John Morgan Greene

John Morgan Greene, an unusually creative, world-renowned physicist and applied mathematician, died on 22 October 2007 in San Diego, California, due to complications from Parkinson's disease. His work on magnetohydrodynamics set the gold standard in fusion plasma physics, and his codiscovery of the soliton inverse scattering transform is among the greatest developments in applied mathematics.

Born on 22 September 1928 in Pittsburgh, Pennsylvania, John spent the bulk of his formative years in Manhattan, Kansas. He consistently placed first in the Kansas state mathematics competition and earned a scholarship from the Pepsi Cola Co to attend Caltech. He graduated from Manhattan High School in 1946, Caltech in 1950, and the University of Rochester in 1956 with a PhD in physics. *His thesis, "Higher-Order Corrections to the Nucleon-Nucleon Potential in Charge-Symmetric Pseudoscalar Theory," was written under the advice of Profs. David Feldman and Robert Marshak. Also, as a student he published work in astrophysics with Prof. Malcolm Savedoff.* While researching nuclear theory at Rochester, he learned about inverse scattering in quantum mechanics, a fortuitous event of subsequent importance.

In 1955 John joined Princeton University's Project Matterhorn, the predecessor to the Plasma Physics Laboratory, where Lyman Spitzer was using his stellarator to confine plasma magnetically for controlled fusion. Simplified magnetohydrodynamic equations were used in early theory to calculate stellarator equilibrium and stability properties.

Over several decades John and his collaborators tackled ever more realistic magnetohydrodynamic calculations for toroidal devices. With *one of us (Johnson)* and Katherine Weimer he coauthored classic papers on toroidal stellarator and tokamak equilibrium and on ideal kink and interchange instabilities. In collaboration with others, including Bruno Coppi and Alan Glasser, they developed a major treatment of dissipative instabilities. John had a lifelong interest in computation and early on explored the limits of computer simulation. He, Ray Grimm, and Johnson developed the *Princeton Equilibrium and Stability in Tokamaks (PEST) code***,** an important tool used worldwide to design and interpret fusion experiments.

With Ira Bernstein and Martin Kruskal, John investigated both nonlinearity and inhomogeneity in the Vlasov equation. In a famous 1957 paper, they constructed exact nonlinear periodic and pulse-like traveling-wave solutions—later called Bernstein-Greene-Kruskal modes—by means of an inverse problem for obtaining trapped particles. That work was a harbinger of the soliton solutions later obtained by inverse scattering.

The history of the Korteweg–de Vries soliton has been widely recounted because of its broad importance in physics and mathematics. John's unique contribution was to the inverse scattering transform, for which he, Clifford Gardner, Kruskal, and Robert Miura received the 2006 Leroy P. Steele Prize from the American Mathematical Society. One day, as Kruskal and Miura were working on the blackboard, John walked by on his way to get coffee. He quipped, "You are trying to solve the inverse scattering problem," which he recalled from his days at Rochester. John was most pleased with his inverse

scattering work; his wife, Alice, recalls his triumphal announcement, “It unfolded like a lily!”

John’s interest in Hamiltonian dynamics arose from the area-preserving maps that describe magnetic field lines in stellarators. After many years of work, in 1968 he published numerical techniques for obtaining and describing periodic orbits, precursors to his famous 1979 paper that described “Greene’s residue criterion.” That criterion, which provides a method for calculating to very high accuracy the parameter value for the destruction of the last *action surface (torus) with golden mean frequency (rotation number),* is deeply significant. That work was placed in a renormalization group setting in the 1980s with his student Robert MacKay and generalized to nontwist maps with Diego del-Castillo-Negrete and one of us (Morrison) in 1996. In 1979 Morrison interested John in viewing magnetohydrodynamics as an infinite-dimensional Hamiltonian system, and that interest resulted in an influential 1980 paper on noncanonical Poisson brackets.

In 1982 John joined the theory group at General Atomics in La Jolla, California, and became an adjunct professor of physics at the University of California, San Diego *in 1983*. In 1992 he published important results on the significance of magnetic field nulls for reconnection. He continued to work with and inspire many colleagues even after his retirement in 1995. In 1992, for his many discoveries, he received the James Clerk Maxwell Prize from the American Physical Society.

John, an Eagle Scout and an avid hiker, camper, and bird watcher, was active in conservation projects and in the Sierra Club. Markedly accomplished, yet gentle and generous, John had a kind and humble spirit that drew the best from his fortunate collaborators. *His unique mannerisms shaded a stunning combination of deep physical insight and exceptional mathematical ability. John's human qualities together with his devotion to science serve as role models to his many colleagues and friends who miss him.*

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