tial cross sections of the formation of charged mesons. For a quantitative evaluation of the expected difference in the spectra of π—mesons, it is necessary to make computations by the method of probability trials to account for the deceleration of the protons and the absorption and scattering of π—mesons in the nuclei.

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Production of Very Strong Magnetic Fields by Rapid Compression of Conducting Shells*

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FOR the practical realization of cyclic accelerators of charged particles to energies in excess of 10^{10} ev, it is necessary to learn to create very strong magnetic fields, in excess of 10^5 oe. At the indicated energies, both for electrons and for protons, the formula

$$V = 3 \cdot 10^4 RH, \quad (1)$$

holds, where V is the energy of the accelerated particles, expressed in electron volts, R is the radius of curvature of the trajectory in meters, and H is the magnetic field intensity in oersteds. Consequently, in a cyclic accelerator for 10^{11} ev. or 100 bev, with a directing magnetic field $H = 10^5$ oe, the radius of the largest orbit must be 30 m, whereas with $H = 10^6$ oe, it needs to be only 3 m. Thus only at fields exceeding 10^5 Oe is there hope of building 100 bev apparatus of not too huge dimensions. If we learn to create magnetic fields of intensities 10^7 to 10^8 oe, we may hope for the practical production of compact cyclic accelerators for energies exceeding even 100 bev.

The strongest magnetic fields have been obtained by passage of powerful current impulses of short duration through ironless electromagnets (P. L. Kapitza). By this impulsive method, fields of order 3×10^5 Oe have been obtained. Further increase of the field was limited by the mechanical strength of the electromagnet coils, which were ruptured by the interaction forces of the currents.

There occurs to us an alternative method of creating very strong magnetic fields: by the rapid compression of conducting shells or loops. By this method it is in principle possible to obtain magnetic fields considerably stronger than the largest attainable by the impulsive method.

Let us consider a conducting hollow sphere, placed in an external magnetic field H_0 created by any practicable method. If the source of external field H_0 is suddenly shut off, the field inside the sphere, because of induced currents, will decay exponentially with relaxation time

$$\tau = \alpha (4\pi\sigma / c^2) R^2, \quad (2)$$

where R is the radius of the sphere, σ is the conductivity in absolute units, c is the speed of light, and α is a numerical coefficient of order unity, determined by the form of the conductor. For a 10 cm copper sphere, the relaxation time according to (2) exceeds 1 sec.

Let us now suppose that the sphere, located in an external field H_0, is subjected to an intense hydrostatic pressure, so that the linear dimensions of the internal cavity decrease by a factor n in a time interval T much shorter than the relaxation time τ. In this case, during the time interval T the conducting material of the sphere may be considered as having practically infinite conductivity, and consequently the magnetic lines of force may be considered rigidly connected to the material ("frozen" magnetic field). Since in the process of compression the magnetic lines of force cannot cross the conducting wall of the sphere, the magnetic flux through the cross section of the sphere will remain constant, i.e.,

$$\Phi = \int_0^R H(r)\, 2\pi r\, dr = \text{const.} \quad (3)$$

Consequently, for an initially uniform magnetic field we get $\pi R^2 H = \text{const}$, whence

$$H / H_0 = (R_0 / R)^2 = n^2, \quad (4)$$

where R_0 and H_0 are the initial values of the inside radius of the sphere and of the magnetic field.

In the process of compression of the sphere, work will be performed against the ponderomotive force of the magnetic field, and therefore the energy of the field undergoing compression will increase. Since in a uniform field the full energy is $\epsilon = H^2 v/8\pi$, where v is the volume of the cavity; therefore, according to (3),

$$\mathcal{E}/\mathcal{E}_0 = R_0/R = n. \quad (5)$$

Thus as a result of an n–fold compression of a hollow sphere, the magnetic field inside the cavity increases by a factor n^2.

The same reasoning holds not only for a spherical shell but for any solid loop; for example, for a torus. In all cases the magnetic field will increase in proportion to the square of the diminution of linear dimensions.

A uniform and intense hydrostatic compression of a sphere, or an inward compression of a solid loop, is quite realizable by means of cumulative explosion of an explosive material. Thus if, by means of implosion, over a period of a second, one compresses a hollow copper sphere so that its internal diameter contracts, say, by a factor 10, the magnetic field inside the sphere will increase by a factor 100. Consequently, an initial magnetic field of 10^5 oe will increase in the example considered to 10^7 oe.

Obviously an accelerator based on the application of very strong magnetic fields obtained by the method under consideration will not be a device with periodic action. Such an accelerator can be designed only for obtaining single pulses of accelerated particles. This circumstance, however, does not constitute a serious disadvantage; for with the known cyclic methods of acceleration, the frequency of the pulses of accelerated particles decreases rapidly with increase of energy, and this is equivalent to operation of the apparatus under single–pulse conditions.

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The Influence of the Entrainment of Electrons by Phonons on Thermomagnetic Effects in Semiconductors

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THE effect of a nonequilibrium distribution of phonons (entrainment of electrons by phonons) on thermoelectric and thermomagnetic effects was first calculated for metals by L. E. Gurevich.[1,2] In semiconductors at temperatures of the order of room temperature, this entrainment has practically no effect on the thermoelectric power. But it is important at low temperatures [3–5]. The purpose of the present note is the calculation of the effect of electron entrainment by phonons on the transverse and longitudinal Nernst–Ettinghausen (N–E) effects in semiconductors.

We shall assume that the electron distribution function in the conduction band is $n = n^0 + n'$, where n' is the small deviation from the equilibrium value n^0. Similarly for phonons $N = N^0 + N'$. At low temperatures, electrons are entrained principally by the acoustic phonons with the highest velocity ω_1; these have considerably longer mean free time τ_{ph} than the phonons which belong to the other two acoustic branches,[6] and the optical vibrations are not excited. A solution of the transport equation on the assumption that the electrons have relaxation time $\tau_e(\epsilon)$, and that their effective mass m is isotropic, gives

$$n' = \frac{\tau_e}{m}\frac{1}{1+(e\tau_e H/mc)^2}\left\{\left(\frac{\varepsilon-\mu_0+g}{T}\nabla T+\nabla\mu, \mathbf{p}\right) + \frac{e\tau_e}{mc}\left(\frac{\varepsilon-\mu_0+g}{T}[\mathbf{H}\nabla T]+[\mathbf{H}\nabla\mu], \mathbf{p}\right)\right\}\frac{\partial n^0}{\partial\varepsilon}. \quad (1)$$

Here $\mu = \mu_0 - e\varphi$ is the electrochemical potential, ϵ is the electron energy and p is their quasi-momentum; the magnetic field H is perpendicular to ∇T and $\nabla\mu$. The term which results from the entrainment is of the order

$$g \approx m w_1^2 \tau_{ph}/\tau_e', \quad (2),$$

where τ_e' is the relaxation time of electrons which are only scattered by phonons.

The function in (1) leads to the following expres-