DPP12-2012-000413

Abstract for an Invited Paper
for the DPP12 Meeting of
the American Physical Society

Novel functional composites of plasmas and metamaterials

OSAMU SAKAI, Kyoto University

Plasmas, which are fairly frequency-dispersive in their dielectric properties, have tunable and nonlinear features that cannot be achieved using other solids and liquids. Such features on variable complex permittivity can be activated in metamaterial structure; when we combine plasmas with metamaterials which have functional micro-structures leading to designable permeability, we can expect a quite broad range of negative refractive index on its complex plane for electromagnetic waves. Furthermore, if a given electromagnetic wave has sufficient wave amplitude to modulate electron density, such a composite work as a strong nonlinear medium with adjustability through the metamaterial features. Such kinds of arguments are reviewed in our recent reports [1,2]. One of the specific physical properties emerging in plasma metamaterials is an exchange phenomenon between attenuation and phase shift via regulated permeability. Conventional collisional plasmas work simply as attenuators for electromagnetic waves, but superposition of a negative permeability state induces significant phase shift of propagating waves with less attenuation. Another example is simultaneous generation of a high-density plasma with a negative-refractive-index state; we predicted quite strong nonlinear processes with double saddle-node bifurcations during this phenomenon, and verified them in our recent experiments. Such composites of plasmas and metamaterials will provide new scientific opportunities as well as industrial applications.

[1] O. Sakai et al., Physics of Plasmas, vol. 17 (2010), 123504.
[2] O. Sakai et al., Plasma Sources Sci. Technol., vol. 21 (2012), 013001.