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Energy Absorption Interferometry: a theoretical and experimental method for probing the behaviour of multimode detectors, sensors and energy-harvesting structures

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Sensors and structures of many different kinds can absorb energy through a number of spatial degrees of freedom simultaneously. For example, the ultra-low-noise detectors being developed for far-infrared space telescopes can absorb energy through typically 1-20 optical modes. An important question is how to match the amplitude and phase patterns of the incoming partially coherent field to those of the detector. Modes that are not coupled efficiently become sources of noise. Measuring the modes to which quantum sensors and complete instruments are sensitive is an important task in optical, far-infrared, elastic and acoustic applications. A new technique, Energy Absorption Interferometry is able to determine the spatial forms of the individual degrees of freedom through which structures can absorb energy. The technique can be applied experimentally, but also makes a powerful numerical tool for studying behaviour: for example, plasmonic surfaces. The method illuminates the device under test with two coherent sources, and then modulates time delay between the excitations. The detected signal displays a fringe, which gives a complex visibility. The experiment is repeated as the two sources are moved, and the measured visibilities assembled into a matrix, which is diagonalized. The eigenvectors are the spatial forms of the individual degrees of freedom through which the structure can absorb energy. One is actually measuring the dynamics of the individual solid state processes responsible for absorption. Remarkably, the two sources do not have to be of the same type, exposing the forms of processes that can be driven by the two kinds of excitation: electromagnetic and elastic, etc. The method is essentially a generalized form of holography, and measures the spatial state of coherence of the reception pattern. It is closely related to aperture synthesis interferometry, used extensively in astronomy. In the talk we describe the principles of EAI, and overview applications.

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