

Ministry of Education and Science of Ukraine
Vasyl' Stus Donetsk National University
Institute of Mathematics of the National Academy of Sciences of Ukraine
Institute of Applied Mathematics and Mechanics
of the National Academy of Sciences of Ukraine



Book of Abstracts

5th INTERNATIONAL CONFERENCE

of Young Scientists

on Differential Equations and Applications
dedicated to Yaroslav Lopatynsky

9-11 November, 2016, Kyiv, Ukraine

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Existence and uniqueness of entropy solution for nonlinear elliptic degenerate anisotropic equations

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Let Ω be a bounded domain in \mathbb{R}^n with a boundary $\partial\Omega$, $n \geq 2$. Assume that $1 < q_i < n$ are real numbers, and ν_i are nonnegative functions in Ω such that $\nu_i > 0$ a.e. in Ω , $\nu_i \in L^1_{\text{loc}}(\Omega)$, $\nu_i^{-1/(q_i-1)} \in L^1(\Omega)$, $i = 1, \dots, n$. Suppose Carathéodory functions $a_i : \Omega \times \mathbb{R}^n \rightarrow \mathbb{R}$, $i = 1, \dots, n$, satisfy the conditions of growth, strict monotonicity and following coercitivity condition: $\sum_{i=1}^n a_i(x, \xi) \xi_i \geq c \sum_{i=1}^n \nu_i |\xi_i|^{q_i} - g(x)$; here c is a positive constant, and $g \in L^1(\Omega)$ is a nonnegative function. Put $q = \{q_1, \dots, q_n\}$, $\nu = \{\nu_1, \dots, \nu_n\}$. We define $W^{1,q}(\nu, \Omega) = \{u \in L^1(\Omega) : \nu_i |D_i u|^{q_i} \in L^1(\Omega), i = 1, \dots, n\}$. $W^{1,q}(\nu, \Omega)$ is a Banach space with respect to the norm $\|u\|_{W^{1,q}(\nu, \Omega)} = \|u\|_{L^1(\Omega)} + \sum_{i=1}^n \left(\int_{\Omega} \nu_i |D_i u|^{q_i} dx \right)^{1/q_i}$.

Denote by $\overset{\circ}{W}^{1,q}(\nu, \Omega)$ the closure of $C_0^\infty(\Omega)$ in $W^{1,q}(\nu, \Omega)$. Let $F : \Omega \times \mathbb{R} \rightarrow \mathbb{R}$ be a Carathéodory function. We consider the Dirichlet problem:

$$-\sum_{i=1}^n \frac{\partial}{\partial x_i} a_i(x, \nabla u) = F(x, u) \quad \text{in } \Omega, \quad (1)$$

$$u = 0 \quad \text{on } \partial\Omega. \quad (2)$$

Definition. An entropy solution of problem (1), (2) is a function $u : \Omega \rightarrow \mathbb{R}$ such that: 1) $T_k(u) \in \overset{\circ}{W}^{1,q}(\nu, \Omega)$, where T_k is a standard cut function of the level $k > 0$; 2) $F(x, u) \in L^1(\Omega)$; 3) if $w \in \overset{\circ}{W}^{1,q}(\nu, \Omega) \cap L^\infty(\Omega)$, $k \geq 1$, and $l \geq k + \|w\|_{L^\infty(\Omega)}$, then

$$\int_{\Omega} \left\{ \sum_{i=1}^n a_i(x, \nabla T_l(u)) D_i T_k(u - w) \right\} dx \leq \int_{\Omega} F(x, u) T_k(u - w) dx.$$

Theorem. Suppose the following conditions are satisfied: (i) for a.e. $x \in \Omega$ the function $F(x, \cdot)$ is nonincreasing on \mathbb{R} ; (ii) for any $s \in \mathbb{R}$ the function $F(\cdot, s)$ belongs to $L^1(\Omega)$. Then there exists a unique entropy solution of problem (1), (2).

Proof is based on results represented in [1], [4].

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