Designing the response-spectra of microwave metasurfaces: theory and experiments

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Abstract: Metasurfaces composed by arrays of coupled plasmonic resonators have attracted tremendous attention due to their extraordinary abilities to manipulate electromagnetic (EM) waves. However, existing theories for such systems are either empirical with model parameters obtained by fitting with simulations, or can only be applied to high-frequency systems where metals exhibit finite permittivity. Here, we extend our recently established leaky-eigenmode (LEM) theory to the microwave regime where metals exhibit infinite permittivity, with all parameters directly computable without fitting procedures. After validating our theory with both simulations and experiments on a benchmark metasurface, we illustrate how to utilize the theory to guide designing microwave metasurfaces with freely tailored line-shapes, including particularly the generation of a bound state in the continuum. All theoretical predictions are verified by experiments and simulations. Our study provides a powerful tool to guide designing functional microwave meta-devices for various applications.

Keywords: Plasmonic resonators; Surface current; Optical lineshapes; Near-field coupling; Metasurface.

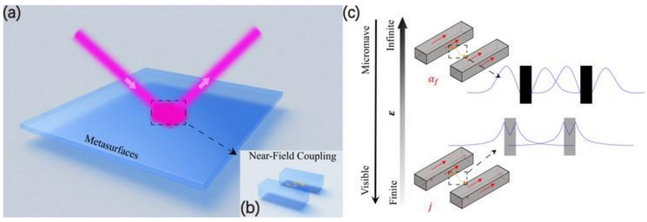

Figure 1: (a) Metasurfaces with complex meta-atoms composed by multiple metallic resonanors where (b) the near-field coupling between inter- resonators playing important role on its optical response. (c) Schematics of permittivity property of metallic resonator at visible and microwave regime where the near-field behavior are determined by body currents j and surface currents α_f, respectively. The top and bottom insets on the right side of Figure 1c illustrate the different near-field distribution between two resonators at low-frequency and high-frequency, respectively.

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