P29

Unveiling the non-linear Zeeman effect in isotopes of krypton and xenon at the linear plasma device PSI-2

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Isotopic broadening alters the line shape of atomic transitions and contributes noticeably to the laser absorption spectra of neutral Kr and Xe investigated at the linear plasma device PSI-2. Of high interest are the odd-numbered isotopes having a nonzero nuclear spin resulting in the hyperfine interaction. The main challenge in analyzing such isotopes is that the hyperfine and Zeeman terms can be of the same order of magnitudes, rendering conventional weak field and strong approximation formulas inadequate for analysis.

The magnetic field at PSI-2 of < 90 mT creates such conditions for the Kr I 760.4 nm, Kr I 785.7 nm, and Xe I 764.4 nm lines. This contribution shows how to correctly account for the Zeeman effect by using a Hamiltonian containing both hyperfine and Zeeman interaction terms as the perturber. Standard atomic physics procedures allow us to derive the energy eigenvalues and relative intensities. Crucially, the theoretical analysis is backed by experimental data, confirming the validity of the methodology in modeling observed spectral features.