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Preface

Front propagation is ubiquitous throughout science and beyond, from the invasion of species in population dynamics, to flame propagation in combustion, to calcium waves in cell signalling, to the dynamics of tumour growth, to the spread of rumours in social networks. Reaction-diffusion-advection equations and systems arise widely in modelling phenomena in biology, physics and chemistry, and travelling fronts and spreading speeds for such equations have been intensively studied ever since the seminal work of Kolmogorov-Petrovskii-Piskounov and Fisher in 1937.

In this special issue, we collect together a series of articles, from a variety of perspectives, that centre around state-of-the-art advances in this field. Topical areas addressed include the effect of nonlocality and delay on front propagation, and the existence of travelling waves in cylindrical domains with nonlinear boundary conditions. A novel approach to characterising the pushed/pulled nature of fronts is extended to a class of delay equations, and a recently-introduced class of population spread models based on reaction-diffusion equations with free boundaries is further developed. Waves for various systems of reaction-diffusion equations, from autocatalytic systems to competition systems to classes of chemotaxis and cross-diffusion systems, are investigated using a range of analytical and numerical approaches. Computational studies are made to try to resolve the fundamental question of front speeds in complex fluid flows, for both cellular and Arnold-Beltrami-Childress flows in reaction-diffusion-advection equations with Fisher-KPP nonlinearity, and for cellular flows in G-equation models of turbulent combustion. The issue also includes a detailed study of modelling aspects of mechano-chemical reaction-diffusion models for calcium waves, as well as work in the active field of lattice differential equations, which arise particularly in certain models for population dynamics and materials, on the topic of wave-like entire solutions in a nonlocal setting with delay.

Several themes and ideas recur throughout the issue - notably the current interest in nonlocal and delay effects on propagation, the usefulness of exploiting both theoretical and computational methods, and the importance of understanding the significance of the results obtained for the underlying application, whether it be to genetic diversity, or the spread of inflammation, or the rôle of quiescent phases in populations, or some other discipline. We hope that readers will find the collection of papers stimulating and enjoyable, and also will discover and develop their own connections, both amongst the work presented here and with their own interests.

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