

Stark splitting and energy transfer between Dy^{3+} – Ho^{3+} and between Tb^{3+} – Er^{3+} in calcium–lithium borate glass

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Abstract. Fluorescence spectrum of Dy^{3+} , Dy^{3+} – Ho^{3+} , Tb^{3+} and Tb^{3+} – Er^{3+} doped in calibo glass have been studied using Ar^+ and excimer lasers. Non-radiative energy transfer from trivalent dysprosium and terbium (donors) to holmium and erbium (acceptors) respectively has been observed on the basis of decrease in the life time of the levels and reduction in fluorescence intensity of Dy^{3+} and Tb^{3+} on increasing Ho and Er concentrations. The interaction mechanism of donor and acceptor ions is found to be dipole–dipole in both cases. Various parameters such as donor–acceptor distances, non-radiative energy transfer efficiency (η) and energy transfer probability (P_{da}) have been computed. Stark splitting have also been marked in several intense transition of the two.

Keywords. Fluorescence; non-radiative; dipole–dipole; transfer efficiency; Stark components.

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1. Introduction

The mechanism of donor-acceptor energy transfer is important in the study of phosphors and laser materials. The energy transfer may be through radiative or non-radiative processes. The non-radiative energy transfer processes are major factors in determining the long wavelength operating limits for the solid state lasers [1].

The non-radiative energy transfer has been studied by several authors [2–8] in different glasses with different rare-earth ions as dopant. A mechanism for energy transfer from donor to acceptor was first suggested by Forster [6] and then extended by Dexter [7]. This theory was however found inadequate to explain all concentration regimes of the acceptor. Fong and Diestler [8] developed a theory which takes into account the fact that for low acceptor concentrations there is usually a one-to-one correspondence between donor and acceptor while at higher acceptor concentrations one donor ion may interact with two or more neighbouring acceptor ions.

The non-radiative energy transfer from Dy^{3+} to Pr^{3+} in calibo and phosphate glasses has been reported by Joshi and coworkers [9, 10]. Similarly energy transfer from Tb^{3+} to Er^{3+} in sodium borate glass has also been studied by Joshi and Pandey [11]. At low acceptor concentration they found the transfer mechanism to be diffusion limited while at higher acceptor concentrations it involves electric dipole–dipole interaction. Nakazawa and Shionoya [12] have studied energy transfer between Tb^{3+} and several other rare earth