Analysis of Coupling Among Circular Horns by a Simple Perturbative Technique

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Recently, the electromagnetic coupling among Corrugated Circular Horns (CCHs) has been analyzed with a rigorous method based on the Generalized Network Formulation (P. Bolli, G. G. Gentili, R. Nesti, and G. Pelosi, Antennas and Wireless Propagation Letters, vol. 3, 11, 200-203, 2004). As the technology to fabricate CCHs is going to consolidate, CCHs are now combined together to realize Focal Plane Arrays (FPAs). In order to accurately design receiving FPAs, which represent one of the new frontiers in Radio Astronomy applications, a tool to characterize the interactions among different feeds is fundamental.

Since the rigorous method is generally extremely time-consuming, a different approach is now presented. The new method is based on the fact that the electromagnetic coupling among CCHs is quite low and, as a consequence, a perturbative approach can be adopted. The new perturbative approach is a step-by-step procedure that iteratively builds up the electromagnetic solution by efficiently adding up higher orders of perturbative contributions to the dominant field until a satisfactory convergence is reached. The dominant field is obtained by neglecting the coupling. In our practical applications just one or at most two perturbative contributions are observed to be significant.

The main benefits of this new technique are: (a) to introduce a new methodology which allows one to exploit a software, developed to analyze a single horn in free-space, also to study its electromagnetic behavior when it is placed inside an array; this could increase the value of many software tools; (b) to have a more efficient solution for the electromagnetic coupling in FPAs; (c) to overcome the limitations of the rigorous method in terms of array dimension: in fact the new tool can analyze an extremely large array cluster with moderate computer resources.

In order to validate the proposed technique, several comparisons are presented and discussed. They include antenna patterns and S-parameters, obtained with the rigorous method and the new perturbative one.