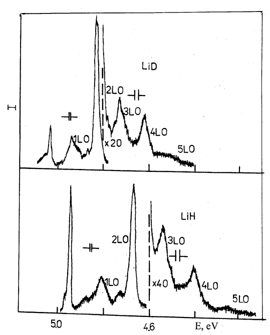
Experimental manifestation of the strong nuclear interaction in the optical spectra of solids

V.G. Plekhanov

Fonoriton Sci. Lab., Garon Ltd, Tallinn 11413, Estonia, vgplekhanov@gmail.com

The primary task amongst other nuclear physics fundamental tasks is experimental measuring of nuclear force interacting between nucleons (protons and neutrons) and their dependence on nucleons' distance in between. The discovery of the neutron by Chadwick in 1932 may be viewed as the birth of the strong nuclear interaction In 1935 Yukawa have tried to develop a theory of nuclear forces. The most important feature Yukawa' forces is they have a small range (~$10^{-15}$ m). However, up to present time phenomenological Yukawa potential can not be directly verified experimentally. We should remind that the strong nuclear interaction - the heart of Quantum Chromodynamics (QCD) which is the part of the Standard Model (SM). According to SM the nuclear force is a result of the strong force binding quarks to form protons and neutrons [1]. Residual part of it holds protons and neutrons together to form nuclei. There are common place in nuclear and high energy physics that the strong force does not act on leptons.

Our report is devoted to study the strong nuclear interaction via measuring the low - temperature (2 K) photoluminescence spectra of LiH ($E_g$ = 4.992 eV) (without strong interaction in hydrogen nucleus) and LiD ($E_g$ = 5.095 eV) (with strong interaction in deuterium nucleus) single crystals.




The uniqueness of the LiH and LiD compounds is that they differ in only one neutron, i.e. lithium ions, electron and proton are the same for them and, therefore they have the same gravitational, weak and electromagnetic interactions. The additions of a neutron to hydrogen nucleus, generates according to Yukawa, a strong interaction between a proton and a neutron, the effect on which on electron is manifested in the isotope shift (0.103 eV) of the zero - phonon photoluminescence line of free excitons in LiD crystals (fig.). The experimental observation of isotope shift (0.103 eV) of the phononless free exciton emission line in LiD crystals is a direct manifestation of the long - range nuclear strong interactions on the leptons [2]. Moreover, we have measured the dependence of the nuclear strong force on the distance between nucleons in deuterium nucleus.

1. D.H. Perkins, Introduction to High Energy Physics (CUP, Cambridge, 2000).

2. V.G. Plekhanov, Atomic Energy **131**, 123 (1921) (in Russian).