XIV Serbian Conference on Spectral Line Shapes in Astrophysics
Bajina Bašta, Serbia, June 19 - 23, 2023
Book of Abstracts, Eds. Luka Č. Popović, Nataša Bon, Edi Bon and Sylvie Sahal-Bréchot

VISUALIZATION OF ADIABATIC DARK STATES UNDER TWO-PHOTON EXCITATION OF SODIUM ATOMS

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In our previous work [1], we theoretically analyzed the formation of three types of adiabatic states (dark, bright, and chameleon) in the Autler-Townes spectra of sodium atoms. Here we report on experimental identification of dark states in the spectra of sodium atoms under two-step laser excitation of a supersonic Na beam. In the experiment, a strong pump laser couples the hyper-fine components $F'' = 1, 2$ of the ground state $3s_{1/2}$ with components $F' = 1, 2$ of excited state $3p_{1/2}$ or $F' = 0, 1, 2, 3$ of $3p_{3/2}$ state. Populations and energies of the adiabatic (dressed) states are probed by scanning a comparatively weak laser field across the $3p_{1/2,3/2} \rightarrow 7d_{3/2}$ transitions. The corresponding excitation spectra reveal the presence of an intense peak with side-peaks of much smaller intensities. The side peaks experience a noticeable shift due to the Autler-Townes effect as the pump laser intensity is increased, while the position of the main peak remains virtually unchanged.

We interpret these experimental findings as the evidence of a "gray" state - a state of nearly constant Autler-Townes energy, that appears bright when the laser coupling is weak, but evolves into a proper dark state upon strong coupling [2].

References

[1] Cinins A., Bruvelis M., Dimitrijević M. S., et al.: 2022, Astronomische Nachrichten 343, e210081.

[2] Kirova T., Cinins A., et al.: 2017, Phys.Rev. A 96, 043421.