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**Stability Properties of the Bell Finite Element as applied to Convection Problems** MAHMOOD MIAH, STEPHEN JARDIN, Princeton Plasma Physics Laboratory — The $C^1$ continuous Bell finite elements (also called the "reduced quintic," or $Q_{18}$) in two- dimensions offer a number of advantages over other representations [1]. These include error scaling as order $h^5$ in space, the ability to directly represent $\partial^4$ operators using the Galerkin method, and a compact representation with asymptotically only 3 degrees of freedom (DOF) per triangular element. Here we examine the properties of a $\theta$-implicit time integration method using this element to solve the convection equation: $\frac{\partial \phi}{\partial t} = \alpha \cdot \nabla \phi$. We find that even for $\theta$=1 (backward Euler) there are a number of undamped sub-element modes in the corresponding eigensystem. In order to selectively damp the numerical, short wavelength eigenmodes of the system while leaving the physical modes intact, we evaluated the effects of adding small amounts of diffusion ($2^{nd}$ order) and hyper-diffusion ($4^{th}$ order) to the equation. These results are presented in terms of the shift of the corresponding eigenvalues in the complex plane, and on the effect of a plane wave propagating at an arbitrary angle with respect to the element orientation.

[1] S. C. Jardin, J. Comput. Phys. 200 (2004) 133

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