

# Retrieval of material parameters by inverting the Airy-Fresnel relation using Hilbert Transform

Mario Versaci<sup>(1)</sup>, Giovanni Angiulli<sup>(2)</sup>, Fabio La Foresta<sup>(1)</sup>, Nadia Mammone<sup>(1)</sup>, Francesco Carlo Morabito<sup>(1)</sup>

(1) DICEAM, “Mediterranea” University, Via Zehender, Reggio Calabria, Italy  
Via Zehender, Reggio Calabria, Italy

(2) DIIES, “Mediterranea” University, Via Zehender, Reggio Calabria, Italy,

The heuristic homogenization approach is intensively employed to characterize electromagnetic Metamaterials (MMs). The effective parameters are extracted within this framework using the Nicolson-Ross-Weir (NRW) method. Special attention must be devoted to handling this procedure because of the branch ambiguity issue, i.e., the lack of uniqueness in evaluating the effective refractive index rooted in using the multivalued complex logarithm to invert the Airy-Fresnel relation. Over the years, several techniques based on the phase unwrapping approach have been introduced, but without any theoretical justification. In this letter, inspired by [1], we propose an analytic continuation approach based on the Hilbert transform to implement the analytic prolongation described in [2] for the unambiguous retrieval of the material parameters by the NRW method. To illustrate its performance, a numerical example is presented.

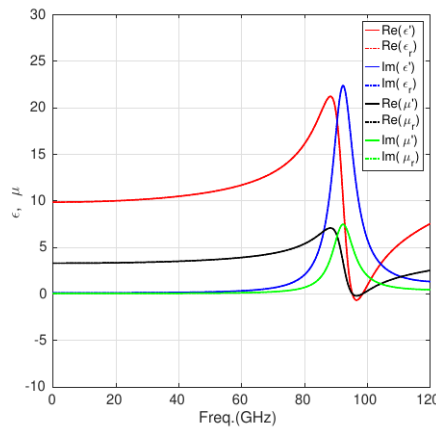


Figure (1): Results of the proposed method vs. exact solution.

## References

- [1] Angiulli, G., & Versaci, M. (2022). Extraction of the electromagnetic parameters of a metamaterial using the Nicolson–Ross–Weir method: An analysis based on global analytic functions and Riemann surfaces. *Applied Sciences*, 12(21), 11121.
- [2] Angiulli, G., & Versaci, M. (2021). Retrieving the effective parameters of an electromagnetic metamaterial using the Nicolson-Ross-Weir method: An analytic continuation problem along the path determined by scattering parameters. *IEEE Access*, 9, 77511-77525.