On a Nonlinear Maxwell’s System in Quasi-Stationary Electromagnetic Fields

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**Abstract:** In this paper we study the motion of a magnetic field \( \mathbf{H} \) in a conductive medium \( \Omega \subset \mathbb{R}^3 \) under the influence of a system generator. By neglecting displacement currents, the magnetic field satisfies a nonlinear Maxwell’s system:

\[
\mathbf{H}_t + \nabla \times [\rho(x, t) \nabla \times \mathbf{H}] = 3D \, f(|\mathbf{H}|) \mathbf{H},
\]

where \( f(|\mathbf{H}|) \mathbf{H} \) represents the magnetic currents depending upon the strength of \( \mathbf{H} \). We prove that under appropriate initial and boundary conditions the system has a global solution and the solution is also unique. Moreover, we show that the solution \( \mathbf{H} \) will blow up in finite time if \( f(s) \) satisfies certain growth conditions. Finally, we generalize the results to the problem associated with a nonlinear boundary condition.

**AMS Mathematics Subject Classifications:** 35Q60

**Key Words and Phrases:** Nonlinear Maxwell’s Equations, Quasi-stationary field, global existence and uniqueness, finite-time blowup.

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