# Adiabatic and Exact Analysis of Periodically Modulated Artificial Surfaces for Holographic Antenna Applications

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The optic concept of holography can been extended to the microwave frequencies offering new potential for antenna applications. The attention to these applications has been recently renewed by the possibility to realize modulated impedance surfaces on the basis of artificial surfaces, as suggested by Sievenpiper (D. F. Sievenpiper, J. Colburn, B. Fong, J. Ottusch, J. Visher, 2005 IEEE AP-S Symposium, Washington, DC, July 2005). The surface impedance modulation that provide a given maximum of the radiated power density, can be obtained by interference of the wave radiated from a feeder and a plane wave coming from the direction of maximum radiation. By modulating the artificial surface impedance as dictated by the above interference pattern, one can construct the required beam when the surface is illuminated by the given feed source. The holographic-pattern process can be used in two different ways, both based on the same synthesis process described above. When the source is far from the surface, the holographic concept is similar to the reflectarray concept. In other words, the phase modulation of the reflection coefficients changes the phase of a local incident ray-field to reconstruct a maximum power density in a desired direction. When the source is close to surface, the modulated surface affects the wavenumber of the surface wave travelling on the non-modulated structure thus leading to a leaky wave mode not present in the non-modulated case. The leaky-wave wavenumber arises from a translation of the surface wave wavenumber in the visible range by the short spectral periodicity introduced by the large spatial modulation. In the case of sinusoidal spatial modulation, the exact solution may be obtained in a rigorous way by using a basic cell defined on the large periodicity.
In this framework, we have studied the simple case of the interference pattern between two waves, one propagating and one evanescent, giving a sinusoidally-modulated interference pattern. As in the previous reference, the artificial surface is constituted by metallic patches printed on a grounded dielectric substrate, with sinusoidal modulation obtained by varying the gap between the patches. A rigorous analysis was developed by using a full-wave method of moment (MoM) based on a Floquet-wave representation, while an approximate solution was carried out by sinusoidally modulating the average impedance associated to the dominant FW contribution (A. Oliner, A. Hessel, IEEE Transactions on Antennas and Propagation, vol. 7, no. 5, pp. 201-208, December 1959). In both cases the attention is focused on the leaky-mode dispersion diagram. A critical comparison between the rigorous and the approximated approaches will be illustrated with the objective to underline the basic limitation of the approximate solution in the perspective to improve the latter solution.