Toward one-photon excitation of S states with twisted light

K. Morin[1], P. Chakrabarti[1], T. Boulier[1*]
[1]*Physics Department, INSA-CNRS-UPS, LPCNO, 135 Av. Rangueil, 31077 Toulouse, France*
**e-mail: boulier@insa-toulouse.fr*

For the last decade, Rydberg excitons have shown great promises for solid-state Rydberg physics [1]. In particular, the nP yellow series of copper oxide displays principal quantum numbers up to n = 30 [2]. In copper oxide, the selection rules dictate that the P series is optically active while the S series is optically dark to first order, making its study more complex. Although two-photon excitation enables exploring even-parity states, this process is inefficient and requires a more complex experimental setup. It has been predicted that this selection rule can be bypassed [3] by giving the (one-photon) excitation beam an additional angular orbital momentum, so as to compensate for the exciton wavefunction parity. Laguerre-Gauss modes could provide this extra angular momentum (Fig. 1).

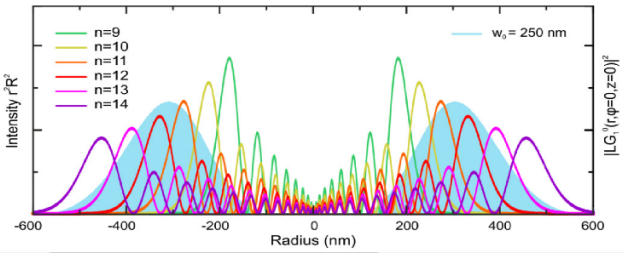

Fig. 1: Size comparison between a l = 1 LG mode and Rydberg excitons from n = 9 to n = 14. From [3].

This poster describes the experimental apparatus that we are currently building in order to test this prediction. A programmable spatial light modulator transforms a yellow Gaussian beam into a Laguerre-Gauss (LG) beam with arbitrary orbital angular momentum. Precision optics enable to focus the LG mode down to sub-micron sizes. We target LG beams with the same size as the Rydberg states we will attempt to excite, so as to engineer a good spatial overlap between the light and the matter wavefunctions.

References

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