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Adaptive space-time finite element method for the p-curl problem from high temperature superconductivity

In applications of high temperature superconductors, a nonlinear eddy current problem, known as the p-curl problem, is often used to model electromagnetic properties of superconducting materials. Due to similarities with the parabolic p-Laplacian, solutions of this problem can exhibit sharp gradients which move in time. Moreover, the development of superconducting devices has been hindered by the computational difficulties at resolving these moving fronts. In this talk, we discuss an adaptive space-time finite element method which can intrinsically reduce the number of degrees of freedom for the p-curl problem. Based on a Helmholtz-Weyl decomposition for the space $W_0^p(\text{curl})$ and a residual type argument, we show the proposed a posteriori error estimators provide an upper bound for the error and as well as for the error in an energy dissipation quantity, known as AC losses. This is joint work with Marc Laforest and Frédéric Sirois at Polytechnique de Montréal.