Numerical simulation of Maxwell's systems in media with anomalous dielectric properties

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In materials showing anomalous dielectric properties, the polarization processes are described in the frequency domain by constitutive laws based on nonlinear models with one or more fractional powers.
As a consequence, the simulation in the time domain of Maxwell's systems for such kind of materials involves non-standard differential or pseudo-differential operators of fractional order [1] whose numerical approximation requires new and specifically devised methods.
In this talk we consider the Havriliak-Negami model which applies to a large extent of materials with anomalous dielectric relaxation properties. After discussing the mean features and properties of this model, we analyze the fractional derivative of Prabhakar type [2] involved for its description in the time domain and we propose some approaches for the numerical simulation of Maxwell's systems.
The extension to other dielectric models, such as the Excess Wing model, is also addressed.

[1] R. Garrappa, F. Mainardi, G. Maione, Models of dielectric relaxation based on completely monotone functions. Fractional Calculus Applied Analysis, 2016, 19(5), 1105-1160
[2] R. Garra, R. Garrappa, The Prabhakar or three parameter Mittag–Leffler function: theory and application. Communications in Nonlinear Sciences and Numerical Simulation, 2018, 56, 314-329,