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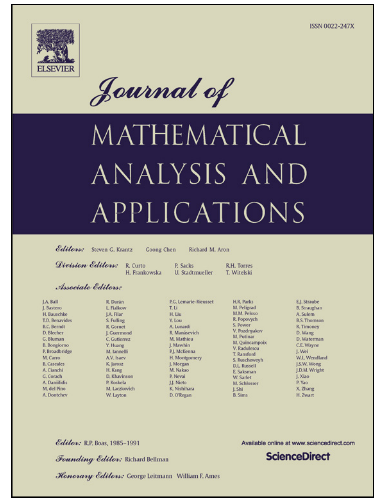
Weisheng Niu, Xiaojuan Chai



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Global attractors for nonlinear parabolic equations with nonstandard growth and irregular data

Weisheng Niu*, Xiaojuan Chai
School of Mathematical Sciences, Anhui University, Hefei 230601, China

Abstract

We investigate the large time behavior of solutions to the following nonlinear parabolic equations

$$\begin{cases} u_t - \text{div } (|\nabla u|^{p(x)-2}\nabla u) + f(x,u) = g & \text{in } \Omega \times \mathbb{R}^+, \\ u = 0 & \text{on } \partial\Omega \times \mathbb{R}^+, \\ u(x,0) = u_0(x) & \text{in } \Omega, \end{cases}$$

where $u_0, g \in L^1(\Omega)$. We first provide the existence and uniqueness of an entropy solution for the problem. Then through some delicate analysis, we establish some regularity results on the solution, by which we prove the existence of a global attractor for the solution semigroup.
Keywords: Global attractor; irregular data; $p(x)$-Laplacian equations

1 Introduction

Let Ω be a bounded domain in $\mathbb{R}^N (N \geq 2)$ with smooth boundary. We consider the large time behavior of solutions to the following nonlinear parabolic problem involving variable exponents

$$\begin{cases} u_t - \text{div } (|\nabla u|^{p(x)-2}\nabla u) + f(x,u) = g & \text{in } \Omega \times \mathbb{R}^+, \\ u = 0 & \text{on } \partial\Omega \times \mathbb{R}^+, \\ u(x,0) = u_0(x) & \text{in } \Omega, \end{cases} \tag{1.1}$$

where $u_0, g \in L^1(\Omega)$, $p \in C(\overline{\Omega})$ with

$$1 < p^- = \min_{x\in\overline{\Omega}} p(x) \leq p^+ = \max_{x\in\overline{\Omega}} p(x) < \infty.$$

We assume that there exists a positive constant c_0 such that

$$|p(x) - p(y)| \leq -\frac{c_0}{\log|x-y|}, \text{ for every } x, y \in \Omega \text{ with } |x-y| < \frac{1}{2}. \tag{1.2}$$

Concerning the nonlinear term $f(x,u)$, we assume that $f : \Omega \times \mathbb{R} \to \mathbb{R}$ is a Carathéodory mapping and there exist positive constants l, C, c_1, c_2, σ_0 and a function $b(x) \in L^1(\Omega)$ such that

$$(f(x,s_1) - f(x,s_2))(s_1 - s_2) \geq -l|s_1 - s_2|^2, \text{ for a.e.} x \in \Omega \text{ and any } s_1, s_2 \in \mathbb{R}, \tag{1.3}$$

$$c_2|s|^{q+1} - C \leq f(x,s)s \leq c_1|s|^{q+1} + C, \quad q \geq 1, \text{ for a.e. } x \in \Omega \text{ and any } s \in \mathbb{R}, \tag{1.4}$$

$$|f(x,s)| \leq b(x), \text{ for a.e. } x \in \Omega \text{ and all } s \in \mathbb{R} \text{ with } |s| < \sigma_0. \tag{1.5}$$

In recent years, due to the applications in various fields such as the flow through porous media [1], image processing [2], and especially the electrorheological fluids (an essential class of

* Corresponding author.
E-mail addresses: niuwsh@ahu.edu.cn

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