Coherently Driven Antennas

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An antenna is a key element for many wireless technologies, including communications and power transfer. The first antennas emerged with the discovery of electromagnetic waves by H. Hertz in 1888, and in recent years antennas have become a crucial part of our daily lives. While antennas for wireless communications are rather established, *wireless power transfer* (WPT), proposed at the beginning of the 20th century by N. Tesla, has been experiencing a rebirth. It was caused by the experimental demonstration that WPT efficiency can be drastically enhanced when the power is transferred via resonant coupling. Transfer over the distance of 2 m with 45% efficiency in the kHz range via strongly coupled magnetic resonances between two metallic coils was achieved. Since then, significant research efforts have been devoted to exploring ways to achieve as high WPT efficiency as possible, whereas the main part of them has been concentrated on optimizing the electromagnetic resonators' geometry, surrounding material, their relative arrangement.

Here, we present our recent achievements in *coherently enhanced wireless power transfer*. The concept of coherently enhanced WPT is based on a fundamental property of the wave nature of electromagnetic field - interference. Only recently it has been found that electromagnetic processes such as absorption and scattering may be effectively controlled via coherent spatial and temporal shaping of the incident electromagnetic field. For example, a coherent perfect absorber (CPA) is a linear electromagnetic system in which perfect absorption is achieved with two or more incident waves, creating constructive interference inside an absorbing structure. We have shown that the same principle that underlies the operation of a CPA can be employed to improve the efficiency of antenna energy transfer, and as a result improve the efficiency of WPT systems. More specific, we have shown that, by coherently exciting the receiving antenna with an auxiliary signal, tuned in sync with the impinging signal from the transmitting antenna, it is possible to enhance the robustness of the system largely. This additional signal improves energy transfer through constructive interference with the impinging wave, compensating any imbalance in the antenna coupling without having to modify the load.