TIME VARIATION OF THE SPECTRAL COMPOSITION OF THE RADIATION FROM AN OPTICAL MASER OF Nd-ACTIVATED GLASS

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It is shown that the number of spectral lines produced during a flash of an optical maser of Nd-activated glass varies with time as do their wavelengths.

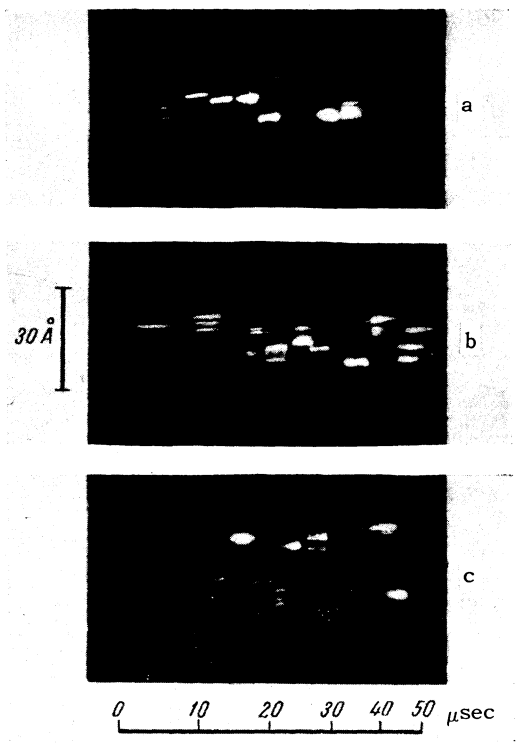
SNITZER [1] has reported that the radiation of an optical maser of Nd-activated glass consists of several lines located in the region 1.061—1.062 μ.

The present paper presents data on the change in time of the spectral composition of this maser. The maser was a cylinder of optical glass containing neodymium, of length 60 mm and diameter 8 mm. The concentration of Nd_2O_3 in the glass was 2%. The spectral analysis was accomplished with a diffraction spectograph with a dispersion of 14 Å/mm, the time analysis with an image converter. The scanning was done in a direction perpendicular to the direction of dispersion of the spectrograph.

The figure shows time-scan photographs of the spectrum of the radiation of the Nd-glass maser for different levels of the "pump" above the generation threshold. The spectral lines appear as horizontal lines the direction of which is the same as the direction of the time scan and the length of which is determined by the height of the spectrograph slit. For our choice of slit height, the time resolution of the record is about 5 μsec, although the registering apparatus has a resolution of about 2×10^{-7} sec.

From the photographs it can be seen that the spectral composition of the separate bursts of radiation making up the generated flash changes from burst to burst. The spectrum of the first burst consists, as a rule, of a single spectral line. In later bursts there occurs a change in wavelength of the generated light and the appearance of several lines is possible. As the intensity of the "pump" is increased there is a tendency for the number of lines generated in each burst to increase, and the number of lines in one burst and the spectral region occupied by them increase toward the end of the flash. The distance between the extreme lines in one burst can reach 20 Å. The wavelength interval encompassing the generated lines belonging to all the bursts widens as the "pump" power is increased, and when this exceeds the threshold by 70%, the interval amounts to 30 Å (see the figure, b).

A consideration of these photographs leads to certain conclusions about the processes occurring in this maser. The first burst of radiation always corresponds to the transition between that pair of sublevels of the terms $^4F_{3/2}$ and $^4I_{11/2}$ which have the most favorable parameters for stimulated emission. The radiation in the second burst comes from another sublevel of the $^4F_{3/2}$ term, since the one from which the transitions occurred in the first burst has become empty while the pop-



Time scan of the spectrum of radiation from a Nd-glass optical maser for pump levels in excess of threshold by: a – 20%, b – 40%, c – 70%.

ulation of the other sublevels of this term has continued to grow on account of the "pump," and the sublevel of the $^4I_{11/2}$ to which transitions were made in the first burst is now inverted with respect to the other sublevels of this term.

The generation of several lines in a single burst can be explained in the following way. When the "pump" energy is far in excess of threshold, the required inversion turns out to be attained for several pairs of sublevels at once. At the initial moment of emergence of the burst the resonator still has a wide spectrum and therefore transitions from several levels are initiated simultaneously; thus several lines are generated in a single burst.

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[1] E. Snitzer, Phys. Rev. Letters 7, 444 (1961).

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