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## **PHOTONICS - EUROPHOTONICS MASTER COURSE**

### **PROPOSAL FOR A MASTER THESIS**

**Course 2013 - 2014**

**Laboratory :** FISICA APLICADA I OPTICA, UNIV. BARCELONA  
**City, Country :** BARCELONA, SPAIN

**Title of the master thesis:** GENERALIZATION OF THE RICHARDS-WOLF THEORY FOR FOCUSED BEAMS TO LENSES INCLUDING PUPIL PLATES

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**Summary of the subject (maximum 1 page) :**

**The limit of classical light confinement is achieved with highly focused laser beams. These beams are used in fluorescence spectroscopy, in confocal microscopy, optical data storage, optical tweezers, etc. The fields of a focused laser beam are determined by the boundary conditions of the focusing optical element and the incident optical field. The aim of the work is to study the focusing of a paraxial optical field by an aplanatic lens. We will follow the theory established by Richards and Wolf [1] but we will generalize the conditions by including a plate in the pupil of the lens. This plate may be of the binary (i.e. real valued) or of the phase type, and will greatly modify the focusing of the incident beam. For example, the use of binary optics to enhance the longitudinal field component has recently been reported [2]. Besides, the produced beam was non-diffracting, allowing even more specialized application.**

**The topic of the Master Thesis is to develop the numerical procedures for the computation of focused fields under the Richards-Wolf approach, but with the additional possibility of including pupil filters in the focusing optics.**

[1] Richards, B. & Wolf, E. 'Electromagnetic diffraction in optical systems. II. Structure of the image field in an aplanatic system'. Proc. Roy. Soc. A 253, 358-379 (1959).

[2] Wang, H et al. 'Creation of a needle of longitudinally polarized light in vacuum using binary optics'. Nature Photonics, vol 2, 501-505 (2008).

**Keywords :** Richards-Wolf theory, light focusing, pupil plates.

**Additional information:** some experience in MATLAB programming required.