# Polarization-based light measurement using geometric phase control and Fourier-transform spectroscopy method

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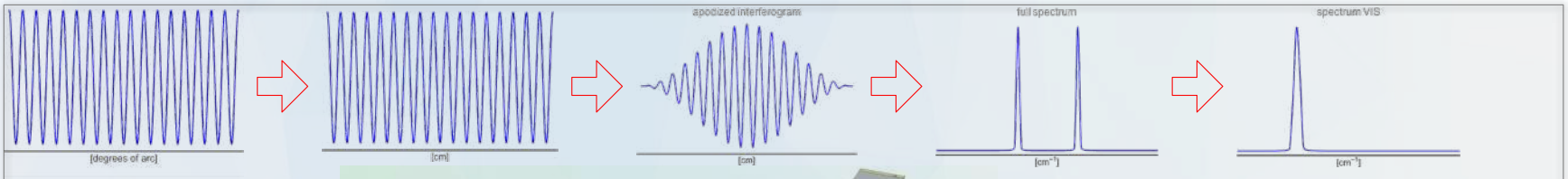
*Interferometry, Fourier-transform and single-pixel detection are well established mathematical and scientific methods for various precision measurements and characterizations. A successful combination of the three is found in Fourier-transform spectroscopy; a method that works by scanning the interferogram of incident radiation and applying the Fourier transformation to obtain the spectrum. Traditionally, the scanning is achieved by moving one of the mirrors in the interferometer, hence by controlling the dynamic phase difference. Our approach is based on controlling the geometric phase in a polarising interferometer.*




$rot = N$ (º) with = 90º

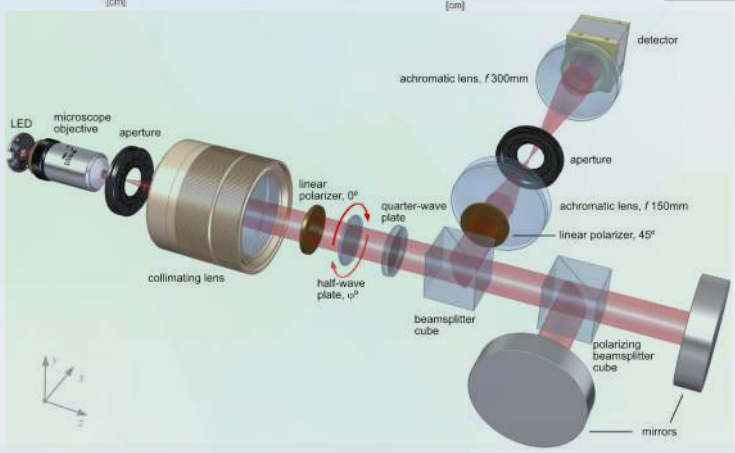
Total rotation of the HWP as a function of the number of fringes, where is the angle for one fringe count.

$OPDe = 2\,d = N$ (º)

The *equivalent* OPD in terms of the counted number of fringes.

$rot = (OPDe/$ (º)

Total rotation as a function of the equivalent OPD.




| *N*pts | *Res* (cm⁻¹) | *OPDe* (cm) | ! *rot*(º) | *N* | *OPDrot*(º) | !*x*(nm) |
|---|---|---|---|---|---|---|
| 512 | 150.4 | 0.00664 | 18.5 | 105 | 9453.5 | 130 |
| 1024 | 92.4 | 0.01082 | 15 | 171 | 15390 | 105.8 |
| 2048 | 69.3 | 0.01442 | 10 | 228 | 20520 | 70.5 |
| 4096 | 38.5 | 0.02595 | 9 | 410 | 36900 | 63.4 |
| 8192 | 28.9 | 0.03461 | 6 | 547 | 49230 | 42.3 |

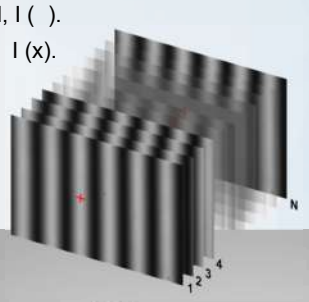
A number of interference fringes are recorded.

The value for the central pixel in each interference image is extracted.

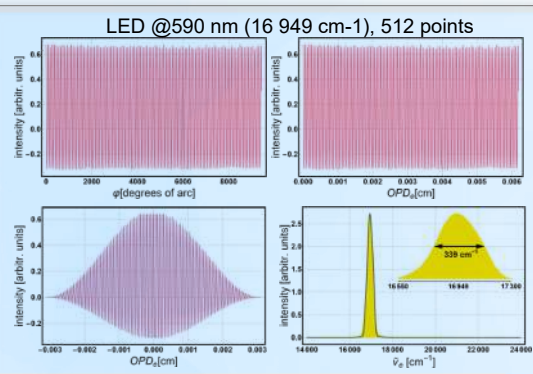
An interferogram is obtained, I ( ).

Following, we convert it into I (x).

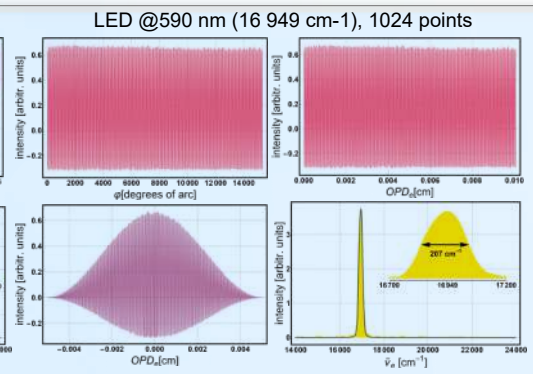
Apply appodization window and perform FT.

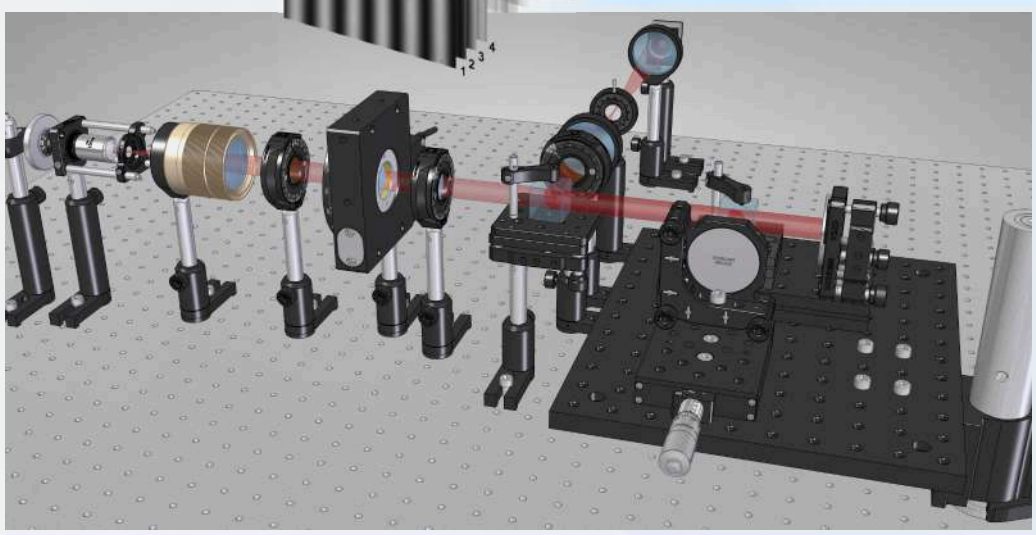



LED @590 nm (16 949 cm-1), 512 points

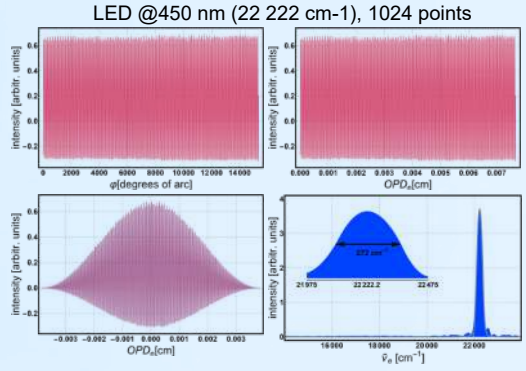



LED @590 nm (16 949 cm-1), 1024 points

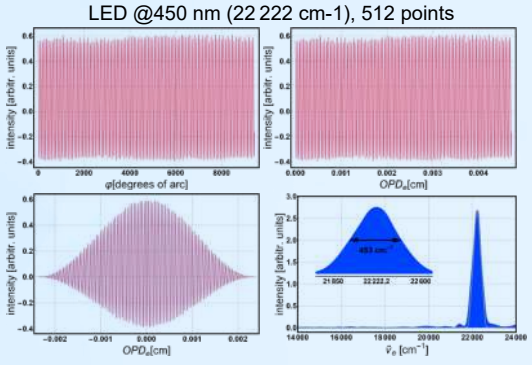


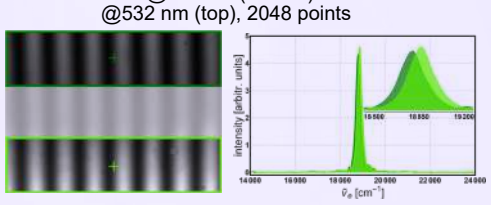
LED @450 nm (22 222 cm-1), 1024 points



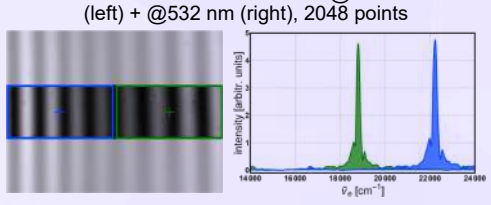

LED @450 nm (22 222 cm-1), 512 points




LED @530 nm (bottom) + filter @532 nm (top), 2048 points




"white" LED and 2 filters: @450 nm (left) + @532 nm (right), 2048 points




- Geometric phase can be used as a phase shifter mechanism for light measurement using Fourier-transform spectroscopy.
- Only monochromatic radiation can be measured due to the achromatic nature of the geometric phase.
- It is possible to measure multiple wavelengths at once by assuring spatially separated sources and a CCD as detector.
- The main advantage is controling rotations of degrees of arc instead of translations on the order of tens of nanometers.
- The amount of this rotation motion is considerably larger and, in consequence, easier to control with less noise involved.

This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS—UEFISCDI, project number PN-III-P1-1.1-TE-2021-0949, within PNCDI III, and under Romanian National "Nucleu" Program LAPLAS VII - contract number 30N/ 2023