1077-65-1210 **Mohamed Ben Romdhane*** (mbenromd@vt.edu), Department of Mathematics, 460 McBryde Hall, Virginia Tech, Blacksburg, VA 24061, and **Slimane Adjerid** and **Tao Lin**. *Immersed Finite Element Spaces with an Interior Penalty Method For Elliptic Interface Problems.*

We present piecewise quadratic immersed finite element (IFE) spaces that are used with an interior penalty (IP) method for solving two dimensional second-order elliptic interface problems without requiring the mesh to be aligned with the material interfaces. The use of an IP formulation with the IFE method is necessary to handle the discontinuity of the IFE shape functions across the mesh edges cut by the interface. The errors in the proposed IFE spaces yield optimal $\mathcal{O}(h^3)$ and $\mathcal{O}(h^2)$ convergence rates in the L^2 and broken H^1 norms, respectively, under mesh refinement. Numerical experiments are presented to validate our theory and show the optimality of the proposed IP-IFE method. We conclude that numerical solutions in the proposed IFE spaces are able to optimally represent the non-smooth behavior of the solution across the interfaces without requiring the mesh to be aligned with the discontinuity. The extensions of the developed quadratic IFE spaces to higher-order IFE spaces are discussed as well. (Received September 18, 2011)