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Galvanomagnetic Properties of Metals at the Heat Exchange Crysis at Boiling of Liquid Helium

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The galvanomagnetic properties of metals and some heat aspects of problem of joule energy generation in cylinder conductors having a radical current under external coaxial magnetic field is investigated by the method of voltage current characteristics. The regime of current supply is used and voltage drop along radius is measured on disk shaped cylinder conductors having been fabricated of pure aluminum. The residual resistance ratio of conductor is of 15000. These boundary conditions ensures the existence of spiral current when electric hall field is absent. Under strong magnetic field, cyclotron frequency being much higher of reversal relaxation time, a resistance increases in magnetic field in accordance with a dependency of conductivity component tensor on magnetic field. On this reason a high level of magnetoresistance in this geometry gives a possibility to investigate the charge transport in wide range of heat generation up to boiling crysis of liquid helium. The results of transport of high density charge through the samples have shown three characteristic dependence of voltage U on a current I:

- monotonic increase of voltage in all range of current (this regime is realized in magnetic field up to 2T);
- non-monotonic dependence of U on I, the extremum being increased in magnitude and displaced to region of small current value with magnetic field growth. This type of characteristic is realized in magnetic field of 2-8T;
- non-monotonic dependence of U on I so that a range of extremum is extended to a plateau - the section with stabilize voltage in definite current range.

The third type of characteristics takes place presumably at anticollinear geometry, the own magnetic field and external that being antiparallel. The first two types of characteristics are observed both for collinear and anticollinear geometry.

The behavior of system is investigated on the base of equation describing an evolution of open thermodynamical system in time. Here the temperature as a field function corresponds to the equation in partial derivatives with

respect to time and spatial coordinate. The stationary state consideration is based in linear analysis of system stability when a decision is presented as a multiplication of time function and coordinate that. The heat balance of sample is estimated using characteristics of boiling regimes of liquid helium. It is shown that am extremum on characteristics of second type takes place at heat generation corresponding to the first boiling crysis. Under these conditions the heat removal function being of N type ensures at definite levels of heat production such temperature increase that heat balance of system is realized with temperature bubble and film branches of boiling curve. Under film boiling and at all for T>5K the decrease of resistance dominates in process and stimulates the falling down section of voltage current characteristics. At small external magnetic field there takes place amonotonic dependence of U on I because the heat removal function realizes the most favorable bubble regime of boiling. For first and second types of characteristics a quasihomogeneous temperature distribution takes place through sample volume.

Third type of voltage current characteristics having voltage stabilization appears to be due to special heat regime of system. The analysis shows that the observed voltage stabilization is probably a result of existence of definite spatial temperature structures in system. The stationary state may be realized when the temperature is nonhomogeneous along radius. This temperature ordering leads to stabilization of voltage when a spatial oscillations at resistance near some average magnitude takes place so the voltage drop is stabilized in some current range. The existence of range with voltage stabilization is rather sufficient condition of temperature structure appearance because there is no any evidences that temperature ordering is impossible when voltage stabilization is absent. Notice that in quasi-linear regime the stability of stationary state may be interpreted using s formalism of open thermodynamical systems. A system is not far from equilibrium state so the symmetry of kinetic coefficients and the linearity of phenomenological relations takes place. The speed of entropy production is positively defined form of state variables that is of temperature. So the stationary entropy production being Lyapunov function is responsible for stability of system. Under these conditions the voltage stabilization is a result of system organization when from all possible states there realizes the one having a minimum speed of energy generation as a multiplication of sample voltage with electric current.