ρv-BOUNDARY VALUE PROBLEM LIKE THE HYDRODYNAMIC APPROACH TO THE SPACE CHARGE PROBLEM MODELING

E. E. Perepelkin, N. G. Inozemtseva, N. P. Repnikova

Moscow State University, Moscow, Russia, e-mail:perepelkin.evgeny@phys.msu.ru

The effect of space charge should be necessary to account at simulation of the dynamics of the high intensity beam and optimization of parameters of accelerators [1]. In the paper the hydrodynamic approach taking into account the space charge effect is considered. The continuum matter with charge density function is used instead of the set of charged particles. In the present paper we present ρV - problem (1) of the problem of finding space charge, with unknown functions of the charge density $\rho(p,\mathrm{t})$ and the field of velocities $\vec{v}(p,t)$:

$$\begin{cases} \dfrac{\partial}{\partial t}\rho(p,t)+div\left[\rho(p,t)\vec{v}(p,t)\right]=0, \quad p\in\Omega, \ \dfrac{\partial}{\partial t}\vec{v}(p,t)+\left(\vec{v}(p,t),\nabla\right)\vec{v}(p,t)=\dfrac{\alpha}{\varepsilon_0}\vec{D}(p,t), \\ \vec{D}(p,t)=-\varepsilon_0\nabla u(p,t), \ \Delta u(p,t)=-\dfrac{\rho(p,t)}{\varepsilon_0}, \\ u\big|_\Gamma=u^0(p,t), \quad \rho\big|_{t=0}=\rho_0(p), \quad \vec{v}\big|_{t=0}=\vec{v}_0(p), \ \dfrac{\partial\rho}{\partial n}\Big|_\Gamma=0, \ \dfrac{\partial}{\partial n}(\vec{v},\vec{n})\Big|_\Gamma=0. \end{cases} \tag{1}$$

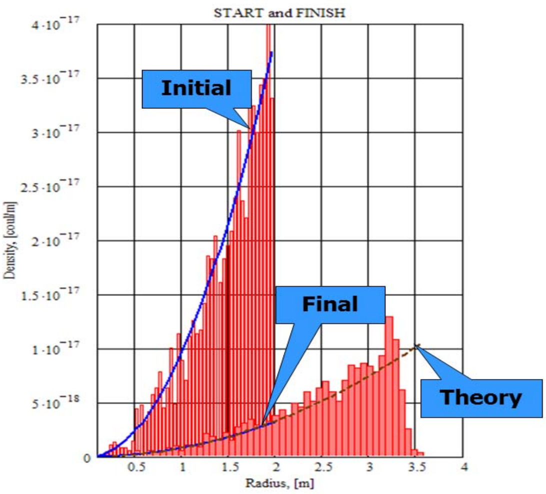

Fig.1 Charge density distributions

The function $\vec{D}(p,t)$ corresponds to the distribution of electric field which is created by the charge with density $\rho(p,t)$; $u^0(p,t)$ is the distribution of electric potential on the boundary Γ of the domain Ω.

At Fig.1, the distribution $\rho(r)r^2$ in the initial and final moments of the time is shown for homogeneously charged ball. The histogram corresponds to the proposed hydrodynamic approximation (1) (ρV - problem). The exact theoretical distribution was obtained in the papers [2-3]. To summarize, we describe briefly the hydrodynamic model. In the framework of this model, the solutions were obtained by numerical methods.

References

1. *E. E. Perepelkin, S. B. Vorozhtsov, A. S. Vorozhtsov, P. Beličev, M. Rajčević and N. Nešković.*" Ion beam dynamics in the VINCY Cyclotron". The 35th European Cyclotron Progress Meeting (ECPM 2006), November 2-4, 2006, Nice, France.
2. *B. I. Sadovnikov, N. G. Inozemtseva, and E. E. Perepelkin,* Exact Solution in the Form of a Shock Wave for the Maxwell and Gravitomagnetism Equations, Doklady Akademii Nauk, 2013, Vol. 452, No. 6, pp. 608–610
3. *E. E. Perepelkin, N. G. Inozemtseva, N. P. Repnikova, M. B. Sadovnikova*, The hydrodynamic approach to the space charge problem modeling, Moscow University Physics Bulletin 6(2014), pp. 53-56.