Photonic orbital angular momentum for quantum interplaying with atoms and entanglement

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Photonic Orbital Angular Momentum (OAM) is becoming a pertinent quantum variable for atom-light interaction, in particular in non-linear interactions. More generally, optical beams containing phase or polarisation singularities reveal new features in atom-light. Four wave mixing (FWM) leads to OAM entanglements and Electromagnetism Induced Transparency (EIT) leads to new magnetometry. Hot vapors are well-adapted for efficient FWM and EIT.

Experiments on FWM with large OAM were done on rubidium vapor using an excitation to $5D_{5/2}$ level which decays through $6P_{3/2}$ level and gives a $5320+420\,nm$ photon pair (Fig.1a) in a co-propagating beam configuration (Fig.1c) [1]. We now consider the more symmetrical 4-levels scheme (Fig.1b), where the $5D_{3/2}$ level is excited giving two NIR photons at 762 and 795 nm. We compare the two configurations and show that they give completely different entanglement (Fig1.c), essentially due to the output wavelengths [2].

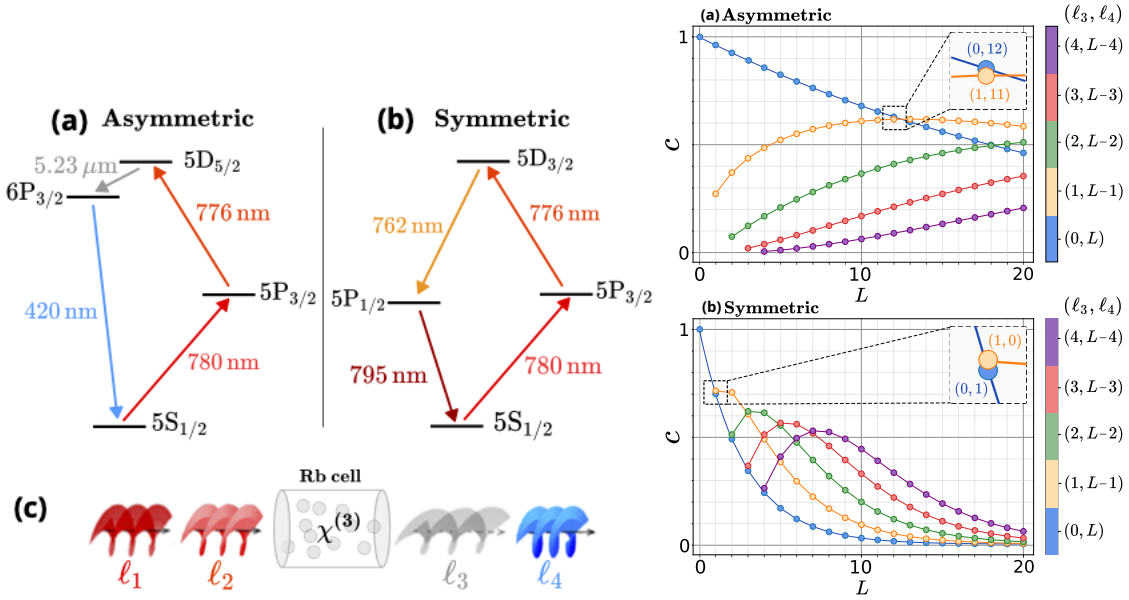

Figure 1: On the left : (a) asymmetric (a) and (b) symmetric Rb 4-levels schemes for FWM for pair generation, (c) principle of the experiment. On the right : (a) probability amplitude OAM of the blue (420 nm) in the output pair, and (b) of the NIR (795 nm).

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