

## Educational Activities IMEIO- UPM

<b>Title:</b> The symmetry approach to integrability and solvability of ordinary and partial differential equations.
<b>Responsible for the activity:</b> Rafael Hernández Heredero
<b>Lecturers:</b> Rafael Hernández Heredero; Pilar Ruiz Gordo; Andrew Pickering
<b>Total number of hours:</b> 12
<b>Location:</b> ETSI Navales, Universidad Politécnica de Madrid
<b>Dates:</b> January 2025 / February 2025

During the second half of the 20th century, Lie's infinitesimal methods experienced a big revival. They were applied to countless problems including the theory of bifurcations, special functions, numerical analysis, control theory, self-similar solutions of hydrodynamics systems and other fields of Physics and Engineering. A panoramic overview of these methods will be given, discussing their application to the resolution of differential equations and to the characterization of integrable equations solvable by quadratures.

A further important development in the field of differential equations, which also took place in the second half of the last century, was the introduction of the inverse scattering transform for completely integrable partial differential equations. Related developments were Darboux/Bäcklund transformations, hidden and higher symmetries and recursion operators for symmetries and conservation laws. Reductions of such integrable systems were found to include the Painlevé equations, which then provided the motivation for the study of solution methods for these classical equations, and other similar ordinary differential equations. In this course we will show how the dimensional analysis is a particular, classical case of Lie theory, and will continue by analyzing how the traditional integration methods for ordinary differential equations are also due to the existence of Lie symmetries. Other solution methods for ordinary differential equations will be studied. Modern solution methods for partial differential equations will also be explored. The goal of modern approaches is to define a concept of integrability of partial differential equations, trying to generalise the Liouvillian definition for ordinary differential systems, and to develop accordingly methods for finding explicit solutions.

**Would you accept that the course could be given by videoconference restricted to some doctoral students who could not attend in person?**

**NO**