Zeeman effect investigations in ^{142}Nd II using Collinear Ion Beam Laser Spectroscopy

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High resolution Zeeman spectra of the hyperfine structure of ionic spectral lines of the 142 isotope of neodymium were observed using a Collinear Ion Beam Laser Spectroscopy technique (CLIBS). Nd ions with mass number 142 were selected by means of a separator magnet and accelerated to a kinetic energy of about 19 keV. The ion beam was then overlapped with a counter-propagating laser beam, tuned and stabilized close to the investigated transition including the Doppler shift. In the interaction chamber the ions are additionally accelerated with a scanning voltage in the range 0-3500 V (corresponding to a wave number shift of 0.75 cm^{-1}), allowing to perform Doppler tuning instead of changing the frequency of the laser. The technique allows to achieve line widths of ca. 60 MHz and to tone the Zeeman patterns with a step size of 5 MHz.

To produce a strong magnetic field perpendicular to the ion beam inside the interaction chamber, and to avoid vacuum contaminations, we used strong permanent neodymium magnets. The field strength was measured by a Hall-effect Gauss-meter and by the Zeeman effect of the ^{138}Ba(II) (5d $^2D_{3/2}$ - 6p $^2P_{3/2}$) transition at 585.368 nm, where the Lande-factors g of the combining levels are known with very high precision. We produced a magnetic field of 330 Gauss perpendicular to the ion beam, uniform through the entire interaction region. Despite the fact that this field is perpendicular to the moving ions, the deflection of the ions having high mass and high kinetic energy is minor, and has no influence on the experiment.

For our investigations, we chose the Nd isotope 142 (I = 0) to avoid difficulties in analysis due to hyperfine structure splitting. The analysis of the experimental spectra of 12 Nd II transitions having wavelengths between 568.853 nm and 589.153 nm (in air) allowed us to determine the Lande-factors for 21 energy levels. 8 of them belong to the $4f^45d$ configuration, 10 to $4f^46p$ and 3 to $4f^35d^2$. Our results are compared with other investigations, in which standard experimental techniques for Zeeman effect measurements were used, having smaller resolution, but applying much higher magnetic field strengths.

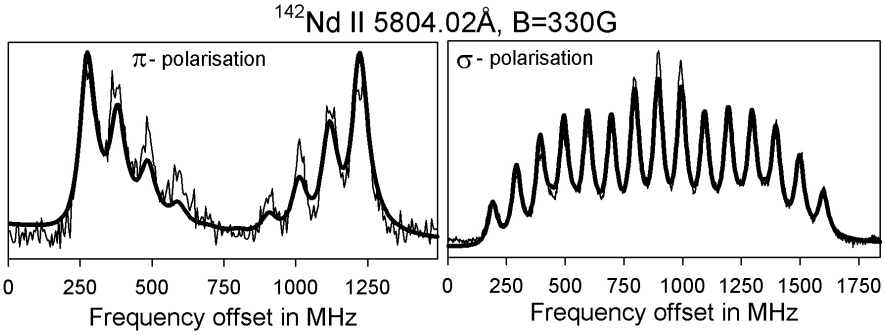

Figure 1: *Zeeman splitting of the Nd II - line 5804.02 Å (transition between levels 6005.33 cm^{-1} (a^6 $K_{9/2}$; g = 0.559) and 23230.0 cm^{-1}(z^6 $K_{9/2}$; g = 0.785)).*

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