

International  
Online Conference



**Algebraic  
and Geometric  
Methods of Analysis**

dedicate to the memory  
of Yuriy Trokhymchuk  
(17.03.1928-18.12.2019)

May 25-28, 2021  
Odesa, Ukraine

## 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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## On the behavior at infinity of ring $Q$ -homeomorphisms

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Let  $\Gamma$  be a family of curves  $\gamma$  in  $\mathbb{R}^n$ ,  $n \geq 2$ . A Borel measurable function  $\rho : \mathbb{R}^n \rightarrow [0, \infty]$  is called *admissible* for  $\Gamma$ , (abbr.  $\rho \in \text{adm } \Gamma$ ), if

$$\int_{\gamma} \rho(x) ds \geq 1$$

for any curve  $\gamma \in \Gamma$ . Let  $p \in (1, \infty)$ . The quantity

$$M_p(\Gamma) = \inf_{\rho \in \text{adm } \Gamma} \int_{\mathbb{R}^n} \rho^p(x) dm(x)$$

is called  *$p$ -modulus* of the family  $\Gamma$ .

For arbitrary sets  $E$ ,  $F$  and  $G$  of  $\mathbb{R}^n$  we denote by  $\Delta(E, F, G)$  a set of all continuous curves  $\gamma : [a, b] \rightarrow \mathbb{R}^n$ , that connect  $E$  and  $F$  in  $G$ , i.e., such that  $\gamma(a) \in E$ ,  $\gamma(b) \in F$  and  $\gamma(t) \in G$  for  $a < t < b$ .

Let  $D$  be a domain in  $\mathbb{R}^n$ ,  $n \geq 2$ ,  $x_0 \in D$  and  $d_0 = \text{dist}(x_0, \partial D)$ . Set

$$\mathbb{A}(x_0, r_1, r_2) = \{x \in \mathbb{R}^n : r_1 < |x - x_0| < r_2\},$$

$$S_i = S(x_0, r_i) = \{x \in \mathbb{R}^n : |x - x_0| = r_i\}, \quad i = 1, 2.$$

Let a function  $Q : D \rightarrow [0, \infty]$  be Lebesgue measurable. We say that a homeomorphism  $f : D \rightarrow \mathbb{R}^n$  is ring  $Q$ -homeomorphism with respect to  $p$ -modulus at  $x_0 \in D$ , if the relation

$$M_p(\Delta(fS_1, fS_2, fD)) \leq \int_{\mathbb{A}} Q(x) \eta^p(|x - x_0|) dm(x)$$

holds for any ring  $\mathbb{A} = \mathbb{A}(x_0, r_1, r_2)$ ,  $0 < r_1 < r_2 < d_0$ ,  $d_0 = \text{dist}(x_0, \partial D)$ , and for any measurable function  $\eta : (r_1, r_2) \rightarrow [0, \infty]$  such that

$$\int_{r_1}^{r_2} \eta(r) dr = 1.$$

Denote by  $\omega_{n-1}$  the area of the unit sphere  $\mathbb{S}^{n-1} = \{x \in \mathbb{R}^n : |x| = 1\}$  in  $\mathbb{R}^n$  and by  $q_{x_0}(r) = \frac{1}{\omega_{n-1} r^{n-1}} \int_{S(x_0, r)} Q(x) dA$  the integral mean over the sphere  $S(x_0, r) = \{x \in \mathbb{R}^n : |x - x_0| = r\}$ , here  $dA$  is the element of the surface area. Let  $L(x_0, f, R) = \sup_{|x-x_0| \leq R} |f(x) - f(x_0)|$ .

**Theorem.** *Suppose that  $f : \mathbb{R}^n \rightarrow \mathbb{R}^n$  is a ring  $Q$ -homeomorphism with respect to  $p$ -modulus at a point  $x_0$  with  $p > n$  where  $x_0$  is some point in  $\mathbb{R}^n$ . Then for all numbers  $r_0 > 0$  the estimate*

$$\lim_{R \rightarrow \infty} \left( L(x_0, f, R) \left( \int_{r_0}^R \frac{dt}{t^{\frac{n-1}{p-1}} q_{x_0}^{\frac{1}{p-1}}(t)} \right)^{-\frac{p-1}{p-n}} \right) \geq \left( \frac{p-n}{p-1} \right)^{\frac{p-1}{p-n}} > 0$$

holds.

*Acknowledgements*

This work was supported by the budget program "Support of the development of priority trends of scientific researches" (KPKVK 6541230).

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