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9. Ordinary Differential Equations and Dynamical Systems

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Normal Forms for Nonautonomous Differential Equations of Carathéodory Type

Smooth transformations of equations $\dot{x} = Ax + f(x)$ into normal form are a well-established tool in dynamical systems theory. Crucial for such transformations is the *non-resonance condition* $\lambda_j - \sum_{i=1}^n k_i\lambda_i \neq 0$ for $j = 1, \dots, n$ and $k \in \mathbb{N}_0^n$ with $2 \leq \sum_{i=1}^k k_i$ and λ_i the distinct eigenvalues of $A \in \mathbb{R}^{d\times d}$. With a new technique from the theory of integral manifolds we generalize normal form results to nonautonomous differential equations $\dot{x} = A(t)x + f(t,x)$ with $A : \mathbb{R} \to \mathbb{R}^{d\times d}$ locally integrable and $f : \mathbb{R}^{1+d} \to \mathbb{R}^d$ a Carathéodory function (i. e. $f(t,\cdot)$ is continous f. a. a. t, $f(\cdot,x)$ is measurable f. a. x). Under the assumption that A has bounded Sacker-Sell spectrum $\lambda_1 = [a_1,b_1], \dots, \lambda_n = [a_n,b_n]$ and is reduced to diagonal form $A = \mathrm{diag}(A_1,\dots,A_n)$ we construct a smooth formal linearization provided the following *non-resonance condition*

$$\lambda_j \cap \sum_{i=1}^n k_i\lambda_i = \emptyset$$

holds. Here $\lambda_i + \lambda_j$ is the intervall $[a_i + a_j, b_i + b_j]$, analogous for $k_i\lambda_i$.