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CHANGE OF POPULATION OF ZEEMAN SUBLEVELS OF THE EXCITED STATE OF $CaF_2:Eu^{2+}$ PUMPED WITH POLARIZED LIGHT

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It is known that the intense phononless line $\lambda 4130$ Å observed in the $CaF_2:Eu^{2+}$ absorption and emission spectra is connected with the electric dipole transition $^8S_{7/2}(f^7) \rightarrow {}^4\Gamma_8(f^6d)$. The absorption spectrum reveals also strong band extending into the ultraviolet region from $\lambda 4130$ Å and having a complicated electron-vibrational structure. Luminescence, just as in ruby and in many other activated crystals, is excited in $CaF_2:Eu^{2+}$ as a result of a two-step process that is made up of transitions to broad energy bands and subsequent non-radiative relaxation, which causes population of the lowest excited level $^4\Gamma_8(f^6d)$. This is followed by the aforementioned radiative transition with $\tau \approx 7 \times 10^{-7}$ sec.

The Zeeman effect at $\lambda 4130$ Å has been adequately interpreted [1]. It is therefore possible to estimate the relative populations of the different sublevels of the excited state from the intensities of the individual Zeeman components. It was already indicated in [1] and [2] that when the crystal is cooled to 1.7°K a change takes place in the populations of the Zeeman sublevels, in spite of the relatively short lifetime τ. This change has an anomalous character and does not correspond to Boltzmann thermalization. We have observed even greater anomalies by using a two-step pumping of $^4\Gamma_8$ with polarized light. A $CaF_2:Eu^{2+}$ crystal with an Eu^{2+} ion concentration less than 0.1 molar per cent was placed in a magnetic field (H = 28 kOe) in such a way that the <100> direction was parallel to H. The exciting light, containing wavelengths shorter than 4130 Å, was incident on the crystal perpendicularly to the field and parallel to the <100> direction. The electric vector of the exciting light was either perpendicular to the field (σ light) or parallel to it (π light). The Zeeman components of $\lambda 4130$ Å were observed in the radiation in a direction perpendicular to the field and photographed in σ and π polarizations with a high-resolution spectrograph.

Figure 1 demonstrates the appreciable increase of the intensities of the components coming from the Zeeman sublevels $^1\Gamma_5^+$ and $^1\Gamma_7^+$ (see Fig. 2) following excitation with π light.

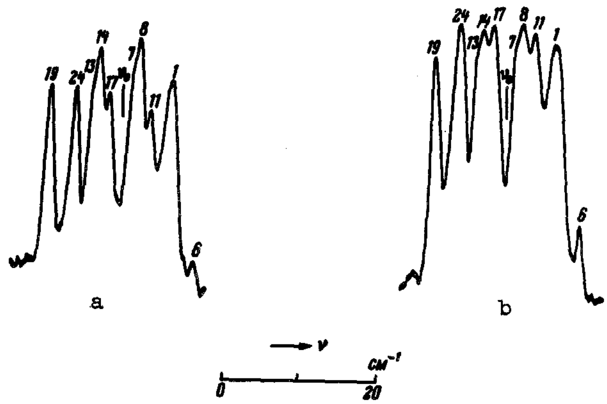

Fig. 1. σ-Components of Zeeman effect of 4130 Å line at H = 28 kOe and T = 1.7°K; a - pumping with σ light; b - with π light.

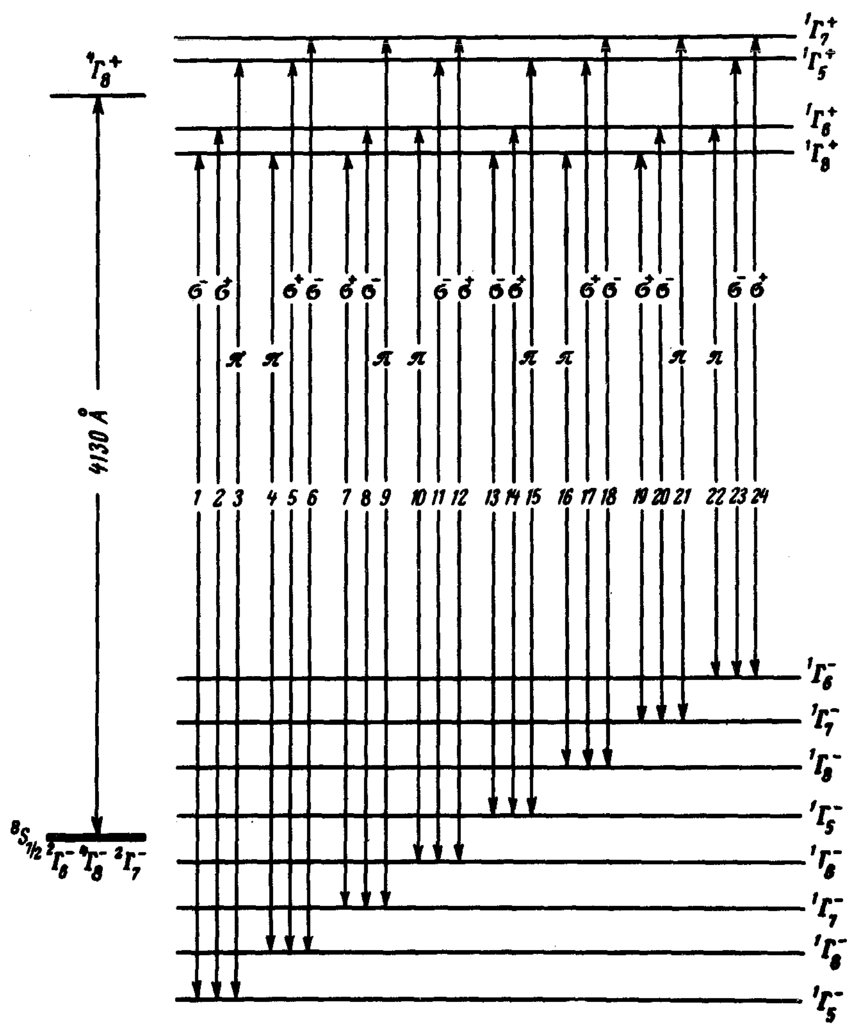

Fig. 2. Scheme of Zeeman transitions of the 4130 Å line for H parallel to <100>.

In this case the intensities of the 4130 Å line Zeeman components have the same appearance as if the quenching in the excited state were to be very weak. We have arrived at this conclusion by comparing the observed component intensities with those calculated in the intermediate-field approximation, developed by M. V. Eremin [3] for the calculation of the fd-configuration levels. Calculation predicts in this case, for example, that the the σ_{17} component should be more intense than its neighbor σ_{14}, and that σ_{24} should in general be the most intense spectral component. This is precisely the intensity ratio obtained by pumping with π light. σ_{17} and σ_{24} are relatively weak in the case of pumping with unpolarized or π light.

The described effect suggests that the polarized light that excites the luminescence in broad bands includes different channels of two-step pumping, and that in each of these channels the selection rules that lead to the population of the Zeeman sublevels of the radiating state via nonradiative relaxation are different. It should be noted here that strong dichroism is observed [4] in the absorption spectrum of $CaF_2:Eu^{2+}$ in a magnetic field at low temperatures, when the sublevel $^1\Gamma_5^-(f^7)$ is predominantly populated, so that light of different polarization excites different bands.

The proposed mechanism of the phenomenon can be called "spin memory" [5,6], provided this term is intepreted more broadly, taking it to mean not simply the response of the populations of the sublevels of the excited state to the population of the sublevels of the ground state having the same symmetry.

It is obvious that the observed phenomenon of optical pumping in the excited state uncovers a way of investigating nonradiative recombination processes in the case of complex optical excitation in crystals.

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DEVIATION FROM OHM'S LAW AND RF GENERATION IN Bi-Sb ALLOYS IN STRONG ELECTRIC FIELDS AT HELIUM TEMPERATURES

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An investigation of the current-voltage characteristics of single-crystal semiconducting $Bi_{1-x}Sb_x$ alloys (x = 8 - 20 at.%) at 4.2°K, a strong increase of the current density was observed in an electric field exceeding a certain critcal value E_c.

Samples measuring approximately 0.3 x 0.5 x 3 mm were cut from single-crystal ingots of Bi-Sb alloys with component purity 99.9999%. Current contacts of copper foil were attached with Wood's alloy to opposite faces along the sample. Potential leads of copper wire (20 μ diameter) were welded [1] to the side face spaced about 1 mm apart. The current flowed either along the binary or the bisector axis of the crystal. The measurements were made with the aid