1135-65-2925 **Douglas N. Arnold*** (arnold@umn.edu), School of Mathematics, University of Minnesota, Minneapolis, MN 55442, and **Lizao Li**. *Generalized Regge elements and Regge calculus.*

Regge calculus, proposed by Tulio Regge in 1961, elegantly discretizes general relativity (GR). It may be viewed as a finite element method for the Einstein equations, using piecewise constant elements. It is a consistent method, as shown by Cheeger et al in 1984, and nearly a conforming method, as shown by Christiansen in 2011. It is very much in the spirit of structure-preserving discretization methods, which are currently of high interest. We will describe a recent new family of finite elements, the generalized Regge elements, one for each polynomial order and valid in any number of dimensions, with the lowest order case recovering Regge. These are structure-preserving finite elements for second-order covariant tensors, such as metrics. We will discuss their implementation and performance, first for problems simpler than GR, such as the computation of geodesics using the elements to approximate the metric. Based on work of Sorkin from 1975, a 4D Regge calculus discretization of GR may be implemented with reasonable efficiency. However, as is becoming clear, this approach to numerical relativity, though consistent, is unstable, and often fails. We will explain the modes of failure and propose a 3+1 approach, using 3D generalized Regge elements, as an alternative. (Received September 26, 2017)