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Editorial

Noether and Space-Time Symmetries in Physics

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Symmetry is the most common and important principle of those which guide efforts to construct realistic theories in science. The notion of symmetry is not only fundamental in cosmological theories, but also in quantum theory, thermodynamics, statistical physics, etc. Symmetry has always been a central concept in physics, and the study of space–time symmetries has played a crucial role in the development of our understanding of the laws of the universe. The Noether theorem, named after mathematician Emmy Noether, has been a particularly powerful tool in this regard, allowing researchers to link the conservation laws of physics with the symmetries of space and time.

Most of the equations for dynamical systems in physics, such as the field equations of any gravity theory, are systems of non-linear ordinary/partial differential equations and are generally difficult to solve. Noether theorem and space–time symmetries are some of the tools which can be used to solve these complicated systems of ordinary/partial differential equations. Symmetries of Lagrangians are of great interest on account of Noether's theorem, which has been widely used in cosmology and gravity theories. Space–time symmetries such as isometries and collineations can reduce the number of unknown functions in space–time metric components.

The principal aim of this Special Edition is to invite researchers working in theoretical and mathematical physics to submit work in which Noether and the space–time symmetry approaches are used to find exact solutions for the corresponding equations representing certain dynamical systems. This Special Issue [1–15] focuses on the most recent advances in the applications of Noether and space–time symmetries to dynamical problems. The papers collected in this Special Issue of *Symmetry* explore the interplay between space–time symmetries and physics, with a particular emphasis on the Noether theorem. Authors cover a wide range of topics, ranging from the foundations of symmetries in classical mechanics to the latest developments in quantum field theory and cosmology.

Among the themes that emerge from the published papers is the importance of symmetry breaking in physics. The Noether theorem tells us that symmetries give rise to conserved quantities. However, in many cases, these symmetries are only approximate, and the conservation laws they generate are only approximately valid. Understanding how and why these symmetries break down is crucial for explaining many of the phenomena we observe in the universe.

Another theme that runs through the papers is the importance of the Noether theorem in the study of fundamental physics. From the foundations of classical mechanics to the most cutting-edge theories of quantum gravity, the Noether theorem has been a powerful tool for understanding the underlying symmetries of the universe.

We hope that this Special Issue will provide a valuable resource for researchers and students interested in the interplay between space–time symmetries and physics. We would like to thank all the authors who contributed to this Issue for their insightful

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Short Biography of Authors

Ugur Camci is an affiliated researcher at the Department of Chemistry and Physics, Roger Williams University (Rhode Island, USA), since 2020. Previously, he was a Professor at the Department of Physics, Canakkale Onsekiz Mart University (2007–2009) and the Department of Physics, Akdeniz University, Antalya, Turkey (2009–2017). He also worked at Feza Gursey Institute (Istanbul, Turkey) as a Postdoctoral Research Fellow in between 1999–2000. During his early career, Ugur gained substantial experience in the field of Mathematical and Gravitational Physics during the research semesters at Feza Gursey Institute. His main scientific research interests focus on space-time symmetries and collineations, Lie and Noether symmetries, application of symmetry methods to the gravity theories, exact solutions of gravitational equations and their properties.

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Ashfaque H. Bokhari is currently a full professor at the Mathematics Department of King Fahd University of Petroleum and Minerals, Saudi Arabia. He is also an Editor of the Arabian Journal of Mathematics published by Springer. He is recipient of the Salam Prize in Mathematics for his work on spacetime symmetries. He received Fulbright, Commonwealth, and DAAD fellowships. He has had a long association with the International Center for Theoretical Physics as an associate member. The area of interest of Ashfaque Bokhari include exact solutions in General Relativity, Cosmology, differential Geometry and Lie point symmetries and partial differential equations.