International
Scientific Conference

Algebraic and Geometric Methods of Analysis

Devoted to 160 anniversary of
Dvytro Grave
(25.08.1863 - 19.12.1939)
Academician of the Ukrainian Academy of Sciences, the first director of the Institute of Mathematics of NAS of Ukraine

May 29 – June 1, 2023
Odesa, Ukraine

List of topics

- Algebraic methods in geometry
- Differential geometry in the large
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Dynamical systems and their applications
- Geometric and topological methods in natural sciences
- Geometric problems in mathematical analysis

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Continual distribution with acceleration and condensation flows

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The kinetic equation Boltzmann is the main instrument to study the complicated phenomena in the multiple-particle systems, in particular, rarefied gas. This kinetic integro-differential equation for the model of hard spheres has a form [1, 2]:

$$D(f) = Q(f,f), \tag{1}$$

$$D(f) = \frac{\partial f}{\partial t} + v\frac{\partial f}{\partial x}, \tag{2}$$

$$\begin{aligned} Q(f,f) = \frac{d^2}{2}\int\limits_{\mathbb{R}^3} dv_1 \int\limits_{\Sigma} d\alpha |(v-v_1,\alpha)| [f(t,v_1',x)f(t,v',x) - \\ - f(t,v_1,x)f(t,v,x)], \end{aligned} \tag{3}$$

We will consider the continual distribution [3]:

$$f = \int\limits_{\mathbb{R}^3} \varphi(t,x,u) M(v,u,x,t) du, \tag{4}$$

which contains the local Maxwellian of special form describing the acceleration and condensation flows of a gas (is an analogue of vortices) [4]. They have the form:

$$M(v,u,x,t) = \rho_0 e^{\beta\left((u-[\omega\times t])^2 + 2[\omega\times x]\right)} \left(\frac{\beta}{\pi}\right)^{\frac{3}{2}} e^{-\beta(v-u-[\omega\times t])^2}. \tag{5}$$

The purpose is to find such a form of the function $\varphi(t,x,u)$ and such a behavior of all hydrodynamical parameters so that the the uniform-integral (mixed) or pure integral remainder [3, 5], i.e. the functionals of the form:

$$\Delta = \sup_{(t,x)\in\mathbb{R}^4} \int\limits_{\mathbb{R}^3} |D(f) - Q(f,f)| dv, \tag{6}$$

$$\Delta_1 = \int\limits_{R^1} dt \int\limits_{R^3} dx \int\limits_{R^3} |D(f) - Q(f,f)| dv, \tag{7}$$

become vanishingly small.

Also some sufficient conditions to minimization of remainder Δ or Δ_1 are found. The obtained results are new and may be used with the study of evolution of screw and whirlwind streams.

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On a flower-shape geometry

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Several important problems arising in many research fields, such as physics and differential geometry, lead to consider elliptic equations when a lack of compactness occurs. From the mathematical point of view, the main interest relies on the fact that often the tools of nonlinear functional analysis, based on compactness arguments, cannot be used, at least in a straightforward way, and some new techniques have to be developed.

Aim of the talk is to present some of these techniques, which strongly use symmetry, together with their applications to elliptic problems with a variational structure. In particular we deal with a group theoretical scheme, raised in the study of problems which are invariant with respect to the action of orthogonal subgroups, and we present a construction, called flower-shape geometry, and its applications to the study of nonlinear problems set in strip-like domains. These results appeared in a joint paper with Giuseppe Devillanova (Politecnico di Bari) and Giovanni Molica Bisci (Urbino).

On equicontinuity of families of mappings with one normalization condition by the prime ends

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Borel function $\rho : \mathbb{R}^n \to [0,\infty]$ is called *admissible* for Γ, abbr. $\rho \in \operatorname{adm}\Gamma$, if $\int\limits_{\gamma} \rho(x)|dx| \geqslant 1$ for each (locally rectifiable) $\gamma \in \Gamma$. We define the quantity

$$M(\Gamma) = \inf_{\rho\in \operatorname{adm}\Gamma} \int\limits_{\mathbb{R}^n} \rho^n(x)\, dm(x) \tag{1}$$

and call $M(\Gamma)$ *a modulus* of Γ; here m stands for the n-dimensional Lebesque measure, see [1, 6.1].

Given sets E and F and a domain D in $\overline{\mathbb{R}^n} = \mathbb{R}^n \cup \{\infty\}$, we denote $\Gamma(E, F, D)$ the family of all paths $\gamma : [0, 1] \to \overline{\mathbb{R}^n}$ joining E and F in D, that is, $\gamma(0) \in E$, $\gamma(1) \in F$ and $\gamma(t) \in D$ for all $t \in [0, 1]$.