1171-65-24 **Shiqiang Xia*** (xiaxx268@umn.edu), 127 Vincent Hall, 206 Church St SE, Minneapolis, MN 55455, and **Bernardo Cockburn** (cockburn@math.umn.edu). *An adjoint-based super-convergent Galerkin approximation of functionals.*

In this talk, we present an adjoint-based method for computing high-order accurate approximations of functionals defined in terms of Galerkin approximations. We illustrate the adjoint-based method under the framework of the hybridizable discontinuous Galerkin (HDG) method. First, we present a priori error analysis of this method for approximating linear functionals. We prove that when the functional is smooth, a convergence rate of 4k is obtained with our adjoint-based method. Second, we show how our method can be extended to non-linear functionals such as the eigenvalue problems. Our numerical results show that the approximate eigenvalues computed by our method converge with a rate of 4k 2 when tensor-product polynomials of degree k are used for the Galerkin approximations. Third, we present a novel fully computable error approximation and mesh adaptation for functionals approximated by the HDG method. Unlike most adjoint-based error estimations in the literature, the novelty of our method is that the error estimate is obtained without requiring a finer mesh or higher-order approximation spaces for solving the adjoint problem. Numerical tests with adaptive mesh refinements for non-smooth solutions are presented to show that our method is efficient and robust. (Received August 03, 2021)