

# Accepted Manuscript

A hybrid approach to solve the high-frequency Helmholtz equation with source singularity in smooth heterogeneous media

Jun Fang, Jianliang Qian, Leonardo Zepeda-Núñez, Hongkai Zhao

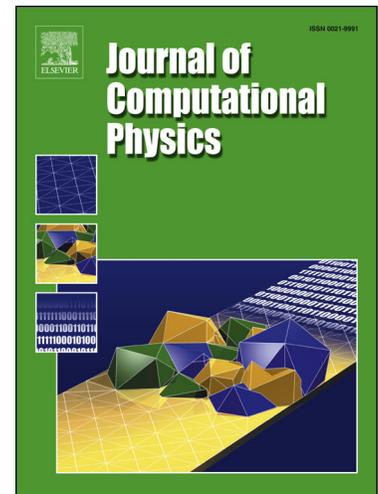
PII: S0021-9991(18)30163-3  
DOI: <https://doi.org/10.1016/j.jcp.2018.03.011>  
Reference: YJCPH 7903

To appear in: *Journal of Computational Physics*

Received date: 21 July 2017  
Revised date: 5 March 2018  
Accepted date: 6 March 2018

Please cite this article in press as: J. Fang et al., A hybrid approach to solve the high-frequency Helmholtz equation with source singularity in smooth heterogeneous media, *J. Comput. Phys.* (2018), <https://doi.org/10.1016/j.jcp.2018.03.011>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



# A hybrid approach to solve the high-frequency Helmholtz equation with source singularity in smooth heterogeneous media

Jun Fang

*Department of Mathematics, University of California, Irvine*

Jianliang Qian

*Department of Mathematics, Michigan State University*

Leonardo Zepeda-Núñez

*Department of Mathematics, University of California, Irvine*

Hongkai Zhao

*Department of Mathematics, University of California, Irvine*

---

## Abstract

We propose a hybrid approach to solve the high-frequency Helmholtz equation with point source terms in smooth heterogeneous media. The method is based on the ray-based finite element method (ray-FEM) [29], whose original version can not handle the singularity close to point sources accurately. This pitfall is addressed by combining the ray-FEM, which is used to compute the smooth far-field of the solution accurately, with a high-order asymptotic expansion close to the point source, which is used to properly capture the singularity of the solution in the near-field. The method requires a fixed number of grid points per wavelength to accurately represent the wave field with an asymptotic convergence rate of  $\mathcal{O}(\omega^{-1/2})$ , where  $\omega$  is the frequency parameter in the Helmholtz equation. In addition, a fast sweeping-type preconditioner is used to solve the resulting linear system.

We present numerical examples in 2D to show both accuracy and efficiency of our method as the frequency increases. In particular, we provide numerical evidence of the convergence rate, and we show empirically that the overall complexity is  $\mathcal{O}(\omega^2)$  up to a poly-logarithmic factor.

*Keywords:* Helmholtz equation, Babich's expansion, ray-FEM, NMLA

Download English Version:

<https://daneshyari.com/en/article/6928659>

Download Persian Version:

<https://daneshyari.com/article/6928659>

[Daneshyari.com](https://daneshyari.com)