DEPARTMENT OF MATHEMATICAL PHYSICS AND DIFFERENTIAL GEOMETRY

HEAD: Prof. dr hab. Janusz Grabowski   (Geometric structures in physics)

is studying various algebraic and geometric structures that play a fundamental rôle in Differential Geometry (including super-geometry) and Physics.

Among them are Poisson and Jacobi structures (in particular, symplectic and contact), Lie algebroids and groupoids, Courant algebroids and Dirac structures, graded manifolds of different types, and principles of Hamiltonian and Lagrangian formalisms – all this with applications to Theoretical Mechanics, foundations of Quantum Mechanics, Quantum Information Theory, etc. The last activity concentrates on contact structures in Geometrical Mechanics and their generalizations and graded supergeometry.

Recent papers:

- Grabowska, Katarzyna; Grabowski, Janusz; Kuś, Marek; Marmo, Giuseppe, *Lifting statistical structures*. *Rev. Math. Phys.* **35** (2023), Paper No. 2250042, 51 pp.

- Grabowska, Katarzyna; Grabowski, Janusz, *A geometric approach to contact Hamiltonians and contact Hamilton-Jacobi theory.* *J. Phys. A* **55** (2022), no. 43, Paper No. 435204, 34 pp.

- Grabowska, Katarzyna; Grabowski, Janusz; Ravanpak, Zohreh*, VB-structures and generalizations.* *Ann. Global Anal. Geom.* **62** (2022), 235-284.

- Grabowska, Katarzyna; Grabowski, Janusz; Kuś, Marek; Marmo, Giuseppe, *Lie groupoids in information geometry*. *J. Phys. A* **52** (2019), Paper No. 505202, 22 pp.

Prof. dr hab. Andrzej Królak
(Mathematical aspects of data analysis from gravitational wave detectors)

The main activity concerns applications of methods of statistics and the theory of stochastic processes to the problem of detection of gravitational waves in the noise of the detector. Detection of gravitational waves that was achieved by LIGO detectors in the year 2015 provided confirmation of Einstein's theory of gravity and opened a new window on the Universe.

He specializes in searches for gravitational wave signals from rotating neutron stars. This is a very challenging problem, as it requires extraction from the noise of the detector extremely weak signals, and searches over extremely large parameter space. He has developed a number of theoretical algorithms and tools to performed such searches. Using these tools a number of computer codes to search for such signals have been developed. The codes are used for the analysis of LIGO and Virgo gravitational wave detector data and resulted in several publications of the LIGO - Virgo consortium. Andrzej Królak is the leader of the Polgraw group, a member group of the Virgo Collaboration (https://www.virgo-gw.eu/). The group consists of 30 scientists from 10 Institutes in Poland.

Selected works:

- P. Jaranowski, A. Krolak, and B. F. Schutz, *Data analysis of gravitational-wave signals from pulsars. I. The signal and its detection*. Phys. Rev. D **58** (1998), (2022), Paper No. 063001.

- P. Jaranowski, A. Krolak, Analysis of gravitational-wave data, <u>Cambridge University Press</u>, Cambridge 2009.

- A. Królak, Handbook of Gravitational Wave Astronomy, *Chapter 41: Principles of Gravitational-Wave Data Analysis* (C. Bambi et al. (eds.). <u>Springer Nature Singapore Pte Ltd.</u> 2022, pp. 1671 – 1707.

<u>Dr hab. Wojciech Kryński</u>   (Differential geometry and geometric control theory)

Recent interests of dr hab. Kryński include topics in differential geometry (in particular conformal and projective geometry, equivalence problems, and applications in general relativity), as well as integrable systems and geometric control theory.

Recent papers:

- W. Kryński, *Dissipative prolongations of the multipeakon solutions to the Camassa-Holm equation*, <u>J. Diff. Equations</u> **266** (2019), 1832-1850.

- W. Kryński, *GL(2)-geometry and complex structures*, <u>J. London Math. Soc.</u> **104** (2021), 1717-1737.

- M. Dunajski, W. Kryński, *Variational principles for conformal geodesics*<u>, Lett. Math. Phys.</u> **111** (2021), Paper No. 127, 18 pp.

- W. Kryński, *Deformations of dispersionless Lax systems,* <u>arXiv:2212.11013</u> (2022).

<u>Prof. dr hab. Bronisław Jakubczyk</u> (Geometric theory of differentia equations)

His research interests lie in the intersection of the theories of differential geometry and geometric theory of differential equations. This includes the action of families of vector fields on manifolds, the geometry of nonlinear control systems, and of vector and affine distributions. The current work of prof. Jakubczyk concerns regular and singular versions of global implicit function theorems on manifolds, and also division and decomposability properties in the exterior algebras of differential forms in presence of singularities.

- B. Jakubczyk, *Exterior multiplication with singularities: a Saito theorem in vector bundles. <u>Ann. Polon. Math.</u>* **125** (2020), 117-138.