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Local super-quadratic conditions on homoclinic solutions for a second-order Hamiltonian system *

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Abstract: In this paper, we study the homoclinic solutions of the following second-order Hamiltonian system

$$\ddot{u} - L(t)u + \nabla W(t, u) = 0,$$

where $t \in \mathbb{R}$, $u \in \mathbb{R}^N$, $L : \mathbb{R} \rightarrow \mathbb{R}^{N \times N}$ and $W : \mathbb{R} \times \mathbb{R}^N \rightarrow \mathbb{R}$. Applying the Mountain Pass Theorem, we prove the existence of nontrivial homoclinic solutions under new weaker conditions. In particular, we use a local super-quadratic condition $\lim_{|x| \rightarrow \infty} \frac{W(t, x)}{|x|^2} = \infty$, uniformly in $t \in (a, b)$ for some $-\infty < a < b < +\infty$, instead of the common one $\lim_{|x| \rightarrow \infty} \frac{W(t, x)}{|x|^2} = \infty$, uniformly in $t \in \mathbb{R}$, which is essential to show the existence of nontrivial homoclinic solutions for the above system in all existing literature.

Keywords: Homoclinic solution; Hamiltonian system; Local super-quadratic condition.

2000 Mathematics Subject Classification. 34C37; 58E05; 70H05

1 Introduction

Consider the second-order Hamiltonian system

$$\ddot{u} - L(t)u + \nabla W(t, u) = 0, \tag{1.1}$$

where $t \in \mathbb{R}$, $u \in \mathbb{R}^N$, $L : \mathbb{R} \rightarrow \mathbb{R}^{N \times N}$, $W : \mathbb{R} \times \mathbb{R}^N \rightarrow \mathbb{R}$ satisfy the following basic assumptions:

- (L) $L \in \mathcal{C}(\mathbb{R}, \mathbb{R}^{N \times N})$ and $L(t)$ is T -periodic (with $T > 0$) and positive definite;
- (W1) $W \in \mathcal{C}^1(\mathbb{R} \times \mathbb{R}^N, \mathbb{R})$, $W(t, 0) \equiv 0$, $W(t, x)$ is T -periodic in t ;
- (W2) $\nabla W(t, x) = o(|x|)$ as $x \rightarrow 0$ uniformly for $t \in \mathbb{R}$.

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