Astronomical spectrograph calibration with UV astrocombs

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Precision spectroscopy plays a vital role in numerous astronomical and cosmological investigations. Techniques like radial velocity, crucial for exoplanet detection, depend on detecting subtle shifts in stellar spectra, achievable only through precise wavelength calibration of spectrographs. Laser frequency combs (LFC) for astronomical spectrographs (astrocombs) have gained considerable attention recently as they can be accurate wavelength calibration sources when linked to atomic time standards. However, reaching visible and ultraviolet (UV) wavelengths with astrocombs remains to be challenging.

Here, we demonstrate astronomical spectrograph calibration in visible and UV wavelengths using nanophotonic waveguides[1]. More specifically, a frequency stabilized 18 GHz electro optic comb in infrared (IR) is frequency upconverted to visible and UV wavelengths using a highly nonlinear lithium niobate waveguide. Visible and UV spectrum is later used to calibrate an astronomical spectrograph SOPHIE (OHP, France). The demonstration shows a viable route towards UV calibration of spectrographs and has the potential to lead further developments in this field.

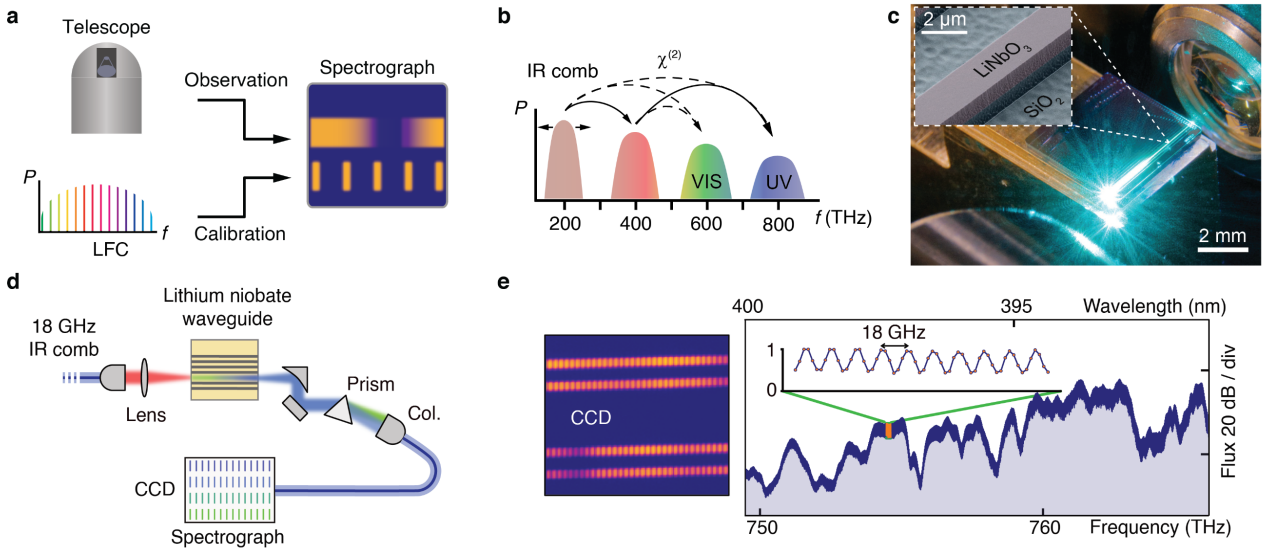

Fig. 1: Astronomical spectrograph calibration with UV astrocombs. a, Simplified calibration scheme for astronomical spectrographs (LFC: Laser Frequency Comb). **b,** Frequency conversion of an infrared (IR) comb to visible (VIS) and ultraviolet (UV) wavelengths. **c,** Lithium niobate waveguide during operation and false-color SEM image of a waveguide (inset). **d,** Setup for UV comb generation. **e,** Cropped CCD detector image of the spectrograph (left) and extracted 1-dimensional spectrum in UV (right).

[1] M. Ludwig, et al. "Ultraviolet astronomical spectrograph calibration with laser frequency combs from nanophotonic waveguides." arXiv preprint arXiv:2306.13609, 2023.