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Theory of an Externally Dispersed Interferometer for Precision Doppler Velocimetry

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An interferometer crossed with an external grating forms a compact, hybrid instrument for broadband high resolution spectroscopy including stellar Doppler velocimetry. A low cost portable velocimeter prototype has been tested on sunlight and bright starlight. The 12 m/s amplitude lunar component of Earth's motion has been measured in sunlight over 1 month, demonstrating sufficient long term stability for practical detection of exoplanets. Precision of better than 1 m/s has been achieved in laboratory null tests. An instrument theory has been developed, allowing comparitive estimates of photon signal to noise behavior for purely dispersive, purely interferometric, and the hybrid technique. The hybrid instrument can perform wide bandwidth mapping of spectra at resolution several times higher than the external grating used alone, due to a heterodyning effect. Example mapping of solar spectra are shown. This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.