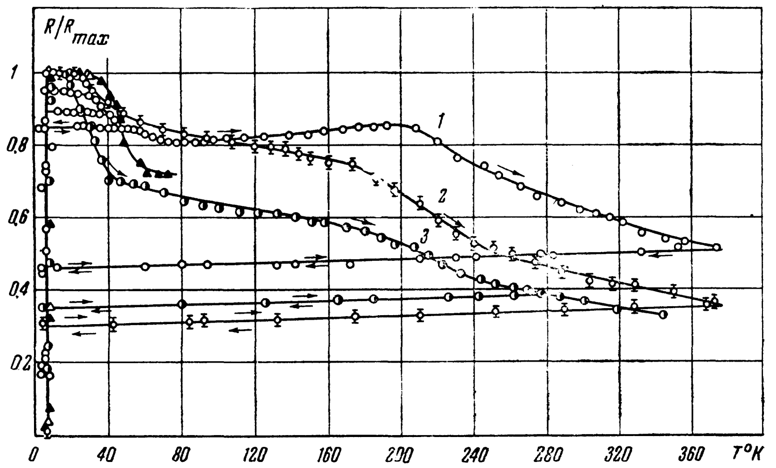

FIG. 2. Temperature variation of electrical resistance of beryllium films: 1 – film thickness 700 A, R_{max} = 200Ω; 2 – thickness 1800 A, R_{max} = 1070Ω; 3 – thickness 400 A, R_{max} ≈ 360Ω; ▲ – data for thickness 500 A, R_{max} = 300Ω (film condensed at 20°K).

gion (up to 20 – 30°K) in which the superconducting modification exists. If heated up to this temperature, the films become superconducting again on subsequent cooling. Heating to temperatures above this leads to an incomplete superconducting transition on cooling again: some resistivity remains, which increases with increasing temperature of heating. Superconductivity is completely lost if heating is carried on above 60°K. This limiting temperature is somewhat lower if the heating time is increased.

We can presume that the first sharp drop on the heating curves is determined by the transition of the film into a different (non-superconducting) modification.

Further on, up to ~200°K the resistivity changes little. Around ~200°K the resistivity drops again and this is connected either with the transition to yet another form, appropriate to bulk beryllium, or with recrystallization of the film.

Structural investigation will enable a more precise opinion to be given on these transitions.

We have shown that by condensing beryllium from the vapor onto a cold substrate a new modification is formed with different properties from normal beryllium, in particular it shows superconductivity. It is possible that this is the same modification which is obtained by plastic deformation at temperatures below 20°K.[2] This seems likely in view of the analogous behavior of bismuth: superconductivity is found in the low temperature modification of bismuth obtained by plastic deformation[6] at a temperature close to the superconducting transition temperature of freshly condensed films.

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Translated by R. Berman
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THE MOTION OF A CHARGED PARTICLE IN A ROTATING MAGNETIC FIELD

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Submitted to JETP editor July 11, 1959

J. Exptl. Theoret. Phys. (U.S.S.R.) **37**, 1463-1464 (November, 1959)

In plasma physics a discussion of the problem of the possibility of localizing a charged particle by a variable electromagnetic field within a certain region of space is of some interest. This question has been discussed by Trubnikov[1] and by Gaponov and Miller.[2] The behavior of a charged particle in a variable electromagnetic field was also discussed by Vedenov and Rudakov.[3] In the present note we show that the localization of a particle is possible in principle by means of a rotating magnetic field under definite quite restrictive conditions.

We assume that the rotating magnetic field is produced, as usual, by two crossed coils situated along the x and y axes, while a constant magnetic field H is applied along the z axis. If the phases of the alternating currents are suitably chosen, an electromagnetic field with the following components (in the quasi-stationary approximation) is produced in the region of space formed by the intersection of the two cylinders

$$\mathbf{E}\left\{-\frac{h\omega}{2c}z\cos\omega t,\ -\frac{h\omega}{2c}z\sin\omega t,\ \frac{h\omega}{2c}(x\cos\omega t+y\sin\omega t)\right\},$$
$$\mathbf{H}\{h\cos\omega t,\ h\sin\omega t,\ H\}, \qquad (1)$$

where h is the amplitude of the rotating magnetic field, and ω is the frequency of rotation.

The equations of motion for the particle may be conveniently written in the following matrix form:

$$\ddot{\mathbf{r}}=\hat{m}_H\dot{\mathbf{r}}+\hat{m}_E\mathbf{r}. \qquad (2)$$

The explicit expression for the matrices $\hat{m}$ may be easily found from (1). In the rotating system of coordinates in which the vector **h** is at rest (2) reduces to the following equation with constant coefficients:

$$\ddot{\mathbf{R}}=\hat{\mu}_1\dot{\mathbf{R}}+\hat{\mu}_2\mathbf{R}. \qquad (3)$$

If $\mathbf{R}=\hat{M}(t)\mathbf{r}$, where $\hat{M}(t)$ is the matrix representing a rotation about the z axis, then the matrices $\hat{\mu}$ and $\hat{m}$ are related by the following equations

$$\hat{\mu}_1=\hat{M}\hat{m}_H\hat{M}^{-1}-2\hat{M}d\hat{M}^{-1}/dt,$$
$$\hat{\mu}_2=\hat{M}\hat{m}_E\hat{M}^{-1}+\hat{M}\hat{m}_Hd\hat{M}^{-1}/dt-\hat{M}\,d^2\hat{M}^{-1}/dt^2. \qquad (4)$$

We introduce the following notation: $\Omega = eH/mc$, $\omega_h = eh/mc$. Then with the aid of (4) the matrices μ may be written in the following form

$$\hat{\mu}_1=\begin{pmatrix}0 & \Omega-2\omega & 0\\ 2\omega-\Omega & 0 & \omega_h\\ 0 & -\omega_h & 0\end{pmatrix},\quad \hat{\mu}_2=\begin{pmatrix}\omega^2+\omega\Omega & 0 & -\omega_h\omega/2\\ 0 & \omega^2+\omega\Omega & 0\\ -\omega\omega_h/2 & 0 & 0\end{pmatrix}. \qquad (5)$$

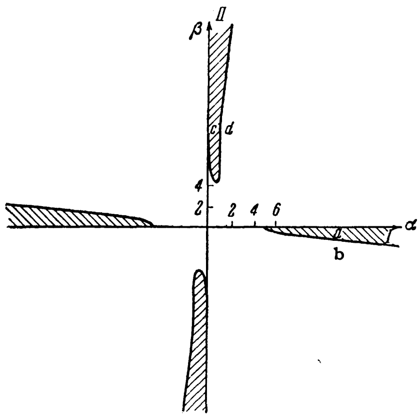
We note that in the rotating coordinate system the electric field has the potential

$$U=-\frac{eH\omega}{c}(X^2+Y^2)+\frac{\omega eh}{2c}XZ$$

(the X axis is chosen in the direction of the vector **h**). On substituting $R = R_0 \exp(i\sqrt{kt})$ into (3) we obtain the following characteristic equation:

$$k^3-\{\omega_h^2+\Omega^2-6\omega\Omega+2\omega^2\}k^2+\{\omega^2(\omega+\Omega)^2-{}^{13}/_4\,\omega^2\omega_h^2\}k$$
$$-{}^1/_4\,\omega^3\omega_h^2(\Omega+\omega)=0.$$

The particle motion is stable (finite) only



when the roots of this equation are positive and are different. The ranges of parameters for which this condition is fulfilled are shown in the diagram (by shaded areas). Region I is bounded by the curve a which (for $\alpha \gg \beta$ and $\alpha \gg 1$, $\alpha = 2\omega/\omega_h$, $\beta = H/h$) asymptotically approaches the horizontal axis, and by the curve b which asymptotically approaches the straight line $9\beta + \alpha = 0$. For $\beta = 0$ the boundary of the region I is given by $\alpha_{cr} \approx 5$. The region II is bounded by the curve c which coincides for $\beta \gg \alpha$, $\beta \gg 1$ with the hyperbola $\alpha\beta = 2$, and by the curve d which has the asymptote $\beta - 9\alpha = 0$.

The regions I and II are symmetric with respect to the origin in the different quadrants.

In conclusion I wish to express my gratitude to A. M. Dykhne, V. L. Pokrovskiĭ, S. K. Savvinykh, and B. L. Zhelnov for their advice and discussions.

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Translated by G. Volkoff
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