XIII SERBIAN CONFERENCE ON SPECTRAL LINE SHAPES IN ASTROPHYSICS
August 23-27, 2021, Belgrade, Serbia
Book of Abstracts, Eds. A. Kovačević, L. Č. Popović and S. Simić
Astronomical Observatory Belgrade, 2021

Invited Lecture

EXPRESSIONS OF "FAST" AND "SLOW" CHAMELEON DRESSED STATES IN AUTLER-TOWNES SPECTRA OF ALKALI-METAL ATOMS

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Upon interaction with atoms or molecules, resonant laser radiation alters ("dresses") the structure of unperturbed quantum states, transforming them into superpositions of the initial ("bare") states. Contemporary scientific literature categorizes the dressed states emerging in Λ type excitation schemes, and their higher–dimensional generalizations such as tripods, as either "bright" or "dark" states (Shore, 2011). The bright states interact with the laser radiation, while the dark states remain decoupled from the radiation. The absence of laser-induced transitions is a fundamental property of the dark states, responsible for a number of their unique features, which are widely demanded in practical applications of laser manipulation of matter, such as laser cooling, optical frequency standards, implementations of slow light and creation of ultrafast systems for storing and reading optical information (Fleischhauer et al. 2005).

To register and study the dressed states, one can implement an Autler-Townes (AT) spectroscopic experiment, as it allows to observe intermediate (i) and the highest excited (final, f) state papulations in a 2-step excitation scheme. In a typical AT arrangement (see Kirova et al. (2017) for details), a strong laser (S) couples intermediate and final levels, producing laser-dressed states, and a weak probe laser (P) provides a modest population transfer to the dressed states by coupling ground (g) and intermediate levels.

In a recent work (Kirova et al., 2017), a new class of dressed states ("chameleon" states) has been identified along with the dark and bright states. Properties of the chameleon states resemble a mixture of bright and dark state properties. In this report and in the subsequent publication we will show that these states can be further categorized into “fast” and “slow” chameleon states. Their manifestations will be illustrated using simulated Autler-Townes absorption spectra of alkali metal atoms. Formation of the chameleon and bright states is associated with different, complementary characteristics of the density matrix, which provide additional opportunities for optical diagnostics of atomic media, including those of astrophysical relevance.

This work was supported by Latvian Council of Science grant No. LZP-2019/1-0280.

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