**Stable time-domain differential equations which
reproduce the warm plasma dielectric tensor**

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Nonlinear and transient phenomena are of great interest in plasma physics [1]. The ability to model such phenomena is a major advantage of time-domain computational techniques.

In [2], we derived stable (provably conservative) time-domain constitutive differential equations which, in the frequency domain, reproduce a finite-order approximation to the dielectric tensor for hot Maxwellian plasmas [3]. In [2], the approximation was accurate to second order in the thermal velocity and only valid for perpendicular propagation, with the electric field perpendicular to the background magnetic field (i.e. reproducing the x-y block of the dielectric tensor). Later [4], we also reproduced the zz-block of the dielectric tensor in this fashion.

This stable approximation is obtained using carefully-chosen rational rather than polynomial approximations to the special functions in the dielectric tensor, which are then related to time-domain differential equations by means of the Fourier transform [5].

Here, we will obtain a conservative set of time-domain differential equations which reproduces, in the frequency domain, the warm plasma dielectric tensor to second order in the thermal velocity and first order in the parallel wavenumber.

- [1] D. N. Smithe. "Time domain modeling of plasmas at RF time-scales". Journal of Physics: Conference Series, 78(1):012069, 2007
- [2] W. Tierens and D. De Zutter. "Finite-temperature corrections to the time-domain equations of motion for perpendicular propagation in nonuniform magnetized plasmas." Physics of Plasmas, 19:1–9, 2012
- [3] M. Brambilla. "Kinetic theory of plasma waves." Clarendon Press, 1998
- [4] W. Tierens. "Finite Element and Finite Difference Based Approaches for the Time-Domain Simulation of Plasma-Wave Interactions." PhD thesis, Ghent University, 2013
- [5] R. M. Joseph, S. C. Hagness and A. Taflove, "Direct time integration of Maxwell's equations in linear dispersive media with absorption for scattering and propagation of femtosecond electromagnetic pulses", Optics Letters, 14:12-14, 1991

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