Guest Editorial

IN PRECISION optical metrology, frequencies in the range of 100 THz are determined with respect to the SI definition of a second, represented by the 9.2-GHz transition of the cesium ground-state hyperfine splitting. Due to the large frequency difference between the Cs standard and the optical transitions of interest, absolute optical frequency measurements in the past have relied on the implementation of elaborate schemes that utilize different harmonics and sub-harmonics of the optical transition and of Cs, together with secondary standards, to bridge the gap between the optical and the microwave regions. Recently, the science of precision optical measurements has been revolutionized with the breakthrough demonstration of a frequency synthesizer based on femtosecond lasers. This new metrology tool uses mode-locked femtosecond pulses spectrally broadened in a microstructure fiber to generate a comb of equally spaced frequencies spanning over an octave. Since the frequency of each mode can be precisely determined, the comb can be used to measure the optical frequency of a stable unknown source by counting the beat notes between the unknown signal and a nearby mode of the comb. This method, which provides a direct link between the optical domain and the Cs standard, has resulted in unprecendented versatility in frequency metrology from the UV to the IR.

This Feature Section contains three invited papers, written by leading groups in the field, that describe the implementation of this new "all optical" frequency metrology tool based on femtosecond laser frequency combs and its application to absolute frequency determinations. The paper by J. L. Hall *et al.* provides a historical recount of the most significant developments in precision optical spectroscopy and metrology that, when combined with the concepts of femtosecond frequency combs, helped realize the precise measurement of frequency standards. The paper by R. Holtzwarth *et al.* details the characteristics of the octave spanning femtosecond frequency comb, how mode frequencies are precisely determined, and how this method is used to implement an optical frequency synthesizer. The paper by L. Hollberg *et al.* describes the measurement of the absolute frequency of the Ca and Hg^{+} optical frequency standard, and provides an analysis of the present performance, limitations, and future requirements of the femtosecond frequency comb.

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Dr. Menoni was awarded the National Science Foundation Career Award in 1995 for the study of short-wavelength heterostructure materials for blue lasers. She is a member of the American Physical Society and the Optical Society of America.