Accepted Manuscript

Global existence of strong solution to the 3D micropolar equations with a damping term

Zhuan Ye

PII: S0893-9659(18)30108-3
DOI: https://doi.org/10.1016/j.aml.2018.04.002
Reference: AML 5483

To appear in: *Applied Mathematics Letters*

Received date : 13 March 2018
Revised date : 3 April 2018
Accepted date : 3 April 2018

Global existence of strong solution to the 3D micropolar equations with a damping term

Zhuan Ye

Department of Mathematics and Statistics, Jiangsu Normal University,

101 Shanghai Road, Xuzhou 221116, Jiangsu, PR China

E-mail: yezhuan815@126.com

Abstract: In this note we establish the existence and uniqueness of global strong solutions to the Cauchy problem of the three-dimensional incompressible micropolar equations with a nonlinear damping term.

AMS Subject Classification 2010: 35Q35; 35B65; 76A10; 76B03.
Keywords: Micropolar equations; Damping; Global regularity.

1. Introduction

In this paper, we focus on the following three-dimensional (3D) incompressible micropolar equations with a nonlinear damping term

$$\begin{cases} \partial_t u + (u\cdot\nabla)u - (\nu+\kappa)\Delta u + \sigma|u|^{\beta-1}u + \nabla p = 2\kappa\nabla\times w, \quad x\in\mathbb{R}^3,\, t>0,\\ \partial_t w + (u\cdot\nabla)w + 4\kappa w - \gamma\Delta w - \mu\nabla\nabla\cdot w = 2\kappa\nabla\times u,\\ \nabla\cdot u = 0,\\ u(x,0)=u_0(x), \quad w(x,0)=w_0(x), \end{cases} \tag{1.1}$$

where $u=u(x,t)\in\mathbb{R}^3$ denotes the fluid velocity, $w=w(x,t)\in\mathbb{R}^3$ the field of microrotation representing the angular velocity of the rotation of the fluid particles, $p(x,t)$ the scalar pressure, and the parameter ν denotes the kinematic viscosity, κ the microrotation viscosity, γ and μ the angular viscosities and σ the damping coefficient. The micropolar equations were first proposed by Eringen [1] in 1966, which can describe many phenomena that appear in a large number of complex fluids such as the suspensions, animal blood, and liquid crystals. For more background, we refer to [11] and references therein.

When $w=0$ and $\kappa=0$, the system (1.1) is reduced to the 3D incompressible damped Navier-Stokes equations which were introduced in [2]. The authors [2] proved that the corresponding system admits global weak solutions for any $\beta\geq 1$, and global strong solution for any $\beta\geq\frac{7}{2}$. Moreover, the strong solution is unique for any $\frac{7}{2}\leq\beta\leq 5$. Subsequently, there are many works devoted to the 3D Navier-Stokes equations with a damping term (see [8, 6, 12, 15]).

Let us review some works about the micropolar equations (1.1) with $\sigma=0$, which have attracted considerable attention in the community of mathematical fluids (see for example [7, 3, 4, 9, 10, 11, 13, 14]). For the initial boundary-value problem, the weak solution was considered by Galdi-Rionero [7]. Lukaszewicz [9] established the global existence of weak solutions with sufficiently regular initial data. The existence and uniqueness of strong solutions to the micropolar equations either local for large data or global for small data are considered in [10, 13, 3, 5] and references therein. However,