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Breaking the Rules: Forbidden Transitions to Rydberg States

We use excitation of ultracold Rb atoms to Rydberg states as a probe of forbidden transitions. In the first set of experiments, we start with 5s ground-state atoms in a MOT and perform pulsed single-photon UV excitation to nd Rydberg states. These transitions, observed over a range of principal quantum numbers $n=27-59$, are electric-dipole (E1) forbidden, but electric-quadrupole (E2) allowed. In the second set of experiments, we use cw excitation at 587.6 nm to drive the E1-forbidden 5p - 8p transition in Rb. This transition is E2 allowed, and weakly magnetic-dipole (M1) allowed. By taking advantage of the different hyperfine selection rules for E2 and M1 transitions, we spectrally separate their contributions. This allows us to set an upper limit on the on the M1 matrix element. Our result is consistent with theory, but disagrees with an earlier measurement.

31. März 2011, 13:00 Uhr

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