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EQUATION OF STATE OF CESIUM AT PRESSURES 20 - 600 atm AND TEMPERATURES 500 - 2500°C

V.A. Alekseev, V.G. Ovcharenko, Yu.F. Ryzhkov, and A.P. Senchenkov
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The equation of state of metals up to temperatures and pressures exceeding the critical values were measured only for mercury [1, 2]. Particular interest attaches to the equation of state of cesium, which, unlike mercury, has a much lower ionization potential, so that thermal ionization of cesium is possible at high temperatures, making its conductivity quite high [3, 4]. The densities of cesium liquid and vapor on the saturation line were previously investigated up to 1770°C by the method of γ counting, using radioactive cesium [5]. To measure the equation of state, we also used the γ count of Cs^{134} (E = 0.606 MeV). Our element, unlike that used in [5], made it possible to measure pressure and therefore also the equation of state of cesium. The measuring element is shown in Fig. 1. It guarantees purity of the cesium, because the cell is sealed. The pressure of the working gas (argon) in the chamber containing the measuring element was applied to the measuring cell through a stainless-steel bellows. To make the cesium source as pointlike as possible, all the free space in the measuring tube was filled with a tungsten rod, leaving a gap on the order of 1 - 2 mm between the rod and the bottom of the tube; this gap was filled with cesium. The heater was a graphite tube. To prevent convective stirring of the argon and to provide thermal insulation, the space between the heater walls and the cell body was filled with a powdered heat insulator based on boron nitride and zirconium oxide. The temperature was measured with a VR-5 - VR-20 thermocouple calibrated up to 2100°C. The gamma radiation left the chamber through a window and was collimated with a lead collimator. The gamma quanta were registered with a CsI scintillator and a photomultiplier. The set-up for recording the thermocouple readings incorporated a digital millivoltmeter as a counting device for the measurement of the gamma counting rate. The readings of the instruments were printed on punched cards and the measurement results were processed with an electronic computer. The obtained phase diagrams of cesium are shown in Fig. 2. The density of the cesium was measured accurate to ±0.005 g/cm³. The thermocouple calibration curve was accurate to ±5°C. The gamma counting rate was 400 - 700 counts/sec.

Altogether, more than 3000 experimental points were obtained. The table lists the values of the density in steps of 250°C. The main reference points of the cesium were taken from [6] for a pressure of 20 atm and were used to verify the correctness of the corrections for the internal background, the expansion of the tungsten tube, etc. The results obtained at temperatures exceeding 2100°C were obtained by extrapolating the calibration-curve temperatures to the 2500°C region, and are therefore shown dashed in Fig. 2. The parameters of the critical point of cesium, determined by the linear-diameter method, are T_{cr} = 1760 ± 20°C, P_{cr} = 115 ± 5 atm, and ρ_{cr} = 0.4 ± 0.02 g/cm³.

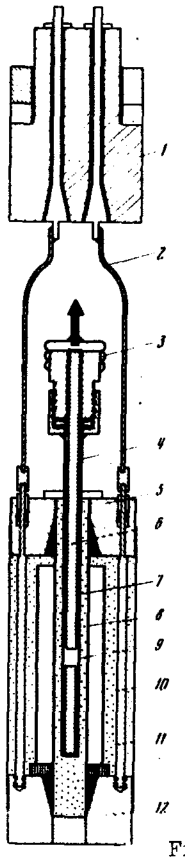

Fig. 1

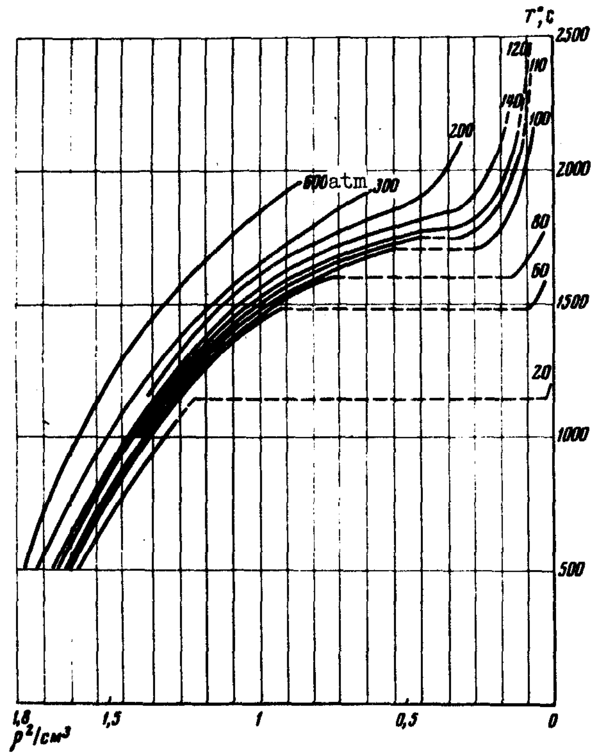

Fig. 2

Fig. 1. Measuring element: 1 - obturator, 2 - electric lead-in, 3 - bellows with cesium, 4 - tungsten tube, 5 - upper electrode of heater, 6 - tungsten insert, 7 - boron nitride, 8 - graphite heater, 9 - thermocouple, 10 - boron nitride, 11 - zirconium oxide, 12 - lower electrode of heater.

Fig. 2. Phase diagram of cesium.

T°,C \ P, atm	20	60	80	100	110	120	140	200	300	600
500	1.615	1.630	1.655	–	–	1.685	1.690	–	1.740	1.775
750	1.485	1.525	1.530	–	–	1.570	1.685	–	1.640	1.710
1000	1.320	1.365	1.380	1.395	1.405	1.415	1.440	–	1.510	1.605
1250	–	1.185	1.205	1.215	1.240	1.245	1.285	1.310	1.355	1.485
1500	–	0.090	0.920	0.955	0.980	1.015	1.060	1.110	1.150	1.310
1750	–	–	0.941	–	0.315	0.495	0.500	0.755	0.875	0.889
2000	–	–	–	0.100	0.140	0.160	0.230	0.375	–	–
2250[1)]	–	–	–	–	0.098	0.100	0.155	–	–	–
2500	–	–	–	–	0.060	0.080	–	–	–	–

1) Temperature calibration by extrapolation from 2100°C.

These parameters lie within the measurement errors of the critical-point parameters obtained by other methods [4, 5, 7]. The critical pressure deviates somewhat from that in [7], where the values of the errors are not indicated.

A comparison of the equation of state of cesium with the equation of state of mercury shows that in the gas phase the compressibilities of cesium and mercury coincide, but in the liquid phase the compressibility of the cesium greatly exceeds that of mercury. Comparing the equations of state of cesium with measurements of the electric conductivity of cesium at analogous pressures and temperatures [2, 4], it can be stated that a 30% decrease of the density of cesium changes its conductivity by three orders of magnitude.

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CHANNELING OF POSITRONS IN SINGLE CRYSTALS

A.I. Didenko, S.A. Vorob'ev, and I.A. Tsekhanovskii
Research Institute for Nuclear Physics, Electronics, and Automation
Submitted 18 August 1970
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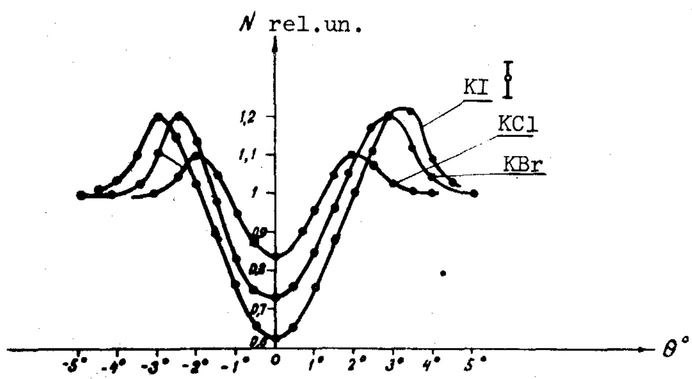
The channeling of heavy charged particles, especially protons, in single crystals has been the subject of many experimental and theoretical studies and has found practical applications [1, 2]. The information of the channeling of light charged particles, particularly positrons, is still insufficient to determine the laws governing this effect and its influence of the interaction between positrons and crystals.

The purpose of this study was to observe experimentally the influence of positron channeling on their back-scattering from single crystals.

The experiment was performed using positrons from radioactive Na^{22}. We measured the counting rate of positrons scattered through 150° relative to the direction of incidence of the primary beam. The divergence of the primary beam was ±0.5°. The scattered positrons were registered by means of the correlated annihilation quanta, using a double-coincidence circuit.

The dependence of the measured counting rate of the positrons scattered through 150° on the orientation of KCl, KBr, and KI crystals relative to the direction of incidence of the primary beam is shown in the figure.



Counting rate of the positrons scattered back at an angle 150° vs. the angle of rotation of the crystal relative to the direction of the incident beam.