Highly accurate numerical methods for evaluation of singular and nearly singular integrals in integral equations

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The solution of integral equations require the numerical evaluation of singular and nearly singular integrals due to the Green's functions that appear in single and double layer potentials. We have recently developed a highly accurate and efficient method for two-dimensional Stokes flow, that is based on so-called interpolatory quadrature. In three dimensions, we are developing a technique called Quadrature by expansion (QBX). It is based on the assumption that the field induced by the integral operator is locally smooth on either side of a boundary, while discontinuities across the boundary are allowed. Local expansions in terms of Taylor poynomials or spherical harmonics are introduced, and the errors are controlled by the truncation of the expansions and the accuracy in the evaluation of expansion coefficients. The performance of the method is illustrated with the solution of problems in three dimensional Stokes flow.