

International
Online Conference



**Algebraic
and Geometric
Methods of Analysis**

dedicate to the memory
of Yuriy Trokhymchuk
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LIST OF TOPICS

- Topological methods in analysis
- Geometric problems of complex and mathematical analysis
- Algebraic methods in geometry
- Differential geometry in the whole
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Geometric and topological methods in natural sciences

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Symplectomorphisms preserving smooth functions on surfaces

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Let M be a compact connected surface and P is a connected one-dimensional manifold without boundary, i.e. either the real line \mathbb{R} or the circle S^1 . Denote by $\mathcal{D}(M)$ the group of all smooth (C^∞) diffeomorphisms of M . This group acts from the right on the space $C^\infty(M, P)$ by the following rule: if $h \in \mathcal{D}(M)$ and $f \in C^\infty(M, P)$, then the result of the action of h on f is the composition map $f \circ h : M \rightarrow P$. For $f \in C^\infty(M, P)$ let Σ_f be the set of its critical points, and

$$\mathcal{S}(f) = \{h \in \mathcal{D}(M) \mid f \circ h = f\},$$

$$\mathcal{O}(f) = \{f \circ h \mid h \in \mathcal{D}(M)\}$$

be respectively the *stabilizer* and the *orbit* of f under that action. Endow these spaces with C^∞ topologies and denote by $\mathcal{D}_{\text{id}}(M)$ and $\mathcal{S}_{\text{id}}(f)$ the corresponding path components of id_M in $\mathcal{D}(M)$ and $\mathcal{S}(f)$, and by $\mathcal{O}_f(f)$ the path component of $\mathcal{O}(f)$ containing f . We will omit X from notation whenever it is empty.

Notice that $\mathcal{S}_{\text{id}}(f)$ is a normal subgroup of $\mathcal{S}(f)$, and the quotient:

$$\pi_0 \mathcal{S}(f) := \mathcal{S}(f) / \mathcal{S}_{\text{id}}(f)$$

is the group of path components of $\mathcal{S}(f)$. This group is an analogue of mapping class group for f -preserving diffeomorphisms.

Let $\mathcal{F}(M, P)$ be a subset of $C^\infty(M, P)$ consisting of maps satisfying the following two axioms:

- (B) The map f takes a constant value at each connected component of ∂M and has no critical points in ∂M ;
- (L) For every critical point z of f , there are local coordinates in which f is a homogeneous polynomial $\mathbb{R}^2 \rightarrow \mathbb{R}$ of degree ≥ 2 without multiple factors.

Evidently, $\mathcal{F}(M, P)$ contains all Morse maps.

For $f \in \mathcal{F}(M, P)$ the homotopy types of $\mathcal{S}_{\text{id}}(f)$ and orbits were described by S. Maksymenko, and the homotopy types of connected components of orbit $\mathcal{O}(f)$ by S. Maksymenko, E. Kudryavtseva (for Morse maps and for smooth functions $f : M \rightarrow \mathbb{R}$ with *simple singularities* which are not homogeneous but quasi-homogeneous), B. Feshchenko, I. Kuznietsova, Yu. Soroka, A. Kravchenko.

Theorem 1. *Let $f \in \mathcal{F}(M, P)$. Then the natural map $p : \mathcal{S}(f) \rightarrow \pi_0 \mathcal{S}(f)$ has a section:*

$$s : \pi_0 \mathcal{S}(f) \rightarrow \mathcal{S}(f),$$

so s is a homomorphism such that $p \circ s = \text{id}_{\pi_0 \mathcal{S}(f)}$.

Moreover, if M is orientable, then there exists a symplectic structure, i.e. a non-degenerate differential 2-form ω , on M , such that the image $s(\pi_0 \mathcal{S}(f))$ consists of symplectic diffeomorphisms with respect to ω .

Kh. F. Kholturayev <i>Perfect metrizable of the functor of idempotent measures</i>	75
Y. Khomych <i>Quasiareal deformation of surfaces of positive Gauss curvature</i>	77
V. Kiosak, O. Lesechko <i>Canonical infinitesimal deformations of metrics of pseudo-Riemannian spaces</i>	78
R. Salimov, B. Klishchuk <i>On the behavior at infinity of ring Q-homeomorphisms</i>	79
T. Kolomiets, A. Pogorui <i>Elements of probability theory and measures with values in hypercomplex algebras</i>	81
N. Konovenko <i>The invariants of planar 3-webs with respect to group of symplectic diffeomorphisms, for the case of the conformal group</i>	84
E. Kudryavtseva <i>Topology of spaces of smooth functions and gradient-like flows with prescribed singularities on surfaces</i>	85
G. Kuduk <i>Nonlocal problem with integral conditions for homogeneous system of partial differential equations of second order</i>	87
I. Kuznietsova, Yu. Soroka <i>Realization of groups as fundamental groups of orbits of smooth maps</i>	88
K. Gürlebeck, D. Legatiuk <i>Modified quaternionic operator calculus and its application to micropolar elasticity</i>	90
S. Maksymenko, E. Polulyakh <i>On non-Hausdorff manifolds of dimension 1</i>	92
S. Maksymenko <i>Symplectomorphisms preserving smooth functions on surfaces</i>	93
M. Maloid-Hliebova <i>Second classical Zariski topology of multiplicative module</i>	94
I. Marko <i>Incomplete spaces of idempotent measures</i>	95
N. Mazurenko, M. Zarichnyi <i>Hyperspaces of convex sets related to idempotent mathematics</i>	96
A. Mednykh <i>Volumes of knots and links in spaces of constant curvature</i>	98
R. Mohseni, R. A. Wolak <i>Twistor spaces on foliated manifolds</i>	99
P. Mormul <i>Two problems in nonholonomic geometry (in quest of a co-worker)</i>	100
F. Mukhamadiev <i>The local τ-density of a linearly ordered spaces</i>	101
T. Obikhod <i>Entropy and phase transitions in Calabi-Yau space</i>	102
A. Orevkova <i>Reducing singularities of smooth functions to normal forms</i>	104
T. Osipchuk <i>On m-convexity and m-semiconvexity of sets in Euclidean spaces</i>	106
V. Ostrovskiy, O. Ostrovska, D. Proskurin, Yu. Samoilenko <i>On representations of q_{ij}-commuting isometries</i>	108
J.F. Peters <i>Homotopic Nerve Complexes with Free Group Presentations</i>	110
P. Laurain, M. Petrace <i>Uniform measures in Euclidean space</i>	112