considerable interest. We shall first calculate the gravitational potential of a point-electron with an infinite filled mass, making use of the relations

$$\Box^2 h_{\mu\nu} = -(2G/c^3)\, T_{\mu\nu}, \tag{2}$$

where

$$T_{ik} = T_{i4} = 0, \qquad T_{44} = (e^2/2)\, x^{-4}. \tag{3}$$

The potential h_{44} takes the form

$$h_{44} = (Ge^2/c^3)\,[(1/2x^2) - (1/x_0 x)], \tag{4}$$

where x_0 is a constant small length, which it is necessary to introduce, in order to avoid the general divergence of h_{44}. At zero h_{44} now diverges as x^{-2}. The self-energy of the gravitational field is $\sim (\nabla h_{44})^2$ and diverges as x^{-6}. It is interesting, however, that by identifying h_{44} with the Newtonial potential, we obtain for x_0 the interpretation of classical radius $x_0 \doteq e^2/2\mathscr{E}_0$.

In the regulated theories we obtain the following results. In the theory of Born-Infeld*

$$\mathbf{D} = (e/x^2)\, \mathbf{x}^0, \quad \mathbf{E} = \mathbf{D}/\sqrt{1 + (x/x_0)^4}, \tag{5}$$

and the gravitational potential is equal to

$$h_{44} = (Ge^2/c^3)\, F(\varphi, k)/2x_0 x$$
$$- (1/4x_0^2) \ln [(\sqrt{1 + (x/x_0)^4} - 1)/(\sqrt{1 + (x/x_0)^4} + 1)],$$

where $F(\phi, k)$ is the elliptic integral, $k = \sqrt{2/2}$,

$$\varphi = \arccos ((1 - x^2/x_0^2)/(1 + x^2/x_0^2)).$$

For $x \gg x_0$, $h_{44} \sim 1/x$; for small distances $h_{44} \sim \ln x$ and diverges at zero. The gravitational self-energy converges and constitutes the portion of the self-energy of the electron required by the theory, as is easy to show,

$$m_{\mathrm{gr}}/m_0 = aG^2 m_0^2/\hbar c,$$

where a is a number ~ 1.

In the theory of Bopp-Podolsky the result turns out to be divergent both for h_{44} and for m_{gr}. Thus only the non-linear electrodynamics allows a completely successful solution of the problem of the gravitational self energy. The result turns out to be favorable, notwithstanding the use of the linear theory of gravitation in calculation carried out above.

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* The question of the gravitational field of the electron in the theory of Born and Infeld was investigated by Fisher[4], who found exact solutions of the Einstein equations for this case.

Translated by D. G. Posin
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The Constriction and Curvature of an Arc in Rarified Gases at Large Currents

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THE idea of the constriction of the column of an electric arc in rarefied gases at large currents under the influence of its own magnetic field (the "pinch-effect") was introduced by Tonks[1]. It was shown that this hypothetical effect could cause a rupture of the arc.

In attempts to observe this phenomenon experimentally in a DC arc (for a Hg-arc at $i = 150$ amp), Thoneman and Cowhig[2] detected only a weakening of the radial electric field, while Mamyrin[3] (for a H_2 arc at $i \sim 100$ amp) found a constriction of the current density distribution by only 30%.

We performed experiments with DC arcs in rarefied Hg-vapor and inert gases in straight cylindrical tubes without constriction. Measurements with a movable probe in a tube of 20 mm diameter in Hg-vapor at $p = 1\,\mu$Hg confirmed that with an increase in the current from 1 to 80 amp the half-width* of the column is diminished by $\sim 25\%$. For a further increase in current to 1-2 kamp, it was impossible to find the corresponding constriction of the arc with probes, as firstly the probe currents, then the tension of the arc, and finally the current of the arc show strong, ever increasing irregular variations with a predominant frequency of the order of $10^4 - 10^5$ cps. Experiments with two identical probes, placed symmetrically with respect to the axis, showed that the current variations in both probes are completely uncorrelated in time: not only the position of the peaks in current but their number and relative height are different. Therefore, there occur in the tube no overall changes of the current intensity in the entire cross section of the column simultaneously, but probably fast irregular motions of the constricted channel of the arc take place over the cross section of the tube. As the arc moves in the tube in a time of the order of 10^{-5} sec, the determination of a possible constriction of the arc requires observation of the arc within times of the order of 10^{-6} sec. Therefore, the arc has been formed by a discharge of a condenser connected by short leads to the tube, the discharge occurring in τ=1-2 μsec. Under these conditions one could observe the arc constricted to a narrow channel.

In Fig. 1 an arc is shown in argon with a tube diameter of 32 mm, $p = 1\,\mu$Hg and $i_{max} = 450$ amp. We see that, notwithstanding the low pressure, the channel of the arc is constricted as compared to the diameter of the tube. The constriction is stronger in Fig. 2, which shows an arc in Hg-vapor with a tube diameter at 9 mm at τ=1.15 μsec, $i_{max} = 425$ amps. The arc is seen in the main part of the Figure to be a narrow channel, spirally curved and adjacent to the wall of the tube. A control experiment shown in Fig. 3 of an arc in the same tube at the same pressure but smaller current (i_{max}= 225 amp τ=2 μsec) does not have any constriction.

The conditions and results of these and numerous analogous experiments in Hg-vapor and in argon compel us to reject for all of them the known explanations for the constrictions of the region of current conduction(contraction of a high-pressure column, the phase of a gas-focused electron beam[4]). One must therefore accept the observed phenomena as being caused by the electrodynamic effects of the magnetic field of the arc.

We did not find a rupture of the arc, caused by the "pinch-effect". An arc sustained continuously in a straight tube without constriction or other obstacles does not rupture, but moves rapidly across the cross section of the tube. A complete description of these experiments will follow.

V. I. Pugacheva participated in these experiments.

Translated by W. Philippoff
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* The distance between points symmetric with respect to the axis, where the electron concentration is half that on the axis.

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The Relation of the Oscillator Strengths for the Components of the Resonance-Doublet of Aluminum and Copper

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THE experimental arrangement used in this paper has been described in detail in the papers of Rozhdestvenskii and Penkin[1] and Penkin[2]. It consists of a source of a continuous spectrum (an SVD tube with krypton), a large Rozhdestvenskii interferometer with a mirror separation of 30 cm, and a spectrometer (quartz-spectrograph E-1).

A column of vapor of the element to be investigated was obtained in a high temperature vacuum furnace with a graphite tube as a heater. The furnace was placed in one of the paths of the interferometer. When a compensation tube and a plane-parallel plate were simultaneously introduced in the other path of the interferometer, one could observe hooks in the spectrometer, coupled with the interferometer, near the absorption lines. The measurement of the distances between the summit of the hooks allows the determination of the oscillator strength of the corresponding transitions. With the help of this arrangement, spectrograms which consisted of photographs of the hooks at the absorption lines of aluminum and copper were obtained. These photographs are reproduced in Fig. 1.

The calculation of the relative values of the numbers f for the components were performed according to the formula of the method of hooks:

$$\frac{f_1}{f_2} = \frac{K_1}{K_2}\left(\frac{\Delta_1}{\Delta_2}\right)^2 \frac{N_2}{N_1}\left(\frac{\lambda_2}{\lambda_1}\right)^3.$$

The indices 1 and 2 relate to the short-wave and long-wave components of the doublet:

$$K = \left(\frac{n-1}{\lambda} - \frac{\partial n}{\partial \lambda}\right) d$$

Here d is a constant of the method, Δ the distance between the summits of the hooks, λ the wavelength of the absorption line, N the concentration of the atoms at the lower level.

For the resonance doublet of aluminum, the ratio

$$f_{3944}/f_{3962} = 3.44$$