WEAKLY BOUND MOLECULES. ANALYSIS BY THE LU-FANO METHOD COUPLED TO THE LEROY-BERNSTEIN MODEL

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We have realized the photo-associative spectroscopy of cold 87Rb atoms, below the (5s1/2+5p1/2) dissociation limit. Recorded spectra exhibit 3 molecular vibrational series : 0g-, 0u+ and 1g.
Such weakly bound molecules (WBM) are described by the dipole-dipole interaction ($1/R^3$ or as $1/R^6$). WBM energies are described by the Le Roy-Bernstein (LRB) model. The discrepancies to LRB law are due to the short distance behaviour of molecular potentials or to couplings between molecular series due to interactions such as spin-orbit or spin-spin interactions.
To analyse precisely the data, we have adapted the Lu-Fano (LF) method - well-known for Rydberg atoms - to WBM. Using the LRB law, a molecular quantum defect is defined and plotted versus the energy. The obtained LF graph allows us to characterise the molecular potential and the interactions.
The 0g- LF graph exhibits a linear variation , signature of the short range behaviour of the molecular potential. A model connects the slope to short range behaviour and allows us to characterise the short range potential [ref 1].
The 0u+ LF graph exhibits sharp variations, signatures of a coupling with a neighbouring series. The coupling is due spin-orbit effects in the molecule. A two series model allows us to evaluate the coupling (the wave function mixing), identify two perturbing levels of the (5s1/2+5p3/2) 0u+ series and do predictions about its first pre-dissociated level [ref 2].
ref 1 : H. Jelassi, B.Viaris De Lesegno, L. Pruvost, Phys. Rev. A. 73, 32501 (2006)
ref 2 : H. Jelassi, B.Viaris De Lesegno, L. Pruvost, Phys. Rev. A. 74, 12510 (2006)