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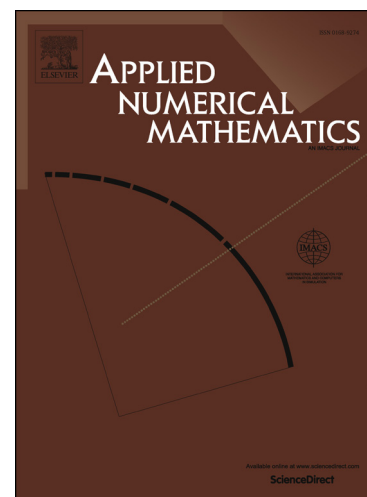
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# Analytical and computational methods for a class of nonlinear singular integral equations

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## Abstract

We consider a general class of nonlinear singular Hammerstein Volterra integral equations. In general, these equations will have kernels containing both an end point and an Abel-type singularity, with exact solutions being typically nonsmooth. Under certain conditions, a uniformly convergent iterative solution is obtained on a small interval near the origin. In this work, two product integration methods are proposed and analysed where the integral over a small initial interval is calculated analytically, allowing the optimal convergence rates to be achieved. This is illustrated by some numerical examples.

*Keywords:*

Nonlinear Volterra integral equation, weakly singular kernel, Hammerstein equations, iterative solution, product integration method.

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## 1. Introduction

This work is concerned with analytical and numerical results for nonlinear Volterra integral equations of the form

$$y(t) = f(t) - \int_0^t \frac{s^\beta}{(t-s)^\alpha} g(y(s)) ds, \quad t > 0, \quad (1)$$

where  $\alpha, \beta$  are positive real constants.

We start with a review on papers dedicated to applications which give rise to VIEs of the above form. In the study of many nonlinear problems in heat conduction, boundary-layer heat transfer, chemical kinetics and superfluidity, we are often led to singular Volterra integral equations of the type [17]

$$y^m(t) = H(t) + \gamma t^{-\mu} \int_0^t \frac{G(y(s), y'(s), s)}{(t^\beta - s^\beta)^\alpha} ds, \quad z > 0, \quad (2)$$

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