APR20-2020-000734

Abstract for an Invited Paper
for the APR20 Meeting of
the American Physical Society

Precision Astronomical Spectroscopy with Laser Frequency Combs[1]

SCOTT DIDDAMS, National Institute of Standards and Technology Boulder

Laser frequency combs were originally developed as the clockwork, or gears, of a new generation of optical clocks that presently operate with uncertainty at the 19-th digit. However, this diverse technology has shown itself to be equally valuable for a much wider range of applications. In astronomy, frequency combs function as an ideal calibration source for precision radial-velocity spectroscopy aimed at finding and studying earth-mass habitable exoplanets. In this talk, I will highlight the science and technology of the near infrared laser frequency comb technology that we built as the primary calibrator for the Habitable Zone Planet Finder (HPF). Fiber-integrated electro-optic modulators and broadband supercontinuum generation in nanophotonic waveguides provide a 30 GHz frequency comb spanning 700 to 1600 nm. The comb has been continuously operated for nearly two years and is used nightly with the HPF for astronomical spectroscopy, enabling on-sky stellar radial velocity uncertainty of 1.5 m/s. This precision is unparalleled for such near-infrared technology and has led to confirmation and orbital characterization of exoplanets around nearby M-dwarfs. We have also been employing a laser frequency comb to calibrate a near-infrared heterodyne radiometer with resolving power of 2,000,000. As a first application we observed a selection of iron lines in the solar spectrum near 1560 nm, achieving absolute frequency instability on measurements of single lines at better than 20 MHz in 20 seconds of averaging. Such high-resolution spectroscopy is being explored as a means to disentangle the spectroscopic signatures of surface activity from the center of mass motion of stars.

[1]this work supported by NIST and NSF AST-1310875