CHALLENGES IN THE DISCRETIZATION OF THE TIME DEPENDENT MAXWELL EQUATIONS AND THE DISCONTINUOUS GALERKIN APPROACH

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I will start by recalling main features of the modern Maxwell theory of electromagnetism: Maxwell's equations (ME), Poynting's theorem, the existence of electromagnetic waves. After re-introducing the appropriate $\mathbf{H}(curl)$ function spaces for the solutions of ME I will discuss practical arguments against the use of conforming discrete basis functions when solving the time dependent problem within the Finite Element Method (FEM). A formulation using fully discontinuous piecewise polynomial basis functions will be presented, which instead achieves high computational efficiency and scalability by exploiting the appropriate covariant and contra-variant (Piola) local transformations for vector fields, borrowed from parametric FEMs. The final part of the talk will be devoted to handling problems formulated on unbounded domains where the correct radiation boundary conditions have to be implemented in the discrete, necessarily bounded, FEM setting. In this framework I will finally show how the same type of aforementioned local transformations can be used to construct materials which provide absorption of electromagnetic waves without any reflection. Numerical examples using the NGSolve solver will be employed throughout.