Balanced heterodyne detection at >20 GHz

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Due to its extreme sensitivity, optical heterodyne detection – also called coherent detection - has found numerous applications in fields are various as spectroscopy [1], optical fiber communications [2], gravity-wave detection [3], quantum optics [4] or astronomy [5]. Measuring ultraweak optical signals such as quantum noise requires that all classical noise terms, such as the relative intensity noise (RIN) of the local oscillator (ie the reference laser) or the electronic noise of the detection chain, are reduced to a level well below the noise level of interest. Balanced heterodyne detection [6], which can effectively cancel this classical noise and amplify the measured signal. Photonic integration at the telecom wavelengths has recently allowed to extend the bandwidth of balanced to dozens of GHz, a feature that could benefit to heterodyne spectrometers for which the optical bandwidth is directly related to the bandwidth of the balanced detector. Increasing the detection bandwidth therefore to In this poster we study the sensitivity and noise properties of a 20-GHz balanced heterodyne detection within the context of astrophotonics, and more precisely of optical spectroscopy and interferometry at ~1.55 µm.

References

[1] A. L. Betz, et al., "Heterodyne detection of CO2 emission lines and wind velocities in the atmosphere of Venus". No. NASA-CR-147231 (1975). [1] Y. He and B. J. Orr, "Rapidly swept, continuous-wave cavity ringdown spectroscopy with optical heterodyne detection: single- and multi-wavelength sensing of gases", Appl. Phys. B 75 (2-3), 267 (2002).

[2] T. Okoshi, "Recent advances in coherent optical fiber communications systems", IEEE J. Lightwave Technol. 5 (1), 44 (1987).

[3] K. Sun, et al. "Sagnac interferometer for gravitational-wave detection." Physical review letters 76.17 (1996).

[4] H. Hansen, et al., "Ultrasensitive pulsed, balanced homodyne detector: application to time-domain quantum measurements," Opt. Lett. 26, 1714-1716 (2001)

[5] D. D. Hale, et al. "The Berkeley infrared spatial interferometer: a heterodyne stellar interferometer for the mid-infrared." The Astrophysical Journal 537.2 (2000).

[6] H. R. Carleton and W. T. Maloney, "A Balanced Optical Heterodyne Detector," Appl. Opt. 7, 1241-1243 (1968).