Coherent 455 nm beam production in a cesium vapor

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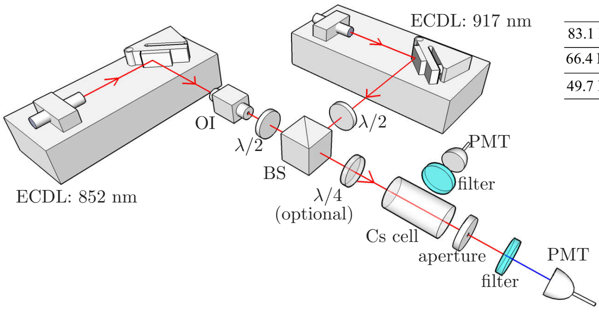
The effects of atomic coherence and interference have become useful and important tools in optical physics, particularly for the enhancement of nonlinear interactions between atoms and light. The atomic species rubidium and cesium have been studied for their apparent suitability for frequency upconversion and specifically the generation of shortwavelength laser beams [1, 2].

We demonstrate efficient frequency upconversion in a resonant atomic media with low-power, cw lasers via techniques of interference and atomic coherence [3]. Two 30 mW infrared lasers induce strong double excitation in a heated cesium vapor cell, allowing the atoms to undergo a double cascade and produce a coherent, collimated, blue beam copropagating with the two pump lasers (see Fig. 1).

The 455 nm beam is found to be collimated with a divergence less than 0.1 mrad. An interference pattern from a MachZehnder interferometer with unequal path lengths confirms that the beam has substantial spatial and temporal coherence with a fringe visibility of 93%. The greatest efficiency is obtained when both pump beams are circularly polarized thereby utilizing cycling transitions at each excitation stage. Unlike a similar system in rubidium [4], no blue-beam production is observed for large detunings of the pump beams. It is possible that this method for frequency upconversion can be extended to other elements, such as sodium and lithium, in order to produce a coherent beam of UV radiation (330 nm and 323 nm, respectively).



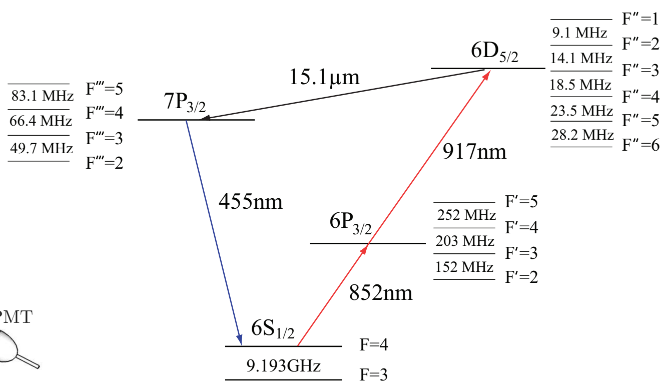


Fig. 1: Experimental setup (Left). Two infrared lasers copropagate through a ^{133}Cs vapour cell thus producing 455 nm radiation. The blue beam is sent through an aperture and a bandpass filter and is detected with a photomultiplier tube (PMT). A PMT is also used to measure the blue fluorescence in the cell. OI, optical isolator; BS, nonpolarizing beam splitter. Energy level scheme in ^{133}Cs (Right). The atoms undergo a double cascade through the $^7P_{3/2}$ state, producing a 455 nm beam on the transition to the ground state.

References

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