Array Sparsification in a Fabry-Perot Cavity Covered by a Partially Reflective Surface for Enhanced Directivity

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The enhancement of directivity by using leaky wave antennas have been a subject of study in the last forty-fifty years and various geometries have been proposed. In the last twenty years attention has been brought also to planar structures made of dielectric layers called 2D leaky wave antennas. The enhanced directivity is based on the excitation by a single radiator of a leaky wave along the antenna geometry, that is a complex modal solution allowed to propagate in the structure. It has been shown that planar antennas with leaky waves with small propagation constant can produce narrow beams at broadside. Various configurations have been considered to enhance the directivity at broadside, such as single or multi dielectric layers to form a cavity resonator often called Fabry-Perot cavity (FPC). This structure is mainly formed by a half wavelength chamber between a ground plane and a partially reflective surface (PRS) located on top of the cavity. The leaky wave is trapped between the ground plane and the above PRS. In the original studies the top PRS was formed by alternating high-density and low-density quarter wavelength dielectric layers or with a periodic screen but in the past years the PRS has been often made of planar periodic structures, made of a thin sheet of periodic slots, dipoles or other more complex geometries.

Although in line of principle the source directivity could be unlimitedly enhanced, a strong directivity results in a very small antenna bandwidth and a very critical design. This trade-off between directivity enhancement and bandwidth suggests to use a sparse array inside the FPC that is designed to produce a moderately enhanced directivity for *each* array elements. Such configuration allows to preserve the needed operating bandwidth and achieve the requested directivity by using sparse arrays of sources. Since each element in the FPC is individually quite directive, a larger spacing between elements is permitted still avoiding grating lobes. The *sparsification* of the array elements results in a simpler structure with fewer elements, a simpler feeding network and a lower coupling between elements as it will be shown in the presentation. The empty space available between sparse elements can be employed to accommodate active RF circuitry or to interleave two different antennas; the latter solution can be useful to arrange dual feed, i.e., two combined feeds sharing the same phase center illuminating the same reflector but with different operating frequency or polarization. In particular we will show some design criteria for sparse arrays, a procedure to design a sparse array in a FPC covered by a periodic PRS, and an application with dual polarization sparse arrays showing a low cross polarization coupling. A comparison between sparse arrays in a FPC with two types of PRS (the quarter wavelength-thick dielectric layers and the reactive periodic FSS) is carried out in terms of performances, construction feasibility and costs.