

Preface

This volume includes an exciting collection of papers on computational and applied mathematics presenting the recent advances in several areas of this field. All the papers have been peer reviewed by at least three reviewers.

In the paper entitled: “Fifty Years of Stiffness” by Luigi Brugnano, Francesca Mazzia and Donato Trigiante a review on the evolution of stiffness is presented. The authors also given a precise definition of stiffness which encompasses all the previous ones.

In the paper entitled: “Efficient Global Methods for the Numerical Solution of Nonlinear Systems of Two point Boundary Value Problems” by Jeff R. Cash and Francesca Mazzia, the authors investigated the numerical methods for the solution of nonlinear systems of two point boundary value problems in ordinary differential equations. More specifically they answer to the question: “which codes are currently available for solving these problems and which of these codes might we consider as being state of the art”. Finally the authors included some new codes for BVP’s which are written in MATLAB. These codes was not available before and allow us for the first time in the literature the possibility of comparing some important MATLAB codes for solving boundary value problems.

In the paper entitled: “Advances on collocation based numerical methods for Ordinary Differential Equations and Volterra Integral Equations” by D. Conte, R. D’Ambrosio, B. Paternoster a survey on collocation based numerical methods for the numerical integration of Ordinary Differential Equations and Volterra Integral Equations (VIEs) is presented. This survey starts from the classical collocation methods and arrive to the important modifications appeared in the literature. The authors consider also the multistep case and the usage of basis of functions other than polynomials.

In the paper entitled: “Basic Methods for Computing Special Functions” by Amparo Gil, Javier Segura and Nico M. Temme, the authors given a survey of methods for the numerical evaluation of special functions, that is, the functions that arise in many problems in the applied sciences. They considered a selection of basic methods which are used frequently in the numerical evaluation of special functions. They discussed also several other methods which are available. Finally, they given examples of recent software for special functions which use the above mentioned methods

and they mentioned a list of new bibliography on computational aspects of special functions available on our website.

In the paper entitled: “Melt Spinning: Optimal Control and Stability Issue” by Thomas Gotz and Shyam S.N. Perera, the authors studied a mathematical model which describe the melt spinning process of polymer fibers. The authors used Newtonian and non-Newtonian models in order to describe the rheology of the polymeric material. They also investigated two important properties, the optimization and the stability of the process.

In the paper entitled: “On orthonormal polynomial solutions of the Riesz system in \mathbb{R}^3 ” by K. Gürlebeck and J. Morais, a special orthogonal system of polynomial solutions of the Riesz system in \mathbb{R}^3 is studied. This system presents a proportion with the complex case of the Fourier exponential functions $\{e^{in\theta}\}_{n \geq 0}$ on the unit circle and has the additional property that also the scalar parts of the polynomials form an orthogonal system. An application of the properties of the above system to the explicit calculation of conjugate harmonic functions with a certain regularity is also presented.

In the paper entitled: “Brief survey on the CP methods for the Schrödinger equation” by L.Gr. Ixaru, a review of the CP methods is presented. The authors investigated, after years of research in the subject all the advantages over other methods.

In the paper entitled: “Symplectic Partitioned Runge–Kutta methods for the numerical integration of periodic and oscillatory problems” by Z. Kalogiratos, Th. Monovasilis and T.E. Simos an investigation on Symplectic Partitioned Runge–Kutta methods (SPRK) is presented. More specifically they present the methodology for the construction of the exponentially/trigonometrically fitted SPRK. They applied the above methodology to methods with corresponding order up to fifth. The trigonometrically-fitted approach is based on two different types of construction: (i) fitting at each stage and (ii) Simos’s approach. The authors also derived SPRK methods with minimal phase-lag as well as phase-fitted SPRK methods. Finally, they applied the methods to several problems.

In the paper entitled: “On the Klein-Gordon equation on some examples of conformally flat spin 3-manifolds” by Rolf Sören Kraußhar a review about recent results on the analytic treatment of the Klein-Gordon equation on some conformally flat 3-tori and on 3-spheres is presented. The paper has two parts. In the first part the time independent Klein-Gordon equation $(\Delta - \alpha^2)u = 0$ ($\alpha \in \mathbb{R}$) on some conformally flat 3-tori associated with a representative system of conformally inequivalent spinor bundles is considered. In the second part a unified approach to represent the solutions to the Klein-Gordon equation on 3-spheres is described.

The *hp* version of the finite element method (*hp*-FEM) combined with adaptive mesh refinement is a particularly efficient method. For this method a single error estimate can not simultaneously determine whether it is better to do the refinement by *h* or by *p*. Several strategies for making this determination have been proposed over the years. In the paper entitled: “A Survey of *hp*-Adaptive Strategies for Elliptic Partial Differential Equations” by William F. Mitchell and Marjorie A. McClain, the authors studied these strategies and demonstrate the exponential convergence rates with two classic test problems.

In the paper entitled: “Vectorized Solution of ODEs in MATLAB with Control of Residual and Error” by L.F. Shampine a study on vectorization which is very important to the efficient computation in the popular problem-solving environment MATLAB is presented. More specifically, the author derived a new error control procedure which is based on vectorization. An explicit Runge—Kutta (7,8) pair of formulas that exploits vectorization is obtained. The new proposed method controls the local error at 8 points equally spaced in the span of a step. A new solver which is based on the above mentiobed pair and it is called `odevr7` is developed. This solver is much more efficient than the solver `ode45` which is recommended by MATLAB.

In the paper entitled: “Forecasting equations in complex-quaternionic setting” by W. Sprössig, the author considered classes of fluid flow problems under given initial value and boundary value conditions on the sphere and on ball shells in \mathbb{R}^3 . The author interest is emphasized to the forecasting equations and the deduction of a suitable quaternionic operator calculus.

In the paper entitled: “Symplectic exponentially-fitted modified Runge—Kutta methods of the Gauss type: revisited” by G. Vanden Berghe and M. Van Daele, the development of symmetric and symplectic exponentially-fitted Runge—Kutta methods for the numerical integration of Hamiltonian systems with oscillatory solutions is studied. New integrators are obtained following the six-step procedure of Ixaru and Vanden Berghe (*Exponential Fitting*, Kluwer Academic, 2004).

We would like to express our gratitude to the numerous (anonymous) referees, to Prof. Hélène de Rode, the President of the European Academy of Sciences for giving us the opportunity to come up with this guest editorial work.

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