA Professor at ICFO Niek van Hulst, they have directly measured the optical phase response of various resonant nanoantennas, showing for the first time the phase delay, and connected time delay, developing through the spectral antenna resonance. The work has been published in the NanoLetters.

Plasmonic nanoantennas produce strong light-matter interactions at the nano-scale, which can control emission and absorption of quantum dots, molecules, etc. The ultrafast coherent control of light localization in such resonant optical antennas is intricately related to the phase response of the involved plasmon resonances. In this work Accanto and colleagues have exploited the second harmonic signal generated by single optical nanoantennas subject to broadband phase-controlled femtosecond pulses to study and tailor the coherent

resonance response. Their results reveal that both the spectral phase and the amplitude components associated with the plasmon resonance of arbitrary individual nanoantennas can be accurately determined.

These recent advances clearly demonstrate that a single nanoantenna intrinsically acts as a nanometer-sized pulse shaper for both the amplitude and the phase of the incident electric field. This, together with the versatility of the fabrication processes, can be exploited to design specific nanostructures to shape incident laser pulses in a nanometre-sized area, therewith facilitating coherent control by plasmonic nanostructures.