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Editorial Note

Alwyn C. Scott and His Legacy in Nonlinear Science

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Saddened by the news of Alwyn Scott's death, the editors of Acta Applicandae Mathematicae (ACAP) decided to dedicate to his memory, a special issue of the journal. At the end of 2008 invitation letters were sent to former Al Scott's collaborators and to the international scientific community. They laid out the plan of a volume with focus on several topics Al was involved in: nonlinear diffusion, Josephson (superconducting) transmission lines, coupled anharmonic oscillators, neural systems and biomolecular dynamics. Another publication project was then underway ([1]; solitons in biology) but ACAP editors felt that it had a more limited scope. The special issue planned by ACAP aimed to reach out to a variety of fields and communicate across disciplines; it did not wish to place limitations on what prospective authors might have felt important, and it encouraged submission of both research articles and review articles as a mix. While positive feedback was received from colleagues, the project has been delayed for couple of years due to unforseen events. It is a pleasure to announce now its completion and to see it in final publication form.

Alwyn Scott was an editor for Acta Applicandae Mathematicae from the beginning. The founding editor of ACAP was Michiel Hazewinkel and the first journal issue appeared in 1983. Alwyn Scott and one of the present editors (Palle Jorgensen), were part of this event. Jorgensen recalls how Alwyn, and the other members of the initial editorial board, shared Michiel's vision for the journal. At the time, over the phone and in wider mathematical circles, Michiel vigorously articulated and promoted his ideas and willingness to take risks in nurturing a forward looking and truly interdisciplinary journal. The nineteen-eighties were a period witnessing solutions of deep problems in mathematics. At the same time, an increased distance between mathematics and its applications could be sensed. Back then, and perhaps even today, one sees trends in mathematics with increasing specialization (overspecialization); a tendency for researchers to narrow their focus, specialist authors to write

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for other specialists, and areas to divorce themselves from ideas originating from the outside. Nevertheless, Michiel insisted that authors make a case for why their theorems will be relevant to researchers in other areas of mathematics, and to neighboring sciences, and Al was a strong supporter of this vision. He remained a supporter of interdisciplinary science to the end.

During his life, Alwyn Scott (1931–2007) pioneered and promoted nonlinear science through fundamental work on nonlinear waves, protein dynamics, nerve impulses and human consciousness. He was a founding editor of Elsevier's Nonlinear Phenomena scientific journal and the founding director of the Center for Nonlinear Studies at the Los Alamos National Laboratory in the United States. He was awarded numerous patents and published more than 150 peer-reviewed articles. He authored six books [2–7] and edited many others [8, 9]. His life and scientific accomplishments are presented by several valuable resources: an obituary written by his son [10] as well as articles and memories published by his past collaborators (Robert H. Austin [11], Chris Eilbeck [12], Robert Ecke, David Campbell, Alan Newell, Mac Hyman [13]). We will therefore focus here only on Alwyn Scott's most known results.

Scott, together with Chu and McLaughlin, wrote their first review on soliton theory in 1973, offering a pioneering and influential account and introduction to the field [14]. The term soliton had been coined earlier by Zabusky and Kruskal for a pulse-like nonlinear wave (now called a *solitary wave*), emerging with unchanged shape and speed, for example, from multi-pulse collisions [15]. Since then, multitudes of soliton wave equations have been found in applied sciences [16–19]. Among other things, during one visit to Heriot-Watt University in Scotland, UK, in 1995, Alwyn contributed to a successful experimental recreation of the Scott Russell's soliton [20].

Inspired by his strong background in physics and his interest in biology, Alwyn Scott championed the idea of the importance of soliton-like localized processes on biological macromolecules, in particular the Davydov soliton [21]; and even in neuroscience [22]. These macromolecules include molecular structure of proteins, carbohydrates, and nucleic acids. Their scope includes biological interactions, molecular associations, and functional properties. Since then, the science of biological macromolecules has flourished and it is now the subject of research journals of its own.

From the papers of Peter Lax [23] we now have the theory of integrable systems, constant of motions derived from what is now called Lax pairs: pairs of time-dependent operators (or infinite matrices) describing the differential equations of soliton waves, and solitons in continuous media. Other developments include the inverse scattering transform used in solving certain non-linear systems. Scott left his print on the theory of integrable systems through his paper with McLaughlin which introduced the use of perturbation theory as an innovative method in the study of solvable (near-integrable) models [24].

In 1977 Scott published an important review on to-date-status of neural network dynamics discussing emergent difficulties in addressing the human mind [25]. Then, while being funded by a European Molecular Biology Organization Fellowship (1979–1980) he studied the interactions of nerve impulses in the squid giant axon. His interest in neuroscience and human consciousness continued during his scientific career and culminated with the book *Neuroscience, a Mathematical Primer* that he published in 2002 [6].

Right up to his death, he edited a comprehensive volume of the *Encyclopedia of Nonlinear Science* to which more than 200 researchers contributed with their articles [9], and he was working on a history of nonlinear science, *The Nonlinear Universe: Chaos, Emergence, Life* which appeared postmortem [7].

This special issue of ACAP is a tribute to Alwyn Scott's work and vision. It contains a review on Davydov solitons and articles covering nonlinear phenomena from physics (interacting wave fronts in nonlinear thermoviscous fluids; magnetic flux lines in superconductors; reduced density matrix of permutational invariant many-body systems) and biology (pattern formation in models of epidemic disease and predator-prey diffusion system; non-autonomous differential systems with impulses and time-varying delays). The editors would like to thank the researchers who contributed with their papers to this special issue and made it successful. Many thanks go to the authors: Tommy Sonne Alstrøm, Peter Leth Christiansen, Yuri Borisovich Gaididei, Søren Madsen, Virginia Muto, Niels Falsig Pedersen, Vladislav Popkov, Anders Rønne Rassmusen, Mario Salerno, Mads Peter Sørensen, and Wan-Tong Li, Ying Li, Yuanfu Shao, Changjin Xu, Xiang-Ping Yan and Jia-Fang Zhang. Likewise, many thanks go to the ACAP editorial board who supported this project.

References

1. Special Issue of the J. Biol. Phys. **35**(1) (2009)
2. Scott, A.: Active and Nonlinear Wave Propagation in Electronics. Wiley, New York (1970)
3. Scott, A.: Neurophysics. Wiley, New York (1977)
4. Scott, A.: Stairway to the Mind: The Controversial New Science of Consciousness, 2nd edn. Springer, New York (1999). 1st edn. (1995)
5. Scott, A.: Nonlinear Science: Emergence and Dynamics of Coherent Structures, 2nd edn. Oxford University Press, New York (2003). 1st edn. (1999)
6. Scott, A.: Neuroscience: A Mathematical Primer. Springer, New York (2002)
7. Scott, A.: The Nonlinear Universe: Chaos, Emergence, Life. Springer, Berlin (2007)
8. Christiansen, P.L., Sørensen, M.P., Scott, A.C. (eds.): Nonlinear Science at the Dawn of the 21st Century. Lecture Notes in Physics, vol. 542 Springer, Berlin (2000)
9. Scott, A. (ed.): Encyclopedia of Nonlinear Science. Routledge, London (2005)
10. Scott, A. Jr.: Alwyn Scott: Pioneer and champion of nonlinear science. http://www.consciousness.arizona.edu/alwyn.htm (2007)
11. Austin, R.H.: Alwyn C. Scott, a subversive character in Biological Physics. J. Biol. Phys. **35**(1), 1–3 (2009)
12. Eilbeck, C.: Alwyn C. Scott. December 25, 1931–January 11, 2007. http://www.ma.hw.ac.uk/~chris/alwyn_scott/
13. Article about Martin Kruskal and Alwyn Scott posted on the website of the Center for Nonlinear Sciences, Los Alamos National Laboratory, USA. http://cnls.lanl.gov/External/Kruskal_Scott_Article.php
14. Scott, A.C., Chu, F.Y.F., McLaughlin, D.W.: The soliton: a new concept in applied science. Proc. IEEE **61**, 1443–83 (1973)
15. Zabusky, N.J., Kruskal, M.D.: Interaction of solitons in a collisionless plasma and the recurrence of initial states. Phys. Rev. Lett. **15**, 240–243 (1965)
16. Scott, A.C.: Soliton binding energy for the quantum discrete nonlinear Schrödinger equation. Phys. Lett. A **151**(3–4), 136–138 (1990)
17. Abrarov, R.M., Christiansen, P.L., Darmanyan, S.A., Scott, A.C., Soerensen, M.P.: Soliton propagation in three coupled nonlinear Schrödinger equations. Phys. Lett. A **171**(5–6), 298–302 (1992)
18. Christiansen, P.L., Hays, M.H., Jørgensen, M.F., Scott, A.C.: Quantizing a rotating wave. Phys. Lett. A **201**(5–6), 407–412 (1995)
19. Gilhøj, H., Eilbeck, J.C., Scott, A.C.: Quantum solitons in the DNLS and Hubbard models. In: Future Directions of Nonlinear Dynamics in Physical and Biological Systems. Series NATO Adv. Sci. Inst. Ser. B Phys., vol. 312, pp. 227–230. Plenum, New York (1993)
20. Russell, J.S.: Report on waves. Br. Assoc. Adv. Sci. **14**, 311–389 (1844)
21. Davydov, A.S.: The theory of contraction of proteins under their excitation. J. Theor. Biol. **38**, 559–569 (1973)
22. Binczak, S., Eilbeck, J.C., Scott, A.C.: Ephaptic coupling of myelinated nerve fibers. Phys. D **148**(1–2), 159–174 (2001)
23. Lax, P.D.: A Hamiltonian approach to the KdV and other equations. In: Nonlinear Evolution Equations, Proc. Sympos. Univ. Wisconsin, Madison, Wis, vol. 40, pp. 207–224. (1978)
24. McLaughlin, D.W., Scott, A.C.: Perturbation analysis of fluxon dynamics. Phys. Rev. A **18**, 1652–1680 (1978)
25. Scott, A.: Neurodynamics: a critical survey. J. Math. Psychol. **15**, 1–45 (1977)