



International  
Scientific Conference

# Algebraic and Geometric Methods of Analysis

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## 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 problems in mathematical analysis
- Geometric and topological methods in natural sciences

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ІНТЕРНАЦІОНАЛЬНИЙ ЦЕНТР СПІВРОБІТНИЦТВА

## On the squares of diffeomorphisms of surfaces

Iryna Kuznietsova

(Institute of Mathematics of NAS of Ukraine, Tereshchenkivska str. 3, Kyiv, 01024, Ukraine)

*E-mail:* kuznietsova@imath.kiev.ua

Sergiy Maksymenko

(Institute of Mathematics of NAS of Ukraine, Tereshchenkivska str. 3, Kyiv, 01024, Ukraine)

*E-mail:* maks@imath.kiev.ua

Let  $M$  be a surface and  $\mathcal{D}(M)$  be the group of  $C^\infty$ -diffeomorphisms of  $M$ . There is a natural right action of the group  $\mathcal{D}(M)$  on the space of smooth functions  $C^\infty(M, \mathbb{R})$  defined by the following rule:  $(h, f) \mapsto f \circ h$ , where  $h \in \mathcal{D}(M)$ ,  $f \in C^\infty(M, \mathbb{R})$ .

Thus, the *stabilizer* of  $f$  with respect to the action

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

consists of  $f$ -preserving diffeomorphisms of  $M$ .

Endow  $\mathcal{D}(M)$  with Whitney  $C^\infty$ -topology and its subspaces  $\mathcal{S}(f)$  with induced one. Denote by  $\mathcal{S}_{\text{id}}(f)$  the identity path component of  $\mathcal{S}(f)$ .

**Definition 1.** Denote by  $\mathcal{F}(M)$  the space of smooth functions  $f \in C^\infty(M, \mathbb{R})$  satisfying the following conditions:

- (1) The function  $f$  takes constant value at each connected component of  $\partial M$  and has no critical points in  $\partial M$ .
- (2) For every critical point  $z$  of  $f$  there is a local presentation  $f_z: \mathbb{R}^2 \rightarrow \mathbb{R}$  of  $f$  near  $z$  such that  $f_z$  is a homogeneous polynomial  $\mathbb{R}^2 \rightarrow \mathbb{R}$  without multiple factors.

**Definition 2.** A smooth vector field  $F$  will be called Hamiltonian-like for  $f \in \mathcal{F}(M)$  if the following conditions hold:

- (1)  $F(x) = 0$  if and only if  $x$  is a critical point of  $f$ ,
- (2)  $f$  takes constant values on orbits of  $F$ ,
- (3) Let  $z$  be a critical point of  $f$ . Then there exists a local representation of  $f$  at  $z$  as a homogeneous polynomial  $g: (\mathbb{R}^2, 0) \rightarrow (\mathbb{R}, 0)$  without multiple factors such that in the same coordinates  $(x, y)$  near the origin  $0$  in  $\mathbb{R}^2$  we have  $F = -g'_y \frac{\partial}{\partial x} + g'_x \frac{\partial}{\partial y}$ .

The smooth flow  $\mathbb{F}: M \times \mathbb{R} \rightarrow M$  generated by a Hamiltonian-like vector field for  $f$  will be called Hamiltonian-like flow for  $f$ .

Denote by  $\Delta^-(f)$  the set of diffeomorphisms from  $\mathcal{S}(f)$  leaving invariant each regular connected component of each level-set of  $f$  and reverses its orientation.

**Theorem 3.** Let  $D^2$  be a 2-disk,  $f \in \mathcal{F}(M)$ . Suppose there exists  $h \in \Delta^-(f)$ , i.e.  $\Delta^-(f) \neq \emptyset$ . Then there exists another  $g \in \Delta^-(f)$  such that  $g = h$  in a neighborhood of  $\partial D$  and  $g^2 \in \mathcal{S}_{\text{id}}(f)$ .

**Theorem 4.** Let  $M$  be an orientable connected compact surface and  $f \in \mathcal{F}(M)$ . If  $\Delta^-(f) \neq \emptyset$ , then there exists another  $g \in \Delta^-(f)$  such that  $g^2 \in \mathcal{S}_{\text{id}}(f)$ .

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