PERTURBATIONS IN THE SPECTRA OF HIGH RYDBERG STATES: CHANNEL INTERACTIONS, STARK AND ZEEMAN EFFECTS

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Rydberg states of principal quantum number $n \gg 50$ have been prepared by irradiation of an atomic beam of xenon with vacuum ultraviolet (VUV) radiation. Narrowband submillimeter-wave (THz) radiation was then used to record spectra of transitions from these Rydberg states to higher or lower-lying Rydberg states. The transitions were detected by selective field ionization and recording either the electrons or the ions, the latter offering the advantage of mass selection.

Rydberg states of high principal quantum number are extremely sensitive to their environment, which can be exploited to characterize the experimental conditions under which the spectroscopic measurements are carried out[a]. The high resolution achieved in the experiments (better than 100 kHz) enabled the study of the spectral lineshapes and line positions in dependence of weak electric (down to below 100μV/cm) and magnetic fields (down to a few μT), and of the density of Rydberg atoms and ions generated in the experimental volume. The experiments rely on the use of a pulsed, broadly tunable, laser-based source of THz radiation[b] for survey scans, and of a phase- and frequency-stabilized submillimeter-wave backward-wave oscillator-based radiation source[c] for precision measurements.

To illustrate the use of these sources, we present the results of the spectroscopic investigations of the hyperfine structure of ^{129}Xe Rydberg states in spectral regions where s-d interactions are expected to play a role.

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