

**Short Course:
Frequency Combs and Applications**

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Course Description:

A laser frequency comb allows the conversion of the very rapid oscillations of visible light of some 100s of THz down to frequencies that can be handled with conventional electronics. This capability has enabled the most precise laser spectroscopy experiments yet, that allowed testing quantum electrodynamics, to determine fundamental constants and to search for possible slow changes of these constants. Using an optical frequency reference in combination with a laser frequency comb has made it possible to construct all optical atomic clocks, that are now outperforming even the best cesium atomic clocks. Direct frequency comb spectroscopy by employing individual modes of the comb may be used for recording broad band molecular absorption. While this has practical relevance for sensitive trace gas analysis, frequency combs may be converted to the extreme ultra violet where no single mode laser exists. Therefore this method might allow high resolution laser spectroscopy in this unexplored region for the first time. Frequency combs are also used to calibrate astronomical spectrographs and might reach an accuracy that is sufficient to observe the change of the expansion rate of the universe in real time and to find Earth-like extrasolar planets. I will discuss the frequency comb principles in detail and present the various applications.