Contribution ID: **121** Type: **Oral Presentations**

The direct and inverse Lie symmetry techniques for nonlinear physical systems

Wednesday 9 July 2025 17:30 (20 minutes)

The paper presents both monographic aspects and new results on how a given nonlinear differential equation can be generalized to an equation with stronger nonlinearities but with an imposed class of solutions. More precisely we are considering a general form of 2D reaction-diffusion equation and, by imposing a pre-defined class of symmetry, we are obtaining the most general equations from the considered class that accept the imposed symmetry.

The procedure is based on the Lie symmetry method and it allows us to obtain the conditions in which a given model accepts nontrivial symmetries. On the other hand, we can to identify and to solve equations that generalize well known solvable nonlinear models.

How the procedure is functioning is illustrated on the model with a mixed second order spatial derivative and with general source term, respectively on the transfer equation with power law nonlinearities.

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Session Classification: Plasma, Statistical and Nonlinear Physics

Track Classification: S08 –Plasma, Statistical and Nonlinear Physics