

The Fermi Pasta Ulam Tsingou (FPUT) Paradox: The Birth of Nonlinear Science

*David K. Campbell
Boston University*

*Basil Nicolaenko Memorial Distinguished Lecture in Nonlinear Studies
Arizona State University
March 27, 2024*

In 1953, Enrico Fermi, John Pasta, Stan Ulam, and Mary Tsingou initiated a series of computer studies in Los Alamos aimed at exploring how simple, multi-degree of freedom nonlinear mechanical systems obeying reversible deterministic dynamics evolve in time to an equilibrium state describable by statistical mechanics. Their expectation was that this would occur by mixing behavior among the many linear modes. Their intention was then to study more complex nonlinear systems, with the hope of modeling turbulence computationally.

What they found instead came to be known as the “Fermi-Pasta-Ulam-Tsingou (FPUT) paradox” and led to the creation of the interdisciplinary field of “nonlinear science” and indirectly to the formation of the Center for Nonlinear Studies (CNLS) at Los Alamos National Laboratory. In this colloquium, I will review the history of these events, focusing initially on the important role that Basil Nicolaenko played in co-founding the CNLS. I will then discuss the important paradigms of nonlinear science---chaos, “solitons,” and patterns—and illustrate how an integrated approach to studying these paradigms has enabled the CNLS to prosper for more than 40 years. I hope at the end of the talk you will understand that the picture below reflects the beauty of nonlinear science.

