Radial profile of the stress tensor in a dusty plasma monolayer

Voronov I. V.[1,2,@] **and Timofeev A. V.**[1,2,3]

[1] Moscow Institute of Physics and Technology, Institutskiy Pereulok 9, Dolgoprudny, 141701, Russia
[2] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg 2, Moscow, 125412, Russia
[3] HSE University, Myasnitskaya 20, Moskva, 101000, Russia

[@] voronov.iv@phystech.edu

We consider a model of planar dusty plasma system of screened Coulomb (Yukawa) charges confined by a parabolic radial trap. We propose a local, axisymmetric method to compute the radial profiles of the diagonal components of the stress tensor. The procedure performs azimuthal averaging of per-particle virials over thin radial layers and yields a decomposition into two density-controlled contributions: (i) an isotropic stress identical to that of a homogeneous Yukawa system, evaluated at the local number density, and (ii) a correction accounting for the body force of the confining potential. Validation against a reference Irving–Kirkwood formulation shows an average relative error of 6% across systems with varied particle numbers and screening strengths. The method relies only on local densities and forces, making it efficient and robust for axisymmetric clusters with a smooth radial density profile, especially when analytic expressions for the homogeneous stress tensor [1] and the density profile [2] are available. The results provide a practical tool for evaluating mechanical properties and stress balance in non-ideal, trapped matter, and are applicable to complex plasma structures.

[1] Feng Y, Goree J, Liu B, Wang L and Tian W d 2016 *Journal of Physics D: Applied Physics* **49** 235203
[2] Totsuji H 2006 *Journal of Physics A: Mathematical and General* **39** 4493