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PERIODIC PROBLEM FOR THE SECOND ORDER VECTOR EQUATION VIA THE THEORY OF VECTOR FIELDS

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We consider the second order differential equation of the form

$$X'' = AX + H(X)\,, \tag{1}$$

where $X \in C^2\big([0, +\infty); \mathbb{R}^n\big)$, $A \in \mathbb{R}^{n\times n}$, $H \in C^1\big(\mathbb{R}^n; \mathbb{R}^n\big)$ and H is bounded function with a property $H(\mathcal{O}) = \mathcal{O}$ $\big(\mathcal{O} = (0, 0, \dots, 0) \in \mathbb{R}^n\big)$, subject to the periodic boundary conditions

$$X(0) = X(T), \qquad X'(0) = X'(T) \qquad (T > 0). \tag{2}$$

Given $(\alpha, \beta) \in \mathbb{R}^{2n}$ denote by $X(t; \alpha, \beta)$ solution of (1) such that

$$X(0) = \alpha, \qquad X'(0) = \beta \qquad (\alpha \in \mathbb{R}^n,\ \beta \in \mathbb{R}^n). \tag{3}$$

Define the mapping

$$\Phi : \mathbb{R}^{2n} \longrightarrow \mathbb{R}^{2n}, \qquad \Phi(\alpha, \beta) = \Big(X(T; \alpha, \beta) - \alpha,\ X'(T; \alpha, \beta) - \beta\Big). \tag{4}$$

We provide the conditions for existence of an isolated singular (critical) point of the vector field Φ, which is not the origin, and this in turn, implies the existence of nontrivial solution of (1), (2).

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