Analysis of beam scattering using clusters of filamentary sources located in complex space

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Abstract—The idea proposed in this paper is to use a model comprising clusters of filamentary sources centered in complex-coordinate space for a more systematic analysis of two-dimensional scattering problems. In this way, each portion of the body surface is illuminated by several beams each originating from a different cluster and hence arriving at a different angle. A better approximation of a general scattering by a large body is thus furnished. In addition, due to the nature of the fields radiated by the complex filamentary sources, the impedance matrix is localized and can, with appropriate thresholding operation be made sparse with almost no degradation in the solution accuracy. Moreover, the possibility of an a priori reduction in the number of sources needed for a given excitation is facilitated. The new approach is applied to analyze electromagnetic scattering by a perfectly conducting circular cylinder excited by a beam whose axis does not intersect the cylinder axis. The new approach makes the solution more general but still very efficient. The numerical results are tested against those of the analytical solution for the problem.

I. INTRODUCTION

Fictitious current models [1,2] have been applied recently to scatterers that are both larger and characterized by a wide range of length-scale features by allowing the coordinates of the source centers assume complex values [3,4]. This paper takes this idea a step forward in suggesting the use of models comprising clusters of sources centered in complex-coordinate space for a more effective analysis of similar scattering problems. The suggested approach is applied to the problem of wave scattering by a large two-dimensional circular cylinder excited by a beam whose axis does not intersect the cylinder axis. Problems of scattering of beams by an infinite cylinder have been studied by Alexopoulos and Park [5] and Kozaki [6]. More recent work on this subject has appeared in [7].

In the new approach, instead of using an even distribution of individual sources we consider clusters of sources. The sources belonging to a given cluster may be quite afar one from the other in the complex space but their branch-cut singularities, which represent their equivalent real-source distribution, are relatively close or even coincide in the real space. In this way, each portion of the body surface is illuminated by several analytically derivable localized fields, which look nearly like Gaussian beam-fields. The various beam-fields illuminating a given portion of the body surface originate from different clusters of sources and consequently