This Week's Citation Classic

Scott A C, Chu F Y F & McLaughlin D W. The soliton: **a** new concept in applied science. *Proc. IEEE* **61**:1443-83, 1973. [University of Wisconsin, Madison, WI; Iowa State University, Ames IA]

The term *soliton* was coined in 1965 for a pulse-like nonlinear wave (solitary wave) that emerges from a multipulse collision having unchanged shape and speed. More than a dozen soliton wave equations have been found representing a wide range of applications in applied science. This review covers the status of soliton research up to 1973. [The *SCI*® indicates that this paper has been cited over 230 times since 1973.]

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"My colleagues, Flora Chu (now in the Electrical Engineering Department at the Massachusetts Institute of Technology) and Dave McLaughlin (Mathematics Department, University of Arizona), and I continue to be surprised and delighted at the interest shown in this review. Before suggesting why the paper has been so often cited, it is appropriate to explain what the term *soliton* means. As coined by Zabusky and Kruskal,[1] this term is generic for special *solitary wave* solutions of certain nonlinear wave equations. What then is a solitary wave? It is a pulse-like wave that travels with constant speed and shape; the effects of dispersion on the wave shape are just balanced by those of nonlinearity. There is just enough *yin* for the *yang;* it is a dynamically self-sufficient object, a 'thing.'

"Solitons are solitary waves that preserve their speeds and shapes after mutual collision. They play a role in the construction of complete solutions for the nonlinear wave equation[2] that corresponds to the role played by Fourier components in the construction of solutions for linear wave equations. Soliton equations are special, but they are by no means unimportant; they arise in such diverse areas of applied science as hydrodynamics, nonlinear optics, plasma dynamics, meteorology, Josephson type superconductive devices, nonlinear acoustics, oceanography, domain wall dynamics, dislocation theory, nonlinear electric filters, and in the theory of elementary particles.

"The 'thingness' of a solitary wave is not a new concept. In 1834 John Scott Russell discovered a hydrodynamic solitary wave[3] during a series of measurements to fix the design of Scottish canal boats. Contrary to opinions of leading nineteenth century scientists, Russell always felt that his 'Great Wave' was poorly understood and of fundamental importance. The growing interest in solitons shown by elementary particle physicists over the past few years is directed toward the solitary wave property. From this perspective, therefore, the soliton is a concept whose time has arrived.

"The paper was first planned in 1971, but we profited greatly from ideas presented and generated at the Clarkson Conference on Nonlinear Waves held at Potsdam, NY during the summer of 1972. Although mathematical concepts are of fundamental importance, it was a physically oriented review and suggestive rather than exhaustive. We missed some important references from the USSR, but the bibliography was as complete as we could make it at the time of publication."

1. **Zabusky N J & Kruskal M D.** Interaction of solitons in a collisionless plasma and the recurrence of initial states. *Phys. Rev. Lett.* **15**:240-3, 1965.
2. **Gardner C S, Greene J M, Kruskal M D & Miura R M.** Method for solving the Korteweg-de Vries equation. *Phys. Rev. Lett.* **19**:1095-7. 1967.
3. **Russell J S**. Report on waves. *Brit. Ass. Rep.* **14**:311-89, 1844.