EQUILIBRIUM RADIATION OF SHOCK-COMPRESSED IONIC CRYSTALS

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As shown earlier in [1], the experimentally measured temperature of shock-compressed ionic crystals agrees sufficiently well, in a certain pressure range, with the temperature calculated from the Mie-Gruneisen equation of state.

On going over to the relatively small pressures, it has turned out (see the table) that registered light fluxes greatly exceed the expected calculated values. This effect is uniquely pronounced in LiF, CsBr, and NaCl crystals. The light fluxes were determined by the method of [1].

Crystal	ρ, kbar	ρ/ρ_0	T_b °K, calculated	T_b °K, experiment	
				λ = 4780 Å	λ = 6250 Å
NaCl	270	1.50	1250	2440	2270
	400	1.61	2120	2700	2450
CsBr	205	1.43	1750	2850	2650
	255	1.52	2300	3170	3000
LiF	340	1.3	550	2080	2020
	650	1.45	1100	2750	2600
	755	1.49	1420	3430	3370
	1040	1.55	2150	3980	3920

The obtained experimental results are listed in the table. The brightness temperatures T_b were determined from the measured light fluxes assuming equilibrium radiation; their values are a measure of the registered light fluxes. The temperatures obtained in this manner are compared in the table with the calculated values obtained from the experimentally determined parameters of the shock waves in the investigated crystals and their equation of state [2-4].

It follows from the table that the experimental brightness temperatures greatly exceed the expected calculated values. The registered radiation is certainly not thermal. Indeed, if it is assumed that the temperature T = 2080°K in LiF at a pressure P = 340 kbar corresponds to thermal radiation, then the energy required to heat the crystal to this temperature would be E_T = 4 kJ/g, whereas the total increase of the internal energy at these pressures

$$\Delta E = \frac{1}{2}\frac{p}{\rho_0}\frac{\sigma - 1}{\sigma}$$

(where $\sigma = \rho/\rho_0$; ρ_0 and ρ are the initial and final densities of the material) is 1.5 kJ/g. If we recognize furthermore that half of this energy goes to overcome the other repulsion forces, then the thermal energy input to the LiF under these conditions is approximately one-fifth the required value. A similar situation takes place also for NaCl, CsBr, and for other states in LiF.

What is the character of the radiation we are dealing with? Since the measurements are made in the visible region, it can be due only to electrons. It is noteworthy that the light fluxes measured in different sections of the spectrum correspond to nearly equal brightness temperatures (see the table), corresponding in turn to Planck radiation. This indicates that the electrons are in equilibrium with one another. At the same time, they are not in equilibrium with the lattice, since their temperature is much lower than the lattice temperature.

Apparently a similar phenomenon was observed by Brooks [5] in shock compression of crystalline quartz along the x axis. The glow observed by him, which appears simultaneously in the entire section of the sample subjected to the action of the shock wave, was identified by him with electroluminescence due either to breakdown of the dielectric or to ionization of the impurities by the electric field generated by the shock wave.

The extent to which the phenomenon observed by us may be related to electroluminescence is unclear, primarily because electroluminescence is characterized by a clearly pronounced wavelength dependence of the radiation intensity, which was not observed in our case. To be sure, an increase of the lattice temperature can lead to a broadening of the "dome" of the radiation. Although at present there is still no clear picture of the observed phenomenon, it can be proposed that plastic deformation leads to the creation of a large number of free electrons having a high temperature and entering gradually into equilibrium with the lattice. Judging from the growth time of the radiation brightness, this radiation is emitted by thin layers of matter directly adjacent to the density discontinuity on the front of the shock wave. It follows from this that the time of establishment of thermal equilibrium between the electrons and the lattice is $\tau \geq 10^{-7}$ sec.

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CHANGE OF EFFECTIVE MAGNETIC FIELD AT THE Sn^{119} NUCLEUS IN GADOLINIUM GARNET ON GOING THROUGH THE COMPENSATION POINT

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We report here measurement of the sign of the effective magnetic field H_{eff} acting on the nuclei of the tin ions in a substituted gadolinium-iron garnet $Gd_{2.7}Ca_{0.3}Fe_{4.7}Sn_{0.3}O_{12}$ at temperatures above and below the compensation point. It was recently observed [1,2] that