viscosity in [6]. The temperature dependence of $T_1$, measured by us along the liquid-vapor coexistence curve, agrees well with the results of [5].

For a detailed interpretation of the results it is necessary to know the behavior of the self-diffusion coefficient D and of the relaxation time $T_2$ of the transverse NMR in the same temperature region.

The results of such investigations will be published in a forthcoming paper.

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# PULSED INCREASE OF INTENSITY OF SOLAR X-RAYS ON 10 DECEMBER 1970

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The present paper is devoted to an analysis of the solar x-ray burst registered by the RIFMA spectrometric apparatus [1] on the mobile automatic laboratory "Lunokhod-1" [2]. In accordance with the capabilities of the apparatus, the energy and time of arrival of each individual quantum were recorded, so that the dynamics of solar x-ray generation could be studied. The energy range of the registered x-ray quanta was determined by the geometry and the operating regime of the proportional counters, as well as by the concrete conditions of the experiment. For the case in question, the energy range was 15 - 30 keV.

Figure 1 shows the time dependence of the x-ray quantum-detector counting rate from which it is possible to determine the temporal characteristics of the burst: start - $18^h44'16''$ Moscow time, 10 December 1970, maximum intensity reached 8 seconds after the start, characteristic time of intensity decay 15 sec, and total duration ~1 min.

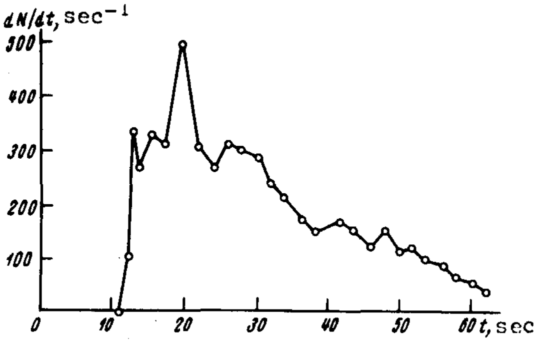

Fig. 1. Time dependence of the counting rate in the detector. The zero of the time scale corresponds to $18^h44'16''$.

As already noted, the apparatus was capable of determining the energy spectra of the detector pulses for arbitrary finite time intervals. Some of them are shown in Figs. 2 and 3. The rising part of the spectrum is due to the increase in the probability of the passage of the quanta through the layer of matter surrounding the working gas of the counter with increasing energy. The descending part, on the other hand, is determined mainly by the shape of the x-ray energy spectrum. By starting with the universally accepted hypothesis (cf., e.g., [3, 4]) that the x-ray quanta have a

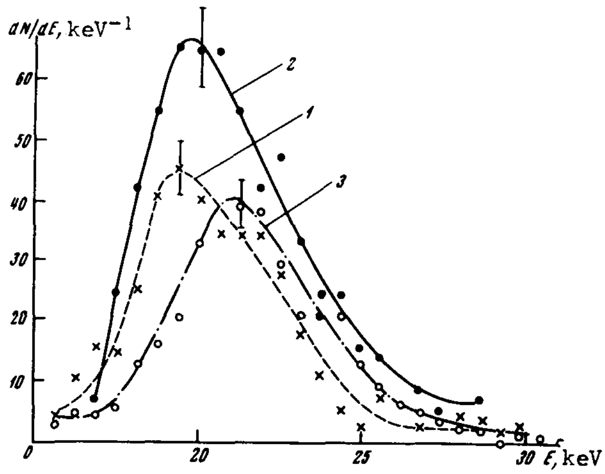

Fig. 2

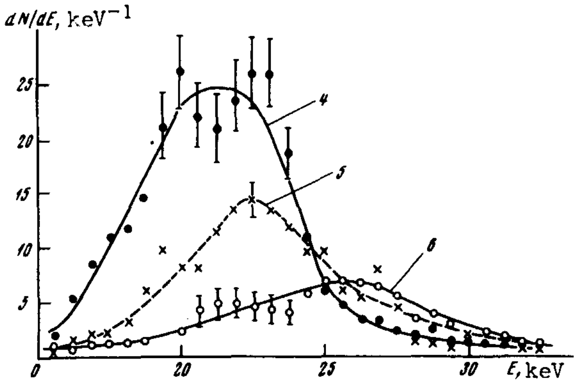

Fig. 3

Fig. 2. Counting rate vs. x-ray energy: 1 - 4 - 6 sec after the start of the burst, 2 - 9 - 10 sec after the start of the burst, 3 - 17 - 20 sec after the start of the burst.

Fig. 3. Counting rate vs. x-ray energy: 1 - 25 - 27 sec after the start of the burst, 2 - 34 - 39 sec after the start of the burst, 3 - 41 - 48 sec after the start of the burst.

power-law spectrum, we calculated the differential spectra for different values of the exponent $\gamma$. An analysis shows that at the instant of intensity maximum the best agreement with the experimental results is obtained for $\gamma = 5 - 6$. In the course of time, the spectrum becomes harder and 44 seconds after the maximum the exponent becomes equal to 2.

It is known [4, 5] that three mechanisms of solar x-ray generation are now under consideration: quasithermal plasma radiation, nonthermal radiation with pulsed injection, and nonthermal with continuous injection of electrons into the region of x-ray generation. The aggregate of the results given above favor the nonthermal mechanism with pulsed injection.

The time dependence of the decrease in the x-ray intensity is determined in the pulsed-injection model by the interaction between the electrons and the surrounding plasma, and does not depend on the acceleration mechanism. The electron lifetime is given by

$$t = \frac{7.25\cdot 10^{7}}{n} E^{3/2}\ \text{sec}, \qquad (1)$$

where n is the density of the ions in the plasma in $\text{cm}^{-3}$ and E is the kinetic energy of the electrons in keV. For $E = 20$ keV and $t = 15$ sec, we obtain $n \approx 5 \times 10^{9}\ \text{cm}^{-3}$. The total number of fast electrons is

$$N_e \approx C(\delta)\epsilon \frac{dI(\epsilon)}{d\epsilon}, \qquad (2)$$

where $C(\delta)$ is the coefficient that depends on the exponent $\delta$ of the electron spectrum, $\varepsilon$ is the energy of the x-rays, and $dI/d\varepsilon$ is the differential spectrum of the x-ray quanta. According to [4, 6], $\delta = \gamma - (0.5 - 0.7)$, i.e., for the instant of time corresponding to maximum intensity we have $4 \leq \delta \leq 5$. Assuming $\delta = 4.5$, we obtain $C(4.5) = 2 \times 10^{32}\ \text{cm}^{-1}\text{sec}$ and $N_e \approx 8 \times 10^{36}$

electrons/outburst. The total energy of the fast electrons in the outburst region can be represented in the form $E_0 = E_{cb} + E_{br} + E_{tb} + E_{cc}$, where $E_{cb}$ and $E_{br}$ are the energy losses to collisions and bremsstrahlung in the outburst region, $E_{tb}$ is the total energy of the electrons leaving the outburst region, and $E_{cc}$ is the energy lost to collisions in the corona. In our case $E_0 = 10^{29}$ erg, $E_{cb} = 8 \times 10^{28}$ erg, $E_{br} = 8 \times 10^{24}$ erg, $E_{tb} = 8 \times 10^{26}$ erg, and $E_{cc} = 2 \times 10^{28}$ erg.

In conclusion we note with gratitide that the short-duration change of counting rate in the energy spectrum in the 20-kV region was noted by V.S. Eletskii. We are grateful to the participants of the seminar, G.E. Kocharov and S.I. Syrovatskii, for useful discussions.

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# OBSERVATION OF SPIN ECHO ON CONDUCTION ELECTRONS IN METALLIC LITHIUM

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A study of transient processes, and especially phenomena of the spin-echo type, yields abundant information on the kinetic properties and internal interactions of spin system. Insofar as we know, spin echo has not been observed before on conduction electrons (CE). Two factors acting in opposite directions hinder the registration of the effect: the exceedingly short times of the spin relaxation in metals (usually $\tau \sim 10^{-8}$ sec) and the high CE diffusion rates (the CE diffusion coefficient in bulky metal is $D \simeq 50$ cm$^2$/sec).

We report here the first observation of CE spin echo in metallic lithium. We succeeded in realizing the necessary experimental conditions for small spherical lithium particles produced in LiF single crystals by neutron bombardment followed by special heat treatment [1]. An estimate of the average diameter of the particles, determined from the asymmetry of the stationary line of paramagnetic resonance with the conduction electrons [2], yielded for our sample $d \simeq 1$ μ.

Such a method of obtaining metal particles in alkali-halide single crystals ensures high purity of the samples, and as a result the longest CE spin relaxation times observable in metals; the small particle dimensions on the other hand, limit the diffusion rate. Indeed, the effective diffusion coefficient can be estimated at $D_{eff} \simeq D(d/\ell)^2$, where $\ell$ is the distance over which the CE diffuses in a bulky metal during the time $\tau_1$ between pulses. In