James Stephen Muldowney (1939 – 2022)

By Michael Li

James S. Muldowney, a Professor Emeritus at the University of Alberta, passed away peacefully at home in Edmonton, Alberta, Canada, on March 7, 2022. An immigrant from Ireland, Jim was born on December 25, 1939 in Thomastown, County Kilkenny, Ireland. He was educated at Coláiste Íosagán in Ballyvourney, a secondary school for top students around Ireland. He attended the National University of Ireland Galway for both his BSc (1960) and MSc (1961) in Mathematical Physics. Jim came to the University of Alberta and received his PhD in Mathematics in 1965. After two years as an Assistant Professor at the University of Oklahoma, Jim came back to Canada and began his long academic career at the University of Alberta and life in Edmonton. He was promoted to Full Professor in 1976 and served as Associate Chair for Graduate Studies, Associate Dean for the Faculty of Graduate Studies and Research, and the University of Alberta Site Director for the Pacific Institute of Mathematical Sciences (PIMS). James supervised four PhD students and numerous MSc students and undergraduate research students. He was a beloved teacher and dedicated his career to the research and teaching of mathematics and service to the scientific community. Jim was an integral part of the Americas Conference series, co-organized two meetings in Edmonton and served on the series' Executive Committee before he retired.

Jim's earlier research was on disconjugacy and nonocillatory properties of second order linear ODEs and exponential dichotomy for linear systems [1]. Since late 1980s, he became interested in compound matrices and the associated compound linear differential systems that govern the evolution of k-dimensional volumes in n-dimensional linear systems. He was first to apply these properties to generalize the Bendixson and Dulac criteria for nonexistence of periodic solutions and the Poincare's stability conditions for periodic orbits, from 2d to higher dimensional autonomous systems [3,4,5,8]. Jim further explored the implications of the asymptotic stability of the second compound system of the linearization along bounded solutions. With Michael Li, Jim proved Autonomous Convergence Theorem in n-dimensional systems (first proposed and proved by Russell Smith) under the C^1 robustness of Bendixson conditions and using the Pugh's Closing Lemma [5]. In further developments, Jim and Michael Li were able to generalize key components of the classical Poincare-Bendixson Theorem from 2d to higher dimensional systems [6]. These results have been successfully applied by many researchers in different fields of applied mathematics, engineering, economics, social sciences, and mathematical biology. In

particular, Jim and Michael were able to use the theory to resolve a long-standing open problem on global stability of SEIR models in epidemiology [7]. The collections of results are now referred to the Li-Muldowney theory (the names appear in alphabetical order and Jim was the brain behind the theory). Jim and Qian Wang developed the theory of compound systems and generalized Bendixson conditions to infinite dimensional dynamical systems of PDEs and delay equations [9]. He was working on a book on that topic before his sudden death.

Jim was devoted to his family. He and his wife, Fidelma, had been together for 58 years, with three children and five grandchildren. He was an avid cross-country skier and a long-distance runner. People who know Jim will remember his warm heart, caring soul, unwavering integrity, great sense of humor, and his infectious Irish smile. He will be deeply missed.

References

[1] J. S. Muldowney, Dichotomies and asymptotic behaviour for linear differential systems. *Trans. Amer. Math. Soc*. **283** (1984), 465-484.

[2] J. S. Muldowney, Compound matrices and ordinary differential equations, *Rocky Mountain J. Math*. **20** (1990), 857-872.

[3] J. S. Muldowney, Implications of the stability of an orbit for its omega limit set. *Advances in stability theory at the end of the 20th century*, 217-229, *Stability Control Theory Methods Appl.*, **13**, Taylor & Francis, London, 2003.

[4] Y. Li and J. S. Muldowney, On Bendixson's criterion. *J. Differential Equations* **106** (1993), 27-39.

[5] M. Y. Li and J. S. Muldowney, On R. A. Smith's autonomous convergence theorem. *Second Geoffrey J. Butler Memorial Conference in Differential Equations and Mathematical Biology* (Edmonton, AB, 1992). *Rocky Mountain J. Math*. **25** (1995), 365–379.

[6] M. Y. Li and J. S. Muldowney, Phase asymptotic semiflows, Poincaré's condition, and the existence of stable limit cycles. *J. Differential Equations* **124** (1996), 425-448.

[7] M. Y. Li, and J. S. Muldowney, Global stability for the SEIR model in epidemiology. *Math. Biosci.* **125** (1995), 155-164.

[8] C. C. McCluskey and J. S. Muldowney, Stability implications of Bendixson's criterion. *SIAM Rev*. **40** (1998), 931-934

[9] J. S. Muldowney and Q. Wang, Compound operators on vector spaces with applications to linear differential equations. *J. Differential Equations* **294** (2021), 118-142.