DOI: 10.34854/ICPAF.51.2024.1.1.131

COLLECTIVE IONS DYNAMICS IN STRONGLY COUPLED ONE-COMPONENT PLASMA. SELF-CONSISTENT RELAXATION THEORY *)

Fairushin I., Mokshin A.V.

Kazan (Volga region) federal university, fairushin_ilnaz@mail.ru

Strongly coupled plasma is an electrically neutral system of charged particles whose interaction energy exceeds the energy of their thermal motion [1]. The properties of the strongly coupled plasma are in many ways similar to the properties of the liquid state of matter [2, 3, 4]. This is especially evident when considering the collective dynamics of the particles of the system. Therefore, methods of liquid theory can be used practically without changes to describe the thermodynamic and transport properties of strongly coupled plasma. Studies of the properties of strongly coupled plasmas are of interest not only from the point of view of fundamental questions in the physics of liquid matter, but also have remarkable applications in various physical situations, including the interiors of neutron stars and white dwarfs, dusty plasmas, ultracold plasmas, and colloidal suspensions [1]. In this work, we develop the theoretical formalism that describes the collective dynamics of ions in the strongly coupled one-component plasma based on the self-consistent relaxation theory [3, 4, 5]. This formalism is based on correlation relations connecting frequency relaxation parameters that characterize three- and four-particle dynamics with parameters related to two-particle dynamics. Calculation of the spectra of the dynamic structure factor and dispersion characteristics over a wide range of wave numbers reveals their agreement with the modeling data and the results obtained using the theory within the framework of the method of frequency moments [6]. The proposed formalism reproduces all the features inherent in a one-component plasma and requires knowledge only of the nonideality and screening parameters, as well as relevant information about the structure.

References

[1]. V.E. Fortov and G.E. Morfill, Complex and Dusty Plasmas: From Laboratory to Space (CRC Press/Taylor and Francis, BocaRaton, 2010).
[2]. J.-P. Hansen, I. R. McDonald, Theory of Simple Liquids, Academic Press, London, (2006).
[3]. A.V. Mokshin, I.I. Fairushin, I.M. Tkachenko, Phys. Rev. E **105**, 025204 (2022).
[4]. I.I. Fairushin, A.V. Mokshin Phys. Rev. E **108**, 015206 (2022).
[5]. A.V. Mokshin, B.N. Galimzyanov, J. Phys.: Condens. Matter **30**, 085102 (2018).
[6]. Yu.V. Arkhipov, A. Askaruly, A.E. Davletov, D.Yu. Dubovtsev, Z. Donko, P. Hartmann, I. Korolov, L. Conde and I.M. Tkachenko, Phys. Rev. Lett. **119**, 045001 (2017).

*) abstracts of this report in Russian