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# MATHEMATICAL MODEL OF THE CHURNING AROUND THE ACUTE EDGE OF A BAR

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It is known that a vortex in the form of a toroid arises in the area of the acute edge of a bar (cathode) when a flux of the superfluid liquid (electrons) is striving along this bar (cathode). We construct a mathematical model of the churning on the base of wave equation

$$\frac{\partial^2 u}{\partial t^2} - \frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial y^2} - \frac{\partial^2 u}{\partial z^2} + \frac{dQ}{du} = 0, \qquad Q = \frac{\mu^2}{4}(u^2-1)^2 + C.$$

Here we add a constant $C$ to the classical form of potential $Q$ for to describe the relaxation of a flux of the superfluid liquid in the area of the acute edge of the bar. Just the same potential $Q$ can be used for to describe a magnetic flux in the area of the acute edge of the cathode. However we can use also potential $Q = C - \mu^2 u^2$ as more corresponding to a distribution of electrons in the area of the acute cathode. An energy installation with an efficiency coefficient of 3000, where a vortex of electrons has the form of a toroid, belongs to Shoulders [1].

Matrix solutions of wave equations with different potentials are defined in article [2]. For our model it is sufficient to use only complex solution $u_1$ and matrix solution $u_2$ as follows

$$u_1(\phi) = \exp(i\phi), \quad u_2(\phi, \vec{a}) = \cos\phi E_2 + \sin\phi \sum_{j=1}^{3} a_j H_j = \exp(\phi \vec{a} H),$$

where $\vec{a}$ is unit vector, $H_1, H_2, H_3$ are unit quaternions and $\phi$ is continuous function on spatial and time variables. Let us take $z$-axis as the continuation of the bar (cathode) axis and consider $x, y$-plane as a complex plane. Then solution $u_1$ forms a unit circle $S^1$ on this plane with the center $O$ situated on the acute edge. Matrix solution $u_2$ describes a field which rotates a unit sphere $S^2$ about vector $\vec{a}$ by angle $2\phi$. Each point on $S^1$ can be considered both as initial point for solution $u_1$ and as a center of $S^2$ and hence as an origin of vector $\vec{a}$ which we can choose as a tangent vector to $S^1$ in the $x, y$-plane. Thus we obtain an infinite set of solutions, each of $u_2$-solutions associates with rotational sphere $S^2$ with its center on $S^1$. This construction completely corresponds to the vortex in the form of the toroid.

## REFERENCES

[1] Kenneth R. Shoulders. Patent Nr. 5018180 (USA) of 9. 12. 1991.

[2] V.V. Gudkov. Algebraic and geometric properties of matrix solutions of nonlinear wave equations. *Math. Phys., Anal. Geom.*, **6** (2), 2003, 125 – 137.