A Rydberg-dressed magneto-optical trap

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The strong dipolar interactions between Rydberg atoms have been exploited to perform numerous experimental studies of interacting many-body systems. A promising approach to create an interacting many-body quantum gas with tunable interactions is to off-resonantly couple a low-lying atomic state to a Rydberg state [1,2]. It has been shown that this so-called Rydberg dressing approach could facilitate the formation of interesting states of matter, such as supersolids [3,4]. Recently, experimental work has demonstrated the tunability of the Rydberg-dressed interaction in optical lattices [5,6], however the effect of these interactions in a randomly distributed ensemble are yet to be observed. Here we present a novel Rydberg-dressing experiment where the excited state of a narrow-line strontium MOT is coupled off-resonantly to a high-lying Rydberg state, producing an operational MOT with measurable Rydberg character. This is supported by a quantitative Monte-Carlo model of the MOT. We are able to measure the Rydberg character of the MOT through its sensitivity to an applied electric field, which without the Rydberg admixture would be nonexistent. Here we present recent experiments which strive to observe a mechanical effect of the long-range dressed interactions in a laser-cooled gas.

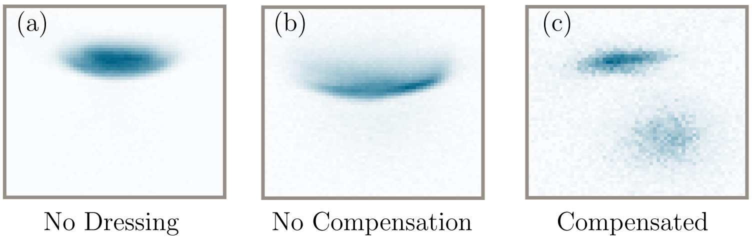

Fig. 1: MOT images after 10ms of dressing at different values of coupling beam Rabi frequency and MOT beam detunings. The coupling beam is detuned $+12$MHz from resonance. (a) MOT image in the absence of the coupling laser with a MOT beam detuning of -110kHz. (b-c) MOT image in the presence of the coupling beam with 4MHz Rabi frequency and MOT beam detuning of -110kHz and $+190$kHz respectively. The presence of the coupling beam causes an AC Stark shift of the MOT transition. If the MOT beam detuning remains unchanged (b), the MOT moves to a lower position. By compensating the AC Stark shift (c), the atoms remain in the coupling beam resulting in a functioning dressed MOT.

References

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