energy of evaporation and acceleration of the vapor, α is the portion of the energy used in evaporation (at high beam densities α is close to unity for absorbing substances). The ratio of the recoil pressure to the pressure p_1 of the beam itself is $p/p_1 \approx v_1 v_f / 2\lambda$ for a beam of particles of nonrelativistic velocity v_1, and $p/p_1 \approx cv_f/\lambda$ for a beam of light. Even for $v_f \gtrsim 10^5$ cm/sec and $\lambda \approx 10^3$ cal/g = 4 $\times 10^{10}$ erg/g we find $p/p_1 \gtrsim 10^4 - 10^5$ for electron or light beams.

These estimates show that the recoil pressure on evaporation may be several orders of magnitude greater than the beam pressure, and this was experimentally observed for the focused beam of a ruby laser.

We shall consider some of the possible applications of this effect.

1. ACCELERATION OF PARTICLES OF MATTER IN A LASER BEAM

Particles or droplets placed in a concentrated laser beam will suffer one-sided evaporation. With such evaporation the particles may acquire a velocity $u = v_f \ln[M_0/M(t)]$. At high concentrations of the light energy in the beam a relative change of the particle mass $M_0/M \gg 1$ may be obtained even after short durations of acceleration (the duration of evaporation is $\tau \approx a\rho\lambda/E^2 c < 1\ \mu$sec for an initial particle dimension $a < 1$ mm and field intensity in the beam $E > 10^5$ V/cm). The short duration of the process of acceleration tends to produce a strong nonuniformity of the evaporation from the particle surface. By this method we can accelerate the remaining portions of the particles to velocities $u \gtrsim 10^7$ cm/sec. This range of velocity is of interest, for example, in the simulation of the action of micrometeorites on the surfaces of bodies, for the formation of a high-velocity gas stream, etc.

2. GENERATION OF ULTRASOUND AND HYPERSOUND

The amplitude of the evaporation pressure may reach high values up to, for example, hundreds of thousands of atmospheres for an electron beam pressure $p_1 \approx mv_1 j/e \approx 10$ atm with current densities at the focus of an electron-beam cutter of $j \approx 10^6$ A/cm^2, and even higher pressures are obtainable in a laser beam. When the beam intensity is modulated the evaporation pressure also becomes modulated and volume oscillations of the medium of intensity $I_s \approx p_m^2/2\rho c_s$ are excited. The coefficient representing transformation of the beam energy into the energy of volume oscillations is

$$k = \frac{I_s}{I} \approx \frac{I v_f^2}{\lambda^2 2\rho c_s} \sim 1$$

for an acoustical impedance of the medium $\rho c_s \approx 10^6$ g-cm/sec, $v_f \approx 10^5$ cm/sec, $\lambda \approx 10^3$ cal/g and $I \approx 3 \times 10^{17}$ erg-cm^{-2} sec^{-1} (which corresponds, for example, to a beam power of 3 kW and a focus-spot cross-section area of $\approx 10^{-7}$ cm^2). In the case of intense evaporation the inertia of the evaporation pressure oscillations will not affect the results right up to high modulation frequencies of $\lesssim 1$ kMc. Consequently, modulation of a beam focused on a surface should generate intense ultrasonic and hypersonic vibrations and increase the fragmenting and cutting action of the beam.

Concluding, we note the possibility of the appearance of these effects in outer space as a pressure on the dust particles of a comet, on the surfaces of space vehicles, meteorites, etc. The direct pressure of solar radiation on space vehicles, may displace their orbits quite considerably (up to ≈ 1 km per day). Therefore, these effects may be useful, for example, for trajectory control by varying the evaporation pressure at the surface of such objects (by the use of special coatings, focusing of solar radiation to intensify evaporation, venetian blinds for control of the intensity of evaporation, etc.).

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MELTING CURVE OF TELLURIUM UP TO 23,000 kg/cm²

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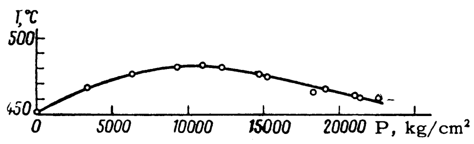
It is known that at extremely high pressures all substances should undergo transition to the metallic state. Many authors relate the sharp change in the velocity of seismic waves and the increase of the density at the boundary of the earth's core to such a transition.

Earlier one of the present authors[1] discussed the boundary of the earth's core from the point of view of the transition of the materials in the earth's mantle to the metallic state, and concluded that the melting curve of the nonmetal phase of some substances may have a maximum below the triple point which represents the equilibrium between the melt, the nonmetal phase and the metal phase. It was considered to be of interest to check this hypothesis experimentally.

Tellurium was selected as the test substance. According to Bridgman[2,3] it becomes metallic with a volume decrease of 5.5% at a pressure of about 45,000 kg/cm^2 at room temperature.

Pressure was produced in a superhigh-pressure multiplier with double mechanical support and internal heating.[4] A polysiloxane liquid was used as the pressure-transmitting medium. The pressure was measured with a manganin resistance pressure gauge accurate to ± 100 kg/cm^2. The temperature was measured with a platinorhodium thermocouple accurate to ± 1.5 deg C.

The figure gives the melting curve of tellurium up to 23,000 kg/cm^2. It shows a maximum at 10,800 kg/cm^2 and 482°C.



It is evident that at pressures above 10,800 kg/cm^2 the tellurium melted with a reduction of volume which, in our opinion, is related to the transition of the liquid to the metallic state, accompanied by a change in the short-range order.[1]

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THE EFFECT OF SPIN ON THE POSITION OF REGGE POLES

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RECENTLY Gribov and Pomeranchuk, while studying the singularities of partial wave amplitudes in orbital angular momentum, discovered an accumulation of poles in the l-plane.[1,2] First, there are accumulations at the energies corresponding to the threshold for the production of n particles. They appear at the points $l = -(3n-5)/2$.[1] This phenomenon occurs both in quantum mechanics and in field theory. Second, in field theory as a consequence of the existence of crossed channels there are accumulations at any energy at negative integer angular momenta.[2] All these accumulations impose limitations on the asymptotic behavior in momentum transfer of the amplitude, i.e., in energy in another channel.

In the present work the effect of particle spin on the position of the accumulation points described above is considered and the results are briefly discussed.

1. Consider, for simplicity, the scattering of two neutral spinless particles (pions). In the intermediate state particles with spin may appear, for example nucleon pairs. Near threshold for pair production the production amplitude is proportional to p^l, where p is the momentum of the produced particles and l is their orbital angular momentum. The value of l depends on the orbital angular momentum j of the pions and on the total spin of the produced particles. The minimum value of l is given by $j - 2\sigma$, where σ is the spin of each of the particles. It is easy to see that this value of l is never forbidden by parity selection rules.

It is easy to show by repeating the considerations of Gribov and Pomeranchuk[1] that this dependence on p results in an accumulation of poles in j at the point $j = -\frac{1}{2} + 2\sigma$ when $p \to 0$. It is clear that this accumulation is present also in the scattering amplitude of the spinless particles, as well as in all other amplitudes connected to it by the unitarity condition.

In precisely the same way the threshold for the production of n particles with the same spin σ gives rise to an accumulation of poles at the point $j = -(3n-5)/2 + n\sigma$.