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Numerical methods for nonlinear integral equations of Prandtl's type

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We are interested in the numerical solution of integral equations of the form

$$-\frac{\epsilon}{\pi}\int_{-1}^{1}\frac{g(y)}{(y-x)^2}dy+\gamma(x,g(x))=f(x)\,,\quad |x|<1\,, \tag{1}$$

where $0<\epsilon\leq 1$ and the unknown function g satisfies the boundary conditions

$$g(\pm 1)=0\,. \tag{2}$$

The integral has to be understood as the "finite part" of the strongly singular integral in the sense of Hadamard, who introduced this concept in relation to the Cauchy principal value.

This type of strongly singular integral equations can be used effectively to model many problems in fracture mechanics.

We discuss solvability properties of such nonlinear hypersingular integral equation of Prandtl's type using monotonicity arguments. Moreover, we investigate collocation and iteration schemes for the numerical solution of such equations. We present also numerical tests for different $f(x)$ and $\gamma(x,g)$ and discuss the influence of the parameter ϵ to the convergence properties of the collocation-iteration methods.