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# New existence results on periodic solutions of non-autonomous second order Hamiltonian systems

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## Abstract

In this paper, we are concerned with the existence of periodic solutions for the following non-autonomous second order Hamiltonian systems

$$\begin{cases} \ddot{u}(t) + \nabla F(t, u(t)) = 0, & \text{a.e. } t \in [0, T], \\ u(0) - u(T) = \dot{u}(0) - \dot{u}(T) = 0, \end{cases}$$

where  $F : \mathbb{R} \times \mathbb{R}^N \rightarrow \mathbb{R}$  is  $T$ -periodic ( $T > 0$ ) in its first variable for all  $x \in \mathbb{R}^N$ . When potential function  $F(t, x)$  is either locally in  $t$  asymptotically quadratic or locally in  $t$  superquadratic, we show that the above mentioned problem possesses at least one  $T$ -periodic solutions via the minimax methods in critical point theory, specially, a new saddle point theorem which is introduced in [M. Schechter, New linking theorems, Rend. Sem. Mat. Univ. Padova 99 (1998), 255-269].

*Keywords:* Periodic solutions; Locally in  $t$  asymptotically quadratic; Locally in  $t$  superquadratic; New saddle point theorem

## 1. Introduction and main results

Consider the second order non-autonomous Hamiltonian systems

$$\begin{cases} \ddot{u}(t) + \nabla F(t, u(t)) = 0, & \text{a.e. } t \in [0, T], \\ u(0) - u(T) = \dot{u}(0) - \dot{u}(T) = 0, \end{cases} \quad (1.1)$$

where  $F : \mathbb{R} \times \mathbb{R}^N \rightarrow \mathbb{R}$  is  $T$ -periodic ( $T > 0$ ) in its first variable for all  $x \in \mathbb{R}^N$ ,  $\nabla F(t, x) = \frac{\partial}{\partial x} F(t, x)$ , and satisfies the following assumption:

( $H_0$ )  $F(t, x)$  is measurable in  $t$  for every  $x \in \mathbb{R}^N$  and continuously differentiable in  $x$  for a.e.  $t \in [0, T]$ , and there exist  $a \in C(\mathbb{R}^+, \mathbb{R}^+)$ ,  $b \in L^1(0, T; \mathbb{R}^+)$  such that

$$|F(t, x)| \leq a(|x|)b(t), \quad |\nabla F(t, x)| \leq a(|x|)b(t)$$

for all  $x \in \mathbb{R}^N$  and a.e.  $t \in [0, T]$ .

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