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Helmholtz Award for MPQ Scientists

For the development of a monolithic, chip based optical frequency comb, Prof. Tobias Kippenberg, Dr. Ronald Holzwarth and Pascal Del`Haye, scientists at Max Planck Institute of Quantum Optics (Garching, near Munich) will receive the Helmholtz Award 2009 by the Physikalisch-Technische Bundesanstalt (PTB). This award is presented every two years for excellent precision measurements in physics, chemistry and medicine by Stifterverband and Helmholtz funds and is endowed with a prize money of 20 000 Euro. The prize awarding ceremony will take place on 23 June 2009 during the Helmholtz symposium which is organized by PTB in memory of its first president Hermann von Helmholtz.

Basically a frequency comb is a tool for generating laser light that is composed of a large number of spectral lines in equal distance. It serves at measuring optical frequencies with very high precision. The experimental set-up which was developed by Prof. Theodor W. Hänsch and distinguished with the Nobel prize in physics 2005 is based on a mode-coupling process in short-pulse lasers. This conventional set-up of a frequency comb consists of very many optical components and is therefore rather bulky.

In contrast, the concept of the monolithic frequency comb developed by Tobias Kippenberg (leader of the independent Max Planck junior research group “Laboratory of Photonics and Quantum Measurements”, meanwhile tenure track assistant professor at the ETH Lausanne (EPFL) in Switzerland), Ronald Holzwarth (manager of the MPQ offshoot company Menlo Systems), and Pascal Del`Haye (PhD student at the experiment), is based on a toroidal microresonator that is produced on a silicon chip. (See also MPQ press release 19.12.2007). Such optical microresonators can store light for a relatively long period. This can lead to extremely high light intensities, i.e. photon densities, at which a great deal of nonlinear effects occur. It is such a nonlinear ‘Kerr effect’ that makes it possible to realise a frequency comb: two light quanta of equal energies are converted to two photons of which the one light quantum has a higher energy, the other a lower energy than the original one. Here the newly produced photons can in turn interact with the original light quanta, thereby producing new frequencies. From this cascade there emerges a surprisingly broad spectrum of frequencies that are in fact perfectly equidistant.

This new type of frequency comb could be used in the future for optical frequency measurements and also for designing clocks of extremely high precision. Another highly interesting field of application is in optical telecommunications: The spectral lines of the monolithic frequency comb have a separation of about 80 gigahertz which turns out to fulfil the typical requirements for the “carriers” of the data channels in fibre-based optical communications. In view of its high application potential the scientists have already applied for patents worldwide. *Olivia Meyer-Streng*

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Original publications:

'Optical frequency comb generation from a monolithic microresonator',
P. Del'Haye, A. Schliesser, O. Arcizet, T. Wilken, R. Holzwarth, T. J. Kippenberg,
Nature, 20. Dezember 2007

'Stabilization of a Microresonator Frequency Comb',
Del`Haye, P., Arcizet, O., Schliesser, A., Holzwarth, R. & Kippenberg, T. J. Full
Physical Review Letters **101** (2008).

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