The thesis presents an investigation about the optical properties of the three rare earth ions Pr\(^{3+}\) (4\(f^2\) electronic configuration), Nd\(^{3+}\) (4\(f^3\)) and Eu\(^{3+}\) (4\(f^6\)) respectively, embedded in CsCdCl\(_3\) crystals with varied concentrations. It is observed that when the R\(^{3+}\) (R = Pr, Nd, Eu) ions are doped into the CsCdCl\(_3\) crystal, in order to maintain the charge neutrality they accommodate in pairs accompanying one vacancy in the host. These pairs can be of two types (i) R\(^{3+}\) - vacancy - R\(^{3+}\) and (ii) vacancy - R\(^{3+}\) - R\(^{3+}\). As a result the R\(^{3+}\) ions feel two types of nonequivalent trigonal (C\(_{3v}\)) crystal fields and hence they produce pair type of absorption spectra for each level which become prominent with the concentration of the dopant ions.

The thesis starts with a brief outline regarding the theoretical background of the energy structure of the rare earth ions in a crystalline environment. Detailed explanation of the crystal field splittings, polarization selection rules etc. are provided using group theoretical methods, taking C\(_{3v}\) crystal field potential as an example. The role of crystal quantum number, effect of exchange interaction, the Zeeman effect, and the methodology of fitting of free ion and crystal field parameters are also discussed.

A brief review of the optical properties of the three rare earth ions viz., Pr\(^{3+}\), Nd\(^{3+}\) and Eu\(^{3+}\) is presented in Chapter 2. Previous works on the crystal spectra of these three systems are listed here. The aim and scope of the thesis are indicated clearly in this chapter.

In the third chapter details of the crystal structure, preparation of the samples by Bridgmann method and the experimental techniques are described. Polarized absorption at 10K has been carried out using a high dispersion plane-grating spectrograph. The Zeeman investigation has been performed in a magnetic field (pulsed) of about 8 Tesla.
Measurements of the peak magnetic field using the pick-up coils and the level splittings of V$^{3+}$ ion having known g value are also described. To conduct the Zeeman experiment original cryostat is modified to a tail-end type cryostat.

Chapter 4 deals with the optical absorption study of the Pr$^{3+}$-doped CsCdCl$_3$ crystals. Analyzing the observed spectra 13 energy levels of Pr$^{3+}$, arising out of five multiplets are identified. The irreducible representations to these energy levels are assigned. Moreover, the best-fit free ion and C$_{3v}$ crystal field parameters are also determined.

Absorption and Zeeman investigation of Nd$^{3+}$: CsCdCl$_3$ crystals are reported in Chapter 5. From the observed absorption 30 energy levels of Nd$^{3+}$, arising out of twelve multiplets are determined along with the assignment of their irreducible representations. The observed Zeeman splittings for the transitions $^4$I$_{9/2}$ $\rightarrow$ $^4$G$_{5/2}$ and $^4$I$_{9/2}$ $\rightarrow$ $^2$G$_{7/2}$ are also studied.

Chapter 6 includes the optical absorption at 10K of the Eu$^{3+}$: CsCdCl$_3$ crystals. The occurrence of two distinct lines corresponding to $^7$F$_{0}$ $\rightarrow$ $^5$D$_{0}$ transition elucidates the presence of two nonequivalent sites. The 6 levels, coming out of 3 multiplets are identified including their irreducible representations.

The last chapter summarizes the results of the work done on these three rare earth systems. As an appendage, some future problems are also discussed.