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材料物理和化学

悬浮在向列相液晶中球形微粒周围的土星环和偶极子缺陷的稳定性

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摘要:

在向列相液晶中悬浮的球形微粒周围可能存在两种类型的缺陷:土星环结构和偶极子结构。文章通过计算它们的自由能,研究了向列相液晶中两种类型缺陷的稳定性。计算结果表明:当$k_{24} < k(1-(1/2)\ln(R_1/r_c))$时,土星环缺陷是稳定的,并且和球形微粒的半径无关,其中R_1是液晶分子的长度, k和k_{24}是弹性常数,r_c是向错线核心的半径;当$k_{24} > k(1-(1/2)\ln(R_1/r_c))$时, 对于半径较小的球形微粒土星环缺陷比较稳定,但是对于较大的球形微粒偶极子缺陷比较稳定。进而可得,通过增加粒子半径、鞍形展曲弹性常数k_{24}或者减小弹性常数k的方法可以实现土星环缺陷向偶极子缺陷的转变。

关键词: 指向矢场　土星环缺陷　自由能

Stability of Saturn-Ring and Dipole Defects Around Microspheres Suspended in Nematic Liquid Crystals

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Abstract:

The stability of Saturn-ring and dipole defects in nematic liquid crystals is studied. Two structures are possible around microspheres suspended in nematic liquid crystals: a Saturn- ring and a dipole, which are investigated by calculating their Frank free energy. As a result, if $k_{24} < k(1-(1/2)\ln(R_1/r_c))$, the Saturn-ring is the preferred configuration which does not depend on the particle size, where R_1 is the length of liquid crystal molecule, k and k_{24} are the elastic constants, and r_c is the radius of the disclination line core. If $k_{24} > k(1-(1/2)\ln(R_1/r_c))$, for small particles the Saturn-ring defect is more stable, and contrarily for large particles the dipole defect is more stable. The results demonstrate that a transition from the Saturn-ring defect to the dipole defect is induced either by increasing the particle size, the saddle-splay elastic constant k_{24} or by decreasing k.

Keywords: director field　Saturn-ring defect　free energy

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