



Reversed phase propagation for hyperbolic surface waves

Repän, Taavi; Novitsky, Andrey; Willatzen, Morten; Lavrinenko, Andrei

Published in:

Proceedings of XXVI International Workshop on Optical Wave & Waveguide Theory and Numerical Modelling.

Publication date:

2018

Document Version

Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):

Repän, T., Novitsky, A., Willatzen, M., & Lavrinenko, A. (2018). Reversed phase propagation for hyperbolic surface waves. In *Proceedings of XXVI International Workshop on Optical Wave & Waveguide Theory and Numerical Modelling*. (pp. 56-56). TU Dortmund University.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Reversed phase propagation for hyperbolic surface waves

Taavi Repän¹, Andrey Novitsky¹, Morten Willatzen¹, Andrei Lavrinenko¹,

¹ DTU Fotonik, Technical University of Denmark, Ørsteds Plads 343, DK-2800 Kongens Lyngby, Denmark
tarap@fotonik.dtu.dk

Magnetic properties can be used to control phase propagation in hyperbolic metamaterials. However, in the visible spectrum magnetic properties are difficult to obtain. We discuss hyperbolic surface waves allowing for a similar control over phase, achieved without magnetic properties.

Hyperbolic metamaterials (HMMs) are strongly anisotropic structures, exhibiting metallic properties on one direction while having dielectric properties in the other. This ability of HMMs to allow propagation of waves with short effective wavelengths (i.e. high-k waves) has sparked interest in HMM based devices for subwavelength imaging: hyperlenses [1]. However, broadening due to losses present in a realistic implementation of HMMs is an obstacle for imaging applications. We have recently shown that by employing magnetic properties, this broadening can be significantly reduced by adding a region with reversed phase propagation due to μ -negative HMMs [2].

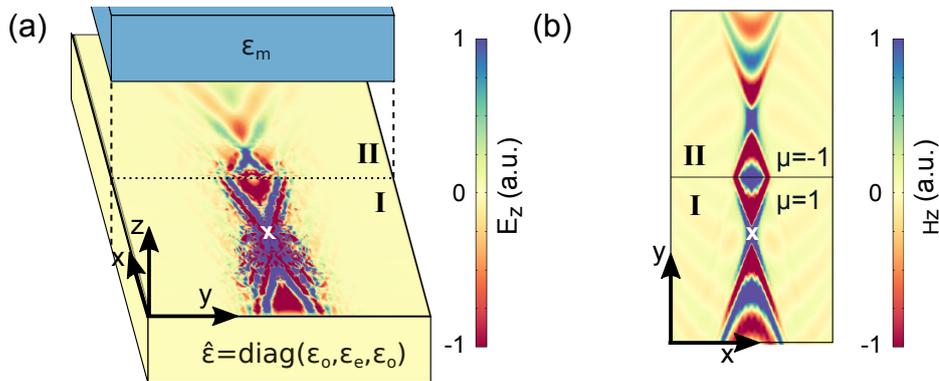


Fig. 1. (a) Geometry of the system, showing both two- and three-layer parts. A point dipole near the surface is used to excite the hyperbolic surface waves. (b) 2D simulation of an analogous case for bulk HMM, with a line source and μ -positive and -negative HMMs. Regions with normal (I) and reversed (II) phase propagation are marked, along with positions of point sources.

The required control over phase propagation can be achieved without magnetic properties in case of surface waves, by using two- and three-layer systems as a counterpart to μ -positive and -negative HMMs, respectively. We study a system composed of an anisotropic metal and a dielectric layer, which supports hyperbolic surface waves (with normal phase propagation). To have region with reversed phase propagation we use a three-layer system, with an additional isotropic metal layer. The system along with numerical simulations is shown in fig. 1. We see that in phase-reversed part the fields are restored towards the original point source. Note that due to lossy media the reconstruction is not perfect.

References

- [1] Zubin Jacob, Leonid V. Alekseyev, and Evgenii Narimanov. Optical hyperlens: Far-field imaging beyond the diffraction limit. *Optics Express*, 14(18):8247, 2006.
- [2] Taavi Repän, Andrey Novitsky, Morten Willatzen, and Andrei V. Lavrinenko. Pseudocanalization regime for magnetic dark-field hyperlenses. *Physical Review B*, 96(19), 2017.