Response solutions for forced systems with large dissipation and arbitrary frequency vectors

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Abstract

We study the behaviour of one-dimensional strongly dissipative systems subject to a quasi-periodic force, described by the ordinary differential equation in $\mathbb{R}$: $\varepsilon\ddot{x} + \dot{x} + \varepsilon\, g(x) = \varepsilon\, f(\boldsymbol{\omega} t)$, where $\varepsilon \in \mathbb{R}$ is a small parameter and $\boldsymbol{\omega}$ is a vector in $\mathbb{R}^d$ ($d \in \mathbb{N}$). The functions $g : \mathbb{R} \to \mathbb{R}$ and $f : \mathbb{T}^d \to \mathbb{R}$ are assumed to be real analytic and in particular, the function $t \mapsto f(\boldsymbol{\omega} t)$ is quasi-periodic in t. We are interested in the existence of response solutions, i.e. quasi-periodic solutions having the same frequency vector as the forcing term. Earlier results available in the literature show that, when the dissipation is large enough and a suitable function involving the forcing has a simple zero, response solutions can be proved to exist and to be attractive provided some Diophantine condition is assumed on the frequency vector. We show that the results can be extended to the case of arbitrary frequency vectors and then we generalise the argument to systems of arbitrary finite dimension.