THE ORBITAL ANGULAR MOMENTUM OF LIGHT IN LASER SPECTROSCOPY

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The states of light with non-zero value of orbital angular momentum (OAM) [1] are useful tool in numerous photonic techniques, for example optical trapping of atoms with putting them into rotational motion, optical processing of quantum information or performing optical quantum memories. One of the interesting applications of, so called, optical vortices is laser spectroscopy with breaking standard selection rules [2].

As part of this paper, the idea of an experimental system for observing quadrupole transitions in atoms, by Laser-Induced Fluorescence method in the hollow cathode discharge lamp, excited by the Laguerre-Gaussian beam (which is an example of an optical vortex) will be presented. Photons which forms classical Gaussian beam possess only Spin Angular Momentum. Because of that only dipole transitions, allowed by standard selection rules $\Delta m_j = 0, \pm 1$, can be driven by Gaussian laser light. To excite atom by the quadrupole transition the orbital component of angular momentum is required to fulfill the condition $\Delta m_j = 0, \pm 1, \pm 2$. The possibility of using a non-zero OAM for spectroscopic purpose has been demonstrated on the calcium ion in Paul's trap [3].

Progress in the construction of the experimental system for the production of optical vortices with a liquid crystal phase plate (Q-plate) and its integration with the existing hollow cathode discharge lamp system will be presented. The optical system is going to convert laser light in OAM light's states in broad visible spectral range. The generated beam in Laguerre-Gauss mode may help with studying the hyperfine structure of rare earth elements, by Laser-Induced Fluorescence method, carried out at the Division of Engineering and Quantum Metrology at the Faculty of Materials Engineering and Technical Physics of the Poznan University of Technology. The proposed modernization of the standard experimental system involved in the conducted research will allow to expand potential research possibilities.

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