complicated Fermi surface, gives grounds for hoping that this effect can be used to determine the curvature of the Fermi surface. According to [2], the independence of $\partial z/\partial H$ of H at $H > H_0$ indicates that the electrons are diffusely scattered from the surface of the sample.

From the curves shown in the figure it is seen that a minimum of $\partial x/\partial H$ is observed in a field on the order of several Oersteds. The conditions for the existence of the minimum were not investigated in detail, but it has been established that it is more sensitive to the quality of the sample than the maximum. Its physical nature is not clear, and possibly its existence is due to surface levels [3, 4].

[1] T.G. Blaney, Phil. Mag. 20, 23 (1969).
[2] B.E. Meierovich, Zh. Eksp. Teor. Fiz. 59, 276 (1970) [Sov. Phys.-JETP 32, 149 (1971)].
[3] M.S. Khaikin, ibid. 39, 212 (1960) [12, 152 (1961)]; Usp. Fiz. Nauk 96, 409 (1968) [Sov. Phys.-Usp. 11, 785 (1969)].
[4] R.E. Prange, Phys. Rev. 171, 737 (1968).

THERMOELASTIC DEFORMATION OF A SOLID SURFACE BY A LASER BEAM

V.V. Apollonov, A.I. Barchukov, V.K. Konyukhov, and A.M. Prokhorov
P.N. Lebedev Physics Institute, USSR Academy of Sciences

Submitted 21 January 1972
ZhETF Pis. Red. 15, No. 5, 248 - 250 (5 March 1972)

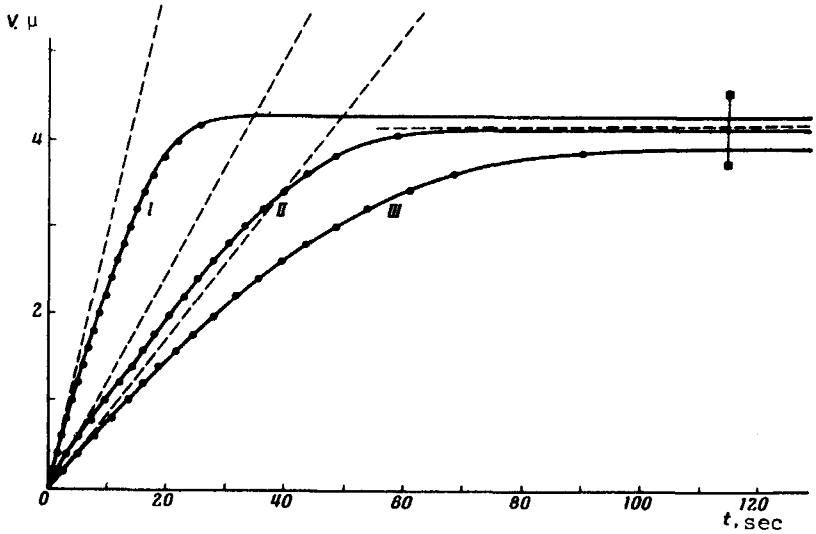
The action of laser radiation on a solid target, accompanied by destruction of its surface, ejection and evaporation of material, and formation of plasma, has been investigated experimentally many times. Such phenomena are typical of high-power laser pulses.

We describe here the behavior of a solid surface under the influence of a continuous laser beam which does not damage the surface, but distorts its profile as a result of thermoelastic deformations. The theoretical problem of thermoelastic deformation of a surface was considered in [1 - 4] in a different formulation.

The radiation source was a single-mode cw CO_2 laser with a fixed power $P_0 = 14$ W, operating in the TEM_{00q} mode. The intensity distribution in the beam was axially symmetrical and described by a Gaussian curve $I(r) = I_0\exp(-2r^2/w^2)$, where w is the half-width of the distribution and I(r) the laser power density (W/cm²). The target was a fused-quartz disk whose diameter (12 cm) and thickness (1.5 cm) were sufficient to make the mathematical model of an elastic heat-conducting half-space applicable to the heat-transfer process and to the mechanical deformations.

We have observed experimentally that laser radiation causes the surface of the irradiated body to bulge at the spot where the beam is incident. A laser interferometry measurement in conjunction with a motion-picture camera yields the deformation at any point of the surface as a function of the time and of the dimension of the irradiation zone. The figure shows the deformation V (in microns) in a direction normal to the surface at the center of the beam, as a function of the irradiation time t (in seconds). Plots I, II, and III correspond to different laser-beam densities at w = 0.35, 0.55, and 0.65 cm.

The curves show that during the initial heating the deformation V is directly proportional to the irradiation time. This part of the curve is given by the formula



$$V = -(1+\mu)\frac{\alpha I_0 \chi}{K}t, \tag{1}$$

which can be obtained by neglecting the heat transfer from the surface in the quasistatic approximation [2]. Here μ, α, χ, and K are respectively the Poisson, linear-expansion, temperature-conductivity, and heat-conduction coefficients. The normal to the surface is directed into the half-space. The inclined dashed lines in the figure were calculated for formula (1).

With increasing heating time, the normal deformations V corresponding to different laser-beam densities tend to a certain finite value V_∞, which is the same for all three curves within the limits of measurement errors. This section of the curve is described by a formula that can be obtained on the basis of [3]:

$$V_\infty = -(1+\mu)\frac{2\alpha P_0}{\pi K}. \tag{2}$$

The horizontal dashed line in the figure is a plot of [2] with the physical constant of fused quartz taken from [5].

The investigated elastic bulging of the surface of a solid (half-space) under the influence of radiation, together with its quantitative estimate, shows that this effect is of undoubted interest for quantum-electronic devices in those cases when the energy absorbed in the reflectors exceed the value permissible for the particular device. For example, in a quasioptical transmission line [6] in which the phase correctors were made of gold-coated quartz with surface curvature ~12 m (reflectance ~98%), complete detuning of the lines was observed after several seconds of exposure to a beam power ~700 W. Calculation has shown that the curvature radii of the correcting mirrors of this line were changed by an approximate factor of 1.5, leading to a complete degradation of the structure of the transmitted beam.

The authors thank F.V. Bunkin and the late V.I. Danilovskaya for valuable discussions.

[1] V.V. Bolotin, Proceedsings of Conference on the Theory of Plates and Shells, Kazan', 1961.

[2] V.I. Danilovskaya and E.M. Shefter, Fiz. khim. obrab. mat. (Physics and Chemistry of Material Processing), No. 3, 1969, p. 13.
[3] I.L. Bailey, A Thermoelastic Problem in a Half-space, Michigan State University, 1958.
[4] I.D. Kil', Inzhenernyi zhurnal, mekhanika, tverdogo tela (Engineering Journal, Mechanics of Solids), No. 1, 1966, p. 140.
[5] E.M. Voronkova, B.N. Grechushnikov, G.I. Distler, and I.P. Petrov, Opticheskie materialy dlya infrakrasnoi tekhniki (Optical Materials for Infrared Technology), Nauka, 1965.
[6] A.I. Barchukov, Yu.B. Konev, A.M. Prokhorov, and V.S. Terin, Radiotekhnika i elektronika 16, 996 (1971).

HIGH-FREQUENCY PLASMA HEATING IN A STELLARATOR

P.Ya. Burchenko, E.D. Volkov, E.D. Kramskoi, A.V. Longinov, G.A. Miroshnichenko, and G.Ya. Nizhnik
Physico-technical Institute, Ukrainian Academy of Sciences
Submitted 21 January 1972
ZhETF Pis. Red. 15, No. 5, 250 - 253 (5 March 1972)

The development of methods of supplying energy for plasma heating in closed magnetic traps is presently one of the serious problems for controlled thermonuclear reactions (CTR). One of the possible solutions of this problem is high-frequency heating. Attempts to use this method in closed magnetic systems entail a number of difficulties connected with the technique of introducing large powers and exciting waves in a dense plasma located in a metallic chamber and in a strong magnetic field [1 - 3].

We report here preliminary results of experiments of high-frequency plasma heating in a closed magnetic trap, namely the "Sirius" stellarator [4]. The main purpose of the investigation was to ascertain the possibility of supplying high-frequency energy to the plasma with the aid of an exciting system that produces a spatially-periodic longitudinal electric field on the periphery of the plasma column. We use such an exciting system in the form of a metallic vacuum chamber of the stellarator, to the dielectric separator of which we connected a high-frequency generator through a system of feeders (Fig. 1).

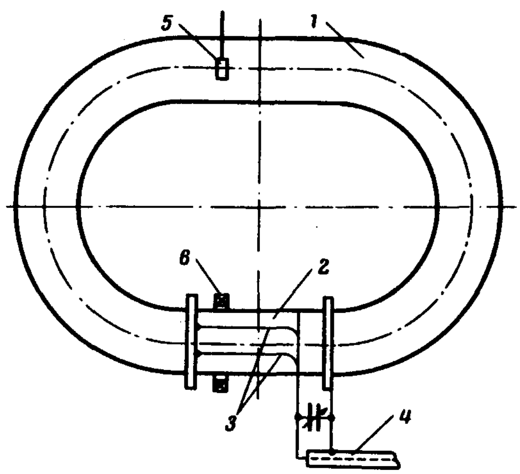


Fig. 1. Diagram of exciting system: 1) metallic vacuum chamber, 2) ceramic section, 3) high-frequency voltage buses; 4) high-frequency supply feeder, 5) high-frequency magnetic probe, 6) diamagnetic probe.

As shown by a theoretical analysis, such systems produce on the periphery of the plasma column a longitudinal electric field E_z with a broad wave-number spectrum

$$E_z = \sum_{n=0}^{\infty} E_{zn} \cos k_{\parallel n} z , \qquad (1)$$

where $k_{\parallel n} = 2\pi n/L$ and ℓ is the length of the vacuum chamber. They can excite in the plasma "slow" electromagnetic waves in which the longitudinal field component E_z exceeds considerably the azimuthal field E_ϕ [5]. For a weakly-inhomogeneous bounded plasma filament, the condition for effective excitation of the slow wave with longitudinal wave