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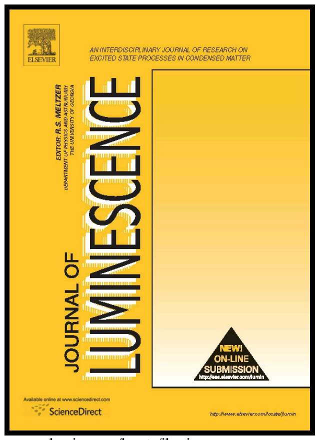

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Study of Mn^{2+} luminescence in β-PbF_2

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Abstract
For the first time excitation and luminescence spectra of Mn^{2+} ions in β-PbF_2 crystals at 77 and 300K, and also the luminescence lifetime are studied. Impurity ions in the crystal form a cubic center and centers of lower symmetry, and also exchange-coupled pairs. The origin of the formation of noncubic centers during the substitution $Mn^{2+} \rightarrow Pb^{2+}$ are the large difference of ionic radii Mn^{2+}(0.80 Å) and Pb^{2+} (1.26 Å) creating the instability of the local structure around the activator ion, its deformation, and exchange striction. The increase in the impurity concentration enhances these factors leading to the change of the relative concentration of different centers. The strong manifestation of the Jahn-Teller (Ham) effect is found in the luminescence excitation spectra. The importance of using the Trees-Racah α and seniority β corrections in the scheme of the crystal field theory (CFT) calculations is demonstrated. The connection between Trees-Racah corrections values and symmetry of Mn^{2+} surrounding in homologous crystals MeF_2 (Me = Ca, Sr, β – PbF_2, Ba) has been revealed.

Keywords
Mn^{2+}, exchange-coupled pair, crystal field, striction, fluorite, optical spectra, photoluminescence.

1. INTRODUCTION

The activation of series members with Mn^{2+} ions gives them the luminescent properties, which make them in-demand as optical materials for different applications [1]. The compounds incorporating Mn^{2+} ions are proposed to be used as efficient luminescent materials with tunable excitation routes and tunable luminescence [2]. In particular, CaF_2: Mn^{2+} crystals are widely used in thermoluminescent dosimetry [3] and they are associated with a problem known as the zero dose problem. Performance of dosimeter starts to depend on pre-history of the sample and, as an example, it could show the dose higher than the natural background even after storage in the dark. The origin of the chronic problem lies in the complex picture of photophysical and photochemical processes occurring in scintillator after exposition to ionizing radiation: the formation of defects and their energy transfer and population dynamics, the mechanism of thermoluminescence itself [4].