Nonuniformity of phase state and phase coexistence in a dusty plasma monolayer

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In the present work, we study the effect of electrostatic confinement, wake interaction, and structural nonuniformity [1,2] on the scenario of a phase transition in a laboratory dusty plasma system. Two types of dusty plasma structures are analyzed: a single-layered structure and a structure with complex geometry that has a 3-dimensional (3D) central section and a quasi-2-dimensional (quasi-2D) peripheral section. Nonreciprocal interaction of dust particles is calculated by two methods: via the widely used point-wake model and via the potential obtained from the kinetic equation for electrons and ions of plasma and a dust particle [3]. We show that both in the monolayer and in the structure with 2D and 3D sections the stationary coexistence of the liquid central part and the solid peripheral part is observed. This is, first, due to the spatial nonuniformity of the systems arising from the action of confinement and, second, due to the nonreciprocal character of particle interactions which leads to the development of wave instabilities. Analysis of instabilities leading to the melting of the central section is provided and local melting criterion is formulated. Obtained results are important for the theory of phase transitions in dusty plasmas and reveal similarities between dust particles and active agents in active matter [4].

[1] Nikolaev V S and Timofeev A V 2019 *Phys. Plasmas* **26** 073701
[2] Nikolaev V S and Timofeev A V 2021 *Phys. Plasmas* **28** 033704
[3] Kolotinskii D A, Nikolaev V S and Timofeev A V 2021 *JETP Lett.* **113** 510
[4] Arkar K, Vasiliev M M, Petrov O F *et al* 2021 *Molecules* **26** 561