# Q 73: Photonics II

Time: Friday 14:30–15:45 Location: B/gHS

Q 73.1 Fri 14:30 B/gHS

**Classically entangled optical beams for high-speed kinematic sensing** — •Stefan Berg-Johansen[1,2], Falk Töppel[1,2], Birgit Stiller[1,2], Peter Banzer[1,2,3], Marco Ornigotti[4], Elisabeth Giacobino[5], Gerd Leuchs[1,2,3], Andrea Aiello[1,2], and Christoph Marquardt[1,2] — [1]Max Planck Institute for the Science of Light, Guenther-Scharowsky-Str. 1/Bldg. 24, D-91058 Erlangen, Germany — [2]Institute of Optics, Information and Photonics, University of Erlangen-Nuremberg, Staudtstr. 7/B2, D-91058 Erlangen, Germany — [3]Department of Physics, University of Ottawa, 25 Templeton, Ottawa, Ontario, K1N 6N5 Canada — [4]Institute of Applied Physics, Friedrich-Schiller University Jena, Max-Wien Platz 1, 07743 Jena, Germany — [5]Laboratoire Kastler Brossel, Université Pierre et Marie Curie, École Normale Supérieure, CNRS, 4 place Jussieu, 75252 Paris, France

We investigate configurations of the optical field whose structure is mathematically equivalent to that of entangled quantum systems [1]. Specifically, we consider the radially polarized beam, whose polarization and transverse spatial degrees of freedom (DOF) inherently display an entangled structure [2,3]. As a consequence, a spatial obstruction of the beam may be detected by measurements on the polarization DOF alone. Leveraging this idea, we demonstrate position tracking of a moving particle with GHz temporal resolution.

[1] R. J. C. Spreeuw, Phys. Rev. A **63**, 062302 (2001).
[2] A. Holleczek *et al.*, Opt. Express **19**(10), 9714 (2011).
[3] F. Töppel *et al.*, New J. Phys. **16**, 073019 (2014).

Q 73.2 Fri 14:45 B/gHS

**Localized surface modification for single mode waveguide generation via Excimer laser scanning mask exposure** — •Humza Mirza[1,2], Sabine Tiedeken[1], Volker Braun[1], Hans Joseph Brückner[1], and Ulrich Teubner[1,2] — [1]Institut für Laser und Optik, Hochschule Emden/Leer - University of Applied Sciences, Constantiaplatz 4, D-26723 Emden — [2]Institut für Physik, Carl von Ossietzky Universität Oldenburg, D-26111 Oldenburg

Localized surface modification of a planar Polymethylmethacrylate (PMMA) substrate is investigated using different irradiation parameters. In particular, a 248nm Excimer laser pulses in combination with a contact mask in scanning mode are used to fabricate waveguides of 2-15$\mu m$ width. An elementary approach was opted to establish a model to find suitable irradiation parameters for the generation of single mode waveguides. Comparison was made to the measured mode field diameter (MFD). The change in the generated refractive index was calculated without using any further direct measuring methods and estimated to be of the order of $10^{-3}$. Using a beam profile measurement system, through calibration of the near field image of a single mode 620 nm fiber, its values were cross referenced with the values derived from the inscribed waveguides. Deduced MFDs were compared to numerical mode field simulations. The results of the present investigations depict satisfactory single mode waveguiding with large mode field diameters.

Q 73.3 Fri 15:00 B/gHS

**Frequency splitting of polarization eigenmodes in microscopic Fabry-Perot cavities** — •Manuel Brekenfeld, Manuel Uphoff, Stephan Ritter, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748 Garching

In recent years, microfabricated Fabry-Perot cavities have been developed. They enable small mode volumes but have shown an increased frequency splitting of the polarization eigenmodes of fundamental transverse modes. This splitting must be controlled for a number of applications ranging from polarimetry to quantum information processing based on cavity quantum electrodynamics. We studied this frequency splitting using $CO_2$ laser-machined cavities and found that it results from elliptical deviations of the mirror surfaces from a rotationally symmetric shape [1]. An analytic model which explains the frequency splitting of polarization eigenmodes in such cavities is in excellent agreement with measurements we made on $CO_2$ laser-machined high-finesse cavities. The model is based on a correction to the paraxial resonator theory, revealing why the effect becomes relevant in microscopic Fabry-Perot cavities. The gained knowledge will help to control the polarization-dependent frequency splitting in microscopic Fabry-Perot cavities and allow the employment of these cavities in experiments which require degenerate polarization eigenmodes.

[1] M. Uphoff *et al.*, arXiv:1408.4367 (2014)

Q 73.4 Fri 15:15 B/gHS

**Multi-component Airy beams** — •Rodislav Driben[1], Vladimir Konotop[2], and Torsten Meier[1] — [1]Department of Physics & CeOPP, University of Paderborn, Warburger Str. 100, D-33098 Paderborn, Germany — [2]3Centro de Fisica Teorica e Computacional, Faculdade de Ciências, Universidade de Lisboa, Avenida Professor Gama Pinto 2, Lisboa 1649-003, Portugal

The dynamics of multi-component (vectorial) coupled Airy beams will be reported. In the linear propagation regime a complete analytic solution describes breather like propagation of the several components featuring non-diffracting self-accelerating Airy behavior [*]. The superposition of several beams with different input properties opens the possibility to design more complex non-diffracting propagation scenarios. In the strongly nonlinear regime the dynamics remains qualitatively robust as is revealed by direct numerical simulations. Due to the Kerr effect the emission of solitonic breathers, whose coupling period is compatible with the remaining Airy-like beams, is observed. The results of this study are relevant for the description of photonic and plasmonic beams networks propagating in coupled planar waveguides as well as for birefrigent or multi-wavelengths beams.

[*] Optics Letters 39(19), 5523 (2014)

Q 73.5 Fri 15:30 B/gHS

**Zitterbewegung in metamaterial simulations of the Dirac equation** — •Sven Ahrens and Shi-Yao Zhu — Beijing Computational Science Research Center, No. 3 He-Qing Road, Hai-Dian District, Beijing, 100084

Zitterbewegung is an oscillatory, non-classical motion of wave packets in Dirac theory, caused by interference of positive and negative energy eigenstates of the free, one-particle Dirac equation. Recently it has been shown, that the propagation of electro-magnetic waves in certain metamaterials can be associated with an effective Dirac equation and that even topological excitations can be found in such wave guides [1].

In our theory, we extend the description of the effective Dirac equation from frequency space into the time domain by using a unitary time evolution. We demonstrate, that Zitterbewegung can occur in metamaterial simulations of the effective Dirac equation.

[1] W. Tan, Y. Sun, H. Chen, SQ. Shen, Sci. Rep. 4:3842 (2014)