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On a new type of bifurcation of limit cycles for a planar cubic system

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1. Introduction

In this paper we study two-dimensional autonomous differential systems of the form

$$\dot{x} = X(x, y), \quad \dot{y} = Y(x, y), \tag{1.1}$$

where $X(x, y) = \lambda x - y + X_3(x, y)$ and $Y(x, y) = x + \lambda y + Y_3(x, y)$, X_3 and Y_3 being homogeneous polynomials of third degree.

The most difficult and important problem for planar differential systems is the determination of their limit cycles. Let us recall that a limit cycle is an isolated periodic solution of the system (1.1), see [10].

In a recent paper [5] a new method has been introduced to study the existence and nonexistence of limit cycles of planar vector fields. This method is based on the following result.

Theorem 1. *Let (P, Q) be a C^1 vector field defined in the open subset U of $\mathbb{R}^2$. Let $V = V(x, y)$ be a C^1 solution of the linear partial differential equation*

$$P\frac{\partial V}{\partial x} + Q\frac{\partial V}{\partial y} - \left(\frac{\partial P}{\partial x} + \frac{\partial Q}{\partial y}\right) V = 0. \tag{1.2}$$

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