DUST-ACOUSTIC WAVES IN A NEAR-IDEAL (GAS-LIKE) CRYOGENIC DUSTY PLASMA

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Dusty plasma is a plasma containing charged particles of micron or submicron size along with electrons and ions [1]. Such a plasma has many practical and fundamental. Laboratory studies of dusty plasma are carried out mainly in DC and RF discharges. The dust fraction in plasma can demonstrate the properties of various states of aggregation, namely: crystal, liquid, gas. The first two states, as well as phase transitions between them, have been well studied to date [2]. At the same time, the properties of the gaseous state of dusty plasma have not been studied in details. The main parameter characterizing the state of aggregation is the coupling parameter Γ, which is equal to the ratio of the kinetic energy of dust particles and the potential energy of their interaction [1,2]. Crystals correspond to the condition Γ>170, liquids Γ~1-170, gases Γ≤1. Another criterion for plasma non-ideality is the parameter $\sigma_d=T_d/T_i$, where T_d is the kinetic temperature of the dust fraction, $T_i \sim T_n$ are the temperatures of ions and buffer gas. For a near-ideal plasma, as a rule, $\sigma_d >> 1$. Note that, in most cases, the discharge dusty plasma is strongly coupled (nonideal) [2] (the aggregate state is a crystal or liquid). Thus, the study of the "gas" state of dusty plasma is an urgent task.

In the proposed work, an experiment is described in which dust-acoustic waves were observed for the first time in a near-ideal dusty plasma [3]. By processing the video image, it was shown that the movement of charged particles was random, which is typical for gases. A pair correlation function was constructed and analyzed, the shape of which had no local maxima, which is also characteristic of the gas phase. The kinetic temperature of the dust fraction was also found, while the estimate of the ratio T_d/T gave $\sigma_d=27>>1$. And finally, the analysis of the coupling parameter gave us an estimate of its value Γ≤1. The observed periodic dust-acoustic wave caused a weak modulation of the dust density, and the wave process was apparently close to the linear stage. Also, in our experiment, a dust structure was observed, which did not have clear boundaries, which also indicates the gas-like state of the dust fraction.

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