3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Analysis of Scattering by Large Open-Ended Cavities Using the Gaussian Beam Shooting Technique

Christine Letrou* (1), Mossaab Hariz(1), Barak Galanti(2), and Amir Boag(2)
(1) SAMOVAR Lab. (UMR CNRS 5157), Télécom SudParis, IP Paris, 91011 Evry Cedex, France;
e-mails: christine.letrou@telecom-sudparis.eu, mossaab.hariz@telecom-sudparis.eu
(2) School of Electrical Engineering, Tel Aviv University, Tel Aviv 69978, Israel;
e-mails: barakg@tauex.tau.ac.il, boag@tau.ac.il

The Gaussian beam shooting (GBS) technique [1] is well suited for problems of high frequency scattering by complex geometries thanks to the spatial and spectral limited extents of paraxial Gaussian beams (GBs). In fact, this approach is especially attractive when the frequencies of interest are so high that the scattering problem is computationally difficult to address by the more conventional asymptotic methods, such as the physical optics (PO). Thus, the GBS is a good candidate for the numerically efficient calculation of monostatic scattering cross section (SCS) by large open-ended cavities inducing multiple internal reflections. In this technique, incident fields are represented by a summation of Gaussian beams based on the two dimensional version of the Gabor frame theory applied at judiciously selected reference planes. A Gabor frame is a set of Gaussian functions obtained by translations of a "mother" Gaussian window in spatial and spectral domains. Gabor frame functions radiate in the form of GBs. The GBs are then tracked along geometrical ray trajectories through multiple bounces from reflecting surfaces. Subsequently, the scattered far field is computed by summing asymptotic contributions of all GBs. For the monostatic SCS computation, only beams propagating to infinity in a narrow angular sector are summed up to obtain the backscattered field in a given direction. We have shown that the method provides frequency independent complexity (per direction of incidence) [1], thus enabling analysis of scattering from geometries that are very large compared to the wavelength.

In this work, we focus on the GBS-based analysis of monostatic scattering from open-ended cavities comprising piecewise planar surfaces. Such geometries require relatively simple implementation while facilitating study of the algorithm's accuracy and stability when GBs undergo multiple reflections. In particular for cavities, the number of reflections depends on the angle of incidence, thus exhibiting non-trivial accuracy and complexity behavior. In our study, the GBS performance is compared to that of iterative PO [2].

1. C. Letrou, M. Hariz, B. Galanti, and A. Boag, "Fast Monostatic Scattering Computation Based on Gaussian Beam Shooting and Frame Decomposition," *2021 IEEE International Conference on Microwaves, Antennas, Communications and Electronic Systems (COMCAS)*, November 2021, Tel Aviv, Israel, pp. 51-54, doi: 10.1109/COMCAS52219.2021.9629065.

2. I. Gershenzon, Y. Brick, and A. Boag, "Shadow Radiation Iterative Physical Optics Method for High Frequency Scattering," *IEEE Trans. Antennas and Propagation*, vol. 66, no. 2, pp. 871-883, Feb. 2018, doi: 10.1109/TAP.2017.2784439..