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Abstract

Full Text

PHYSICS

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CONTINUOUS SOLAR OPTICAL QUANTUM GENERATOR ON Dy^{2+} IN CaF_2

The first optical quantum generator (OQG) using solar radiation for excitation was realized on Dy^{2+} in CaF_2 at the temperature of liquid neon (27°K). To focus the radiation of the sun

Fig. 1. Photograph of the experimental setup

a spherical mirror of diameter $\sim$ 350 mm was used, at whose focus there was placed a Dewar vessel with the working crystal of dimensions $25.4 \times 6.35 \times 3.18$ mm ([1]).

In the present communication a solar OQG on Dy^{2+} in CaF_2, operating at the temperature of liquid nitrogen (77°K), is described. The crystals used were grown from the melt in a fluorinating atmosphere by the crucible-lowering method, with an initial DyF_3 concentration of about 0.03%. To convert Dy^{3+} into Dy^{2+}, γ-radiation from a cobalt source (Co^{60}) was used. The irradiation dose was $\sim 10^6$ r. The experiments were carried out in Moscow, in the twenties of August 1964, at noon, under a cloudless sky.

Excitation of the generator was carried out in the absorption band of the $4f \rightarrow 5d$ transitions, lying from 25,000 to 10,000 cm^{-1}. The generation corresponds to the transition ${}^5I_7 \rightarrow {}^5I_8$, terminating approximately 35 cm^{-1} above the ground state (2). Solar radiation was collected by a standard glass aluminized mirror from a KPT-15 motion-picture projection unit with a diameter of $\sim$ 450 mm. The quality of the mirror used was not high, which produced, at the focus, an image of the sun with a diameter of $\sim$ 10 mm.

Fig. 2. Time dependence of generation. The value of one scale division is 250 μsec

The design of the generator made it possible to orient the mirror to any point in the sky (see Fig. 1).

For more effective transfer of the sun' s radiation into the crystal, a conical condenser made of optically homogeneous K8 glass or fluorite was used; the working sample, with dimensions $26 \times 3 \times 4$ mm, was attached to it by means of optical contact. The optical resonator was provided by silver mirrors deposited on the end faces of the crystal, whose parallelism was no worse than $15''$. The transmission of one mirror was $\sim 3\%$. The condenser with the crystal was located in a cryostat with pure liquid nitrogen. The mirror had an effective area of ~ 1500 cm^2, which ensured an operating regime of the generator close to threshold. Slight partial shading of the mirror led to disruption of generation. Preliminary laboratory investigations of the generator with excitation from a xenon lamp of the DKSP type showed that the generation wavelength was 2.3590 ± 10 Å. Figure 2 shows an oscillogram of the time dependence of generation. An InSb photoresistor with a germanium filter was used as the radiation indicator. The time constant of the recording circuit was about $\sim 10^{-6}$ sec. The power of the solar optical quantum generator was estimated to be several microwatts.

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Note: Figure translations are in progress. See original paper for figures.