the energy release. Then $t = (a/A)^{1/k}$ and $q(r) = q_0 \sin^2 [(\pi/4T)(r/A)^{1/k}]$, i.e., q(r) yields information on k and A, i.e., on the mechanism of the process causing the shadowing.

To determine k we plotted $\log \sin^{-1}(q/q_0)^{1/2}$ against log 2r for various gases and obtained the values of k from the slope $\tan\psi = 1/k$. It turns out that for Kr and Ne k is close to 0.5, whereas for air and He it is close to unity.

We have considered the most probable processes. The width of the shadowing region decreased with increasing pressure, just as the velocity of a shock wave or an optical-detonation wave decreases the photoionization region is decreased.

For quasispherical plasma spreading we have $(d/dt)\rho_0 a^3 \dot{a}^2 \approx W(t)$; for a contribution with sinusoidally varying power $W = W_0 \sin(\pi t/2T)$ we get from this for $t < 2T$ the value $a \approx (w_0 T^3/\pi^3 \rho_0)^{1/5} \sin^{4/5}(\pi t/8T) \sim t^{4/5}$; when $t \leq T$, this model is valid for sparks that are small or commensurate with the dimensions of the shadowing. These cases include apparently air and He.

For long sparks with large longitudinal development rates, a better description is obtained by assuming a quasicylindrical contribution with an instantaneous energy release $Q_1 = dQ/dz = W/\dot{z}$. In this case $(d/dt)\rho_0 a^2 \dot{a}^2 \approx W_1(t)$ we obtain $a \approx (Q_1/\rho_0)^{1/4} t^{1/2}$. For example, for radiative transfer of the breakdown front along a beam cone $W(t)/\pi r^2 \sim I_{br} = B/\rho_0$ we get for $W = \dot{W}t$ the relation $z = r/\tan\theta = (\rho \dot{W} t)^{1/2}/\tan\theta$, i.e., $\theta_1 \approx \theta/z \sim (\dot{W}T/\rho_0)^{1/2} \tan\theta$, i.e., $a \sim t^{1/2} \rho_0^{3/8}$, making dependence on t and on the density ρ_0 for Kr and Ne close to the experimental results $k \approx 0.5$ and $a(\rho) \sim 1/\rho_0^{0.5 \text{ to } 0.3}$.

These results demonstrate the efficacy of this new simple diagnostics method (we obtain the dependence of the time variation from integral distributions). We note the diagnostics of the transverse spreading of a spark by a longitudinal beam was never performed before.

This diagnostics method can be supplemented with investigations of the axial beam with the aid of a coaxial photocell or a photomultiplier or a calorimeter, in the presence of a spark or without a spark, making it possible to obtain additional information on the evolution of the shadowing process (signal $\mathcal{E}(t) \sim I(t)\,[a_0^2 - a^2(t)]$). We note that an insert made of a material that produces a second harmonic, placed in the hole of the lens, can also increase the efficiency of the diagnostics.

It is also possible to register not only the breakdown, but also the nonlinear variation of the refractive index in the focus of a laser.

ABSOLUTE CALORIMETER FOR THERMAL MEASUREMENTS WHILE HEATING OR COOLING

E. L. Kiziriya and E. Yu. Roinishvili
Physics Institute, Georgian Academy of Sciences
Submitted 30 June 1969
ZhETF Pis. Red. 10, No. 4, 165 - 167 (20 August 1969)

In many thermodynamic measurements it is of interest, and sometimes necessary, to study processes that occur when the investigated system is being heated or when it is gradually cooled. The presently available calorimeters do not make it possible to perform such experiments. The main difficulty lies in an exact registration of the amount of heat drawn from the sample.

We were able to solve this problem by using two methods: heat exchange with a calibrated heat conductor, and the Peltier effect.

In the former case, the heat conductor may be a pile of thermocouples that join the sample to a thermal screen. If the temperature difference between the opposite junctions of the pile is small ($\Delta T \ll T$), the heat flux between the screen and the sample equals

$$W = n\lambda\Delta T + \alpha\Delta T, \tag{1}$$

where n is the number of thermocouples in the pile, λ is the thermal conductivity of one thermocouple, and α is a coefficient that depends on the temperature, shape, and surface quality of the screen and of the cell in which the sample is placed.

The first term of (1) corresponds to the thermal flux through the thermocouple pile, and the second to the flux due to radiation. Heat exchange via convection and via thermal conductivity of air is excluded by using a sufficiently high vacuum. Recognizing that the voltage at the thermopile terminals is $U = n\varepsilon\Delta T$ (ε is the Seebeck coefficient), we obtain for the heat flux (1) the expression

$$W = [(\lambda/\epsilon) + (\alpha/n\epsilon)]U = kU .$$

The coefficient k depends on the temperature and can be determined when the instrument is calibrated. To decrease the errors connected with the flux instability due to heat radiation, it is necessary to satisfy the condition $\alpha \ll n\lambda$.

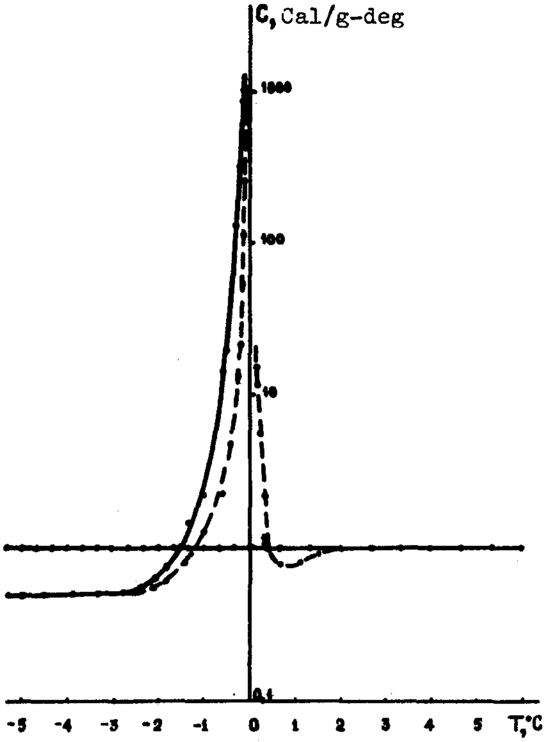

Fig. 1.

The presence of the thermopile makes it possible for the sample and screen to lose heat by another method, namely by the Peltier effect. In this case the screen temperature is kept equal to the sample temperature by means of a servomechanism, and the power W drawn by the thermopile equals [1] $W = \pi I[1 - (I/I_0)]$, where π is the Peltier coefficient and I is the current flowing through the pile.

The parameters π and I_0 also depend on the temperature and must be determined when the instrument is calibrated.

Thus, the accuracy with which the heat drawn from the sample is determined depends on the accuracy with which the voltage U or the current I is measured, and on the time stability of the parameters k, π, and I_0.

We have constructed a calorimeter that realizes the two foregoing principles. To illustrate its operation, we measured the specific heat of water while it was cooled continuously in the region of the water-ice transition (Fig. 1). The solid curve corresponds to cooling (the supercooled state was maintained to -8°C), and the dashed curve corresponds to the usual heating regime.

The heat was drawn from the thermal screen by a three-stage semiconducting thermopile, on the cold junction of which it was possible to obtain a temperature of -80°C. The specific heat of the sample can be determined from the formula $c = W[(dR/dT)/\Delta R]\Delta t$, where dR/dT is the temperature coefficient of the resistance thermometer, and Δt is the time necessary for the thermometer resistance to change by an amount ΔR. The relative error in the determination of c is of the order of 0.3%. The obtained latent heat of melting of water, referred to 0°C, is 79.6 cal/g, which is in good agreement with the published data [2].

The authors are grateful to Academician E. L. Andronikashvili of the Georgian Academy of Sciences for suggesting the problem and stimulating the work, and to Doctor of Technical Sciences E. A. Kolenko and M. G. Epshtein for supplying the semiconducting thermopile.

[1] E. Calvett and H. Prat, Recent Progress in Microcalorimetry, Pergamon, 1963.
[2] E. Dorsey, Properties of Ordinary Water, N. Y. 1940.

THE RESONANCE $Y_0^*(1327) \to \Lambda + \gamma$

N. P. Bogachev, Yu. A. Budagov, V. B. Vinogradov, A. G. Volod'ko, V. P. Dzhelepov, V. G. Ivanov, V. S. Kladnitskii, S. V. Klimenko[1], Yu. F. Lomakin, G. Martinska[2], Yu. P. Merekov, I. Patocka[2], V. B. Fligin, and P. V. Shlyapnikov
Joint Institute for Nuclear Research
Submitted 1 July 1969
ZhETF Pis. Red. <u>10</u>, No. 4, 168 - 172 (20 August 1969)

The purpose of this experiment was to study the production of "strange" resonances whose final decay products contain Λ^0 or K^0 particles and γ quanta.

A propane bubble chamber [1] with working volume 100 x 50 x 40 cm in a magnetic field of 1.7 Tl was exposed in a beam of pions with momentum $p = 5.1$ GeV/c and $\Delta p/p = \pm 2\%$ [2]. The results presented below are based on the processing of 230000 photographs.

We selected events in which the primary interaction was associated simultaneously with at least one V^0 event and one electron-positron pair.

In accordance with visual criteria and the data of the subsequent reduction, the interactions were divided into two groups, $\pi^- + p$ and $\pi^- + C$.

In π^-p events, the admixture of interactions between pions and quasi-free protons in the carbon nuclei is $\sim 30\%$. All the selected events were measured in accordance with one system of programs for reconstructing the geometry of the events and identifying the Λ^0, K^0, and γ. An additional identification of the unseparated V^0 particles was based on δ-electrons, ionization, and the free path of the positively charged particle. The histograms presented below, with Λ^0 hyperons, contain $\sim 3\%$ of K^0-meson admixture.

The obtained effective-mass spectrum of the $\Lambda^0\gamma$ combinations for π^-p events has two maxima (Fig. 1). The first corresponds to the creation of a Σ^0 hyperon, and the second, going beyond

---

[1] Institute of High Energy Physics, Serpukhov, USSR

[2] P. I. Safarik University, Kosice, Czechoslovakia