

George Pólya Awards

Johnner Barrett

“Unlawful Calculations: A Look into Lie’s Notebook,” *The College Mathematics Journal*, 53:2, 104–115. doi.org/10.1080/07468342.2021.2019550

Many great thinkers throughout history, including mathematicians, have faced challenges and obstacles in their pursuit of knowledge and understanding. And, sometimes, mathematicians and their cryptic-looking notes may catch the unwanted attention of law enforcement officials. In the article “Unlawful Calculations: A Look Into Lie’s Notebook,” Johnner Barrett explores the mathematical advances that arose out of a collaboration between Sophus Lie and Felix Klein during the Franco-Prussian War—a voyage of mathematical discovery that landed Lie in prison!

This engaging article connects the humanity driving mathematics with concepts from calculus (such as slope or vector fields) and differential equations (such as separation of variables) to geometric notions such as slides. “Blending pictures and calculation in this way to solve problems was exactly what Lie did.” (Barrett, p. 107) And that is exactly what Barrett leads the reader to do, providing a missing link between the practice and theory of vector calculus and differential equations. Barrett begins his review of Lie’s notebook by carefully explaining how vector fields can be viewed as partial derivatives and associated with certain transformations, or “slides”, thereby yielding a geometric interpretation of the technique of separation of variables. In fact, by examining slides that leave certain graphs unchanged, one may discover a clever change of variable to help solve a given ODE. Barrett’s article contains many examples and exercises to help train the reader in this geometric approach to differential equations.

“Unlawful Calculations” simultaneously provides motivation for undergraduates to take a course in differential equations while also providing new and useful techniques for those already familiar with such coursework. And, for those faculty who teach advanced courses in applications of mathematics, Barrett’s article shows a successful approach to blending history, practice, theory, and a variety of mathematical ideas. Lie’s month-long stay in prison gave him “plenty of peace and quiet” to help formulate his ideas. Readers will enjoy the engaging exposition, underlying mathematical connections, and clever geometric reasoning.

Response

Truth is more exciting than fiction. Menzio’s and Lie’s tales tell themselves. An advisor had told me of Lie’s plight. Then my wife pointed out Catherine

Rampell's article about Menzio and slowly, "Unlawful Calculations" came to life. I had prepared a talk involving some of the examples in "Unlawful Calculations" and these combined easily with the story. I am delighted "Unlawful Calculations" has earned the George Pólya Award, highlighting symmetries of differential equations. Visualizing differential equations in this way uses both sides of the brain, a key to success. This is the result of many years of study and connects vector calculus and differential equations in an accessible way. May this inspire people to explore Lie's geometric methods in a law-abiding fashion.

Biographical Sketch

Johnner Barrett began studying group actions and differential equations at Penn State University and continued at Oregon State University. "Unlawful Calculations" is the entertaining product of these studies. Johnner communicates complex concepts in understandable terms, making mathematics accessible to a broad range of people in many disciplines. Beyond mathematics, Johnner is a performing musician, recreational linguist and martial artist.