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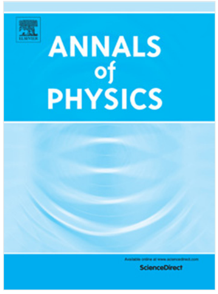

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Differential Poisson's ratio of a crystalline two-dimensional membrane

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Abstract

We compute the differential Poisson's ratio of a suspended two-dimensional crystalline membrane embedded into a space of large dimensionality $d \gg 1$. We demonstrate that, in the regime of anomalous Hooke's law, the differential Poisson's ratio approaches a universal value determined solely by the spatial dimensionality d_c, with a power-law expansion $\nu = -1/3 + 0.016/d_c + O(1/d_c^2)$, where $d_c = d - 2$. Thus, the value $-1/3$ predicted in previous literature holds only in the limit $d_c \to \infty$.

Keywords: crystalline membrane, Poisson's ratio

1. Introduction

Poisson's ratio is defined as the ratio of a transverse compression to a longitudinal stretching. In the classical theory of elasticity, the Poisson's ratio is given by

$$\nu_{\rm cl} = \frac{\lambda}{2\mu + (D-1)\lambda},$$

where μ and λ are the Lamé coefficients and D is the dimensionality of the elastic body [1]. General conditions of thermodynamic stability restrict the Poisson's ratio to the range between -1 and $1/(D-1)$. Conventionally, a material contracts in transverse directions when it is stretched in the longitudinal direction, such that the Poisson's ratio is positive. However, some exotic, so-called auxetic [2], materials have a negative Poisson's ratio. Although examples of such materials, e.g., pyrite, have been known for a long time [3], the interest to auxeticity started only at the end of 1980s after the observation of a stretching-induced transverse expansion of polyurethane foam [4]. Nowadays, a negative Poisson's ratio is found in various materials and artificially engineered structures (see Ref. [5] for a review).

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