EVIDENCE FOR EXISTENCE OF THE BOUND EXCITON STATES
IN Pr$^{3+}$- DOPED LiNbO$_3$ CRYSTAL

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In the LiNbO$_3$:Pr$^{3+}$ system the most intensive Pr$^{3+}$ luminescence is due to the
$^1D_2 \rightarrow ^4H_4$ transition at about 630 nm. The emission from higher energy states: $^3P_0$
and $^1S_0$ is effectively quenched by nonradiative processes. In this contribution we
present the arguments for existence of the Pr$^{3+}$-coupled localized exciton system
that is responsible for the nonradiative processes. We report on the LiNbO$_3$: Pr$^{3+}$
absorption spectra, photoluminescence spectra for different excitation, the
$^1D_2 \rightarrow ^4H_4$ luminescence excitation spectra and excited state absorption (ESA)
spectra.

The analysis of absorption and luminescence spectra allows for estimation of the
semi-empirical parameters describing the LiNbO$_3$:Pr$^{3+}$ system (free-ion Racah
integrals, spin–orbit coupling and crystal field Wybourne parameters).

In the excitation spectrum of the $^1D_2 \rightarrow ^4H_4$ luminescence, apart of the sharp lines
related to the $^4H_4 \rightarrow ^3P_J$ transitions, we observe two distinct bands peaking at
26000 cm$^{-1}$ and 30000 cm$^{-1}$. These bands have been attributed to the exciton bound
to the Pr$^{3+}$ ion.

The existence of these excitonic states is verified by the ESA spectra that are
different when exciting directly into the bound exciton band or into the $^3P_1$ state.
Analysis of the band shapes and the ESA characteristics allows for reproduction of
the configurational coordinate diagram of the whole system.