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## VUV and UV fluorescence and absorption studies of $\text{Nd}^{3+}$ and $\text{Ho}^{3+}$ ions in $\text{LiYF}_4$ single crystals

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### Abstract

The laser induced fluorescence spectra of  $\text{LiYF}_4:\text{Nd}^{3+}$  (YLF:Nd) and  $\text{LiYF}_4:\text{Ho}^{3+}$  (YLF:Ho) single crystals, pumped by an  $\text{F}_2$  pulsed discharge molecular laser at 157 nm were obtained in the vacuum ultraviolet (VUV) and ultraviolet (UV) regions of the spectrum. With this pumping arrangement a number of new fluorescence peaks were observed for the first time. They are assigned to the dipole allowed transitions  $4f^25d \rightarrow 4f^3$  and  $4f^95d \rightarrow 4f^{10}$  of the  $\text{Nd}^{3+}$  and  $\text{Ho}^{3+}$  ions, respectively. The absorption spectra of the same crystal samples in the VUV and UV spectral regions were taken as well.

### 1. Introduction

The allowed radiative interconfigurational d–f transitions of rare-earth (RE) activated ions in the wide band gap dielectric crystals offer the possibility to use these materials for generating coherent VUV and UV light [1]. This is an attractive idea due to the relative simplicity of this method in comparison with the existing nonlinear methods using gases and molecules. Ehrlich et al. [2] have optically pumped YLF:Ce crystals to generate laser light in the 305–335 nm range and also  $\text{LaF}_3:\text{Ce}$  crystals with laser emission at 286 nm [3]. The first laser action in the VUV from solid state dielectric crystals has been reported by Waynant and Klein [4,5]. They used the  $\text{LaF}_3:\text{Nd}^{3+}$  dielectric crystal to generate laser action

at 172 nm when it was optically pumped by incoherent light (emitted from excited  $\text{Kr}_2^*$  molecules). Recently we have used the same crystal to generate VUV laser action [6,7] at 172 nm using as the pumping source an  $\text{F}_2$  pulsed discharge molecular laser operating at 157 nm. The realisation of this simple new pumping arrangement opens the way for the wide use of RE activator ions in dielectric crystals for generating coherent tunable VUV and UV light. Hence the spectroscopic study of the rare-earth activated wide band gap dielectric crystals can be very useful for the future development of new laser sources. In this paper we report on the interconfigurational  $4f^25d \rightarrow 4f^3$  and  $4f^95d \rightarrow 4f^{10}$  VUV and UV fluorescence and absorption features of  $\text{Nd}^{3+}$  and  $\text{Ho}^{3+}$  ions in  $\text{LiYF}_4$  (YLF) single crystals, when they are excited with laser light from an  $\text{F}_2$  pulsed discharge molecular laser at 157 nm. With this pumping arrangement some new fluorescence peaks were observed and assigned to the

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