Interferometry and Vibration Isolation
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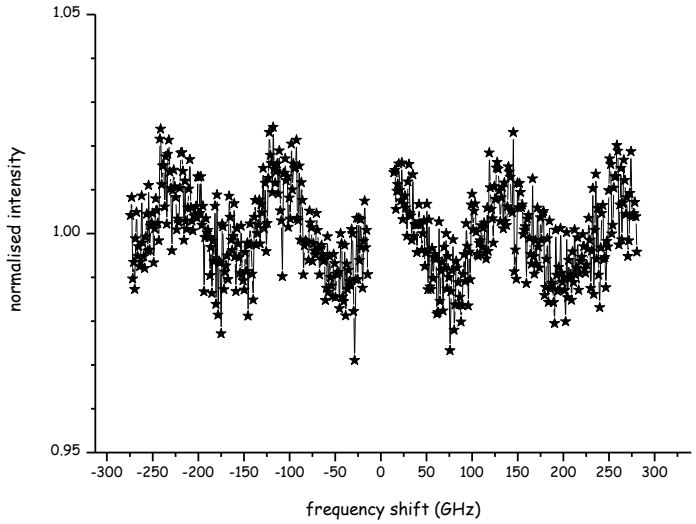
Ripples in white light spectrum

It has been reported to us that sometimes an oscillation is observed in the transfer function of our tandem interferometers, at small mirror spacing (usually less than 2 millimetres), being also visible in white light spectra measured in the same conditions. This happened only in a very small number of devices and was impossible to reproduce up to now. In a recent experiment, we have been able to observe a similar effect and shed some light on the problem.

We measured a white light spectrum by placing a piece of white paper directly in front of the entrance pinhole of a JRS TFP-1 spectrometer and illuminating this with a flash light. The spectrum shown in Figure 1 was obtained using a Hamamatsu H10682 photon counter as detector (D1). The modulation of the spectrum is small but clearly visible. In further measurements, the oscillation period (in terms of GHz) has been verified to stay relatively constant when changing mirror spacing and scan amplitude, while a modest shift in position was observed by comparing measurements taken at different times and with different mirror spacing.

Figure 1 : normalised spectrum from diffuse white light evidencing oscillations (0.5 mm mirror spacing)



When the Hamamatsu detector was replaced with a LaserComponents COUNT® SAPD detector (D2) the oscillation was no longer seen. Since the APD detector has a strong focussing lens in front to concentrate the light onto the small sensitive area, it seemed possible that in the first case the oscillations resulted from a modulation of the transmitted intensity of the light passing through the glass envelope of the detector D1. This would also explain the periodic behaviour in frequency and the sinusoidal shape, since the

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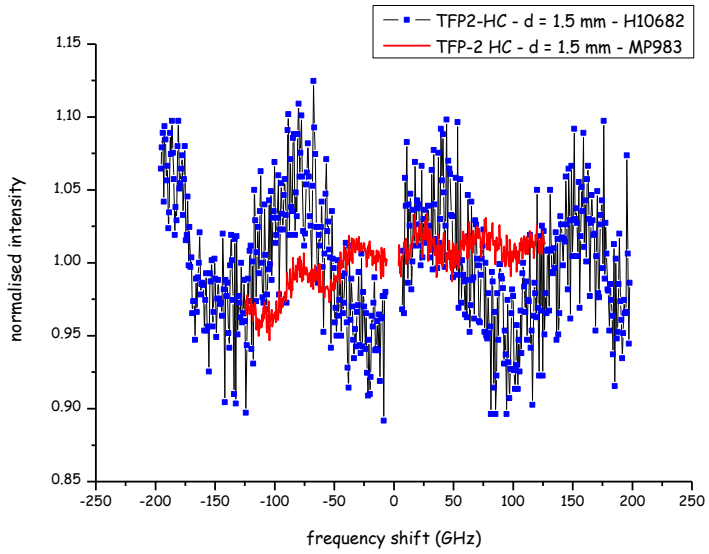
detector envelope would behave like a poor quality etalon plate. In the second case the effect of the strongly convergent light falling on D2 was to average the modulation to zero.

A second series of measurements was made by reproducing the phenomenon on a JRS TFP-2 HC spectrometer, i.e. a device equipped with a completely different optical layout, optimised for high contrast spectroscopic measurements.

Despite the strong instrumental differences, the same effect with comparable parameters was observed when D1 was installed in this spectrometer. When a Perkin Elmer MP983 detector (D3) was used to replace D1, an oscillation with shorter period and smaller intensity was measured. Both these measurements are plotted in Figure 2.

Figure 2 : different kinds of oscillations measured on a TFP-2 HC, using two different detectors (D1 and D3)



These observations all play in favour of the idea that this effect is introduced by the detector. If this was the correct explanation, the oscillation would be maximum if the light falling on the detector were parallel.

In both the spectrometer models, the output light is bundled into a cone of aperture about f/22; by placing a paper mask in front of the final lens the aperture was reduced to about f/80 and the following spectrum (Figure 3) was obtained. The oscillation is here considerably stronger, as expected.

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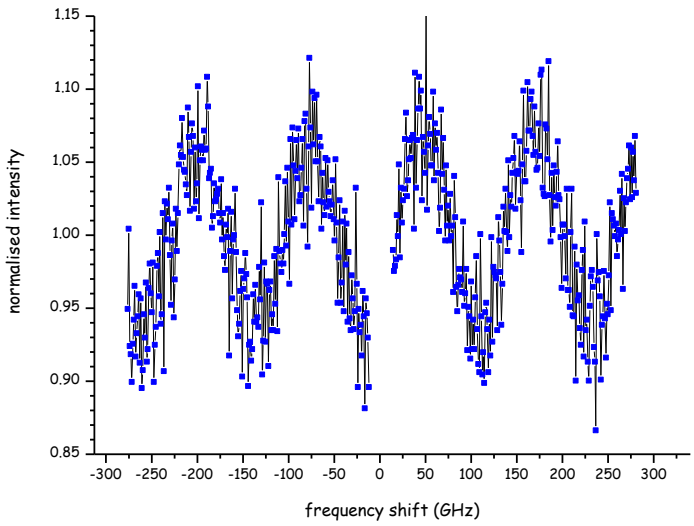
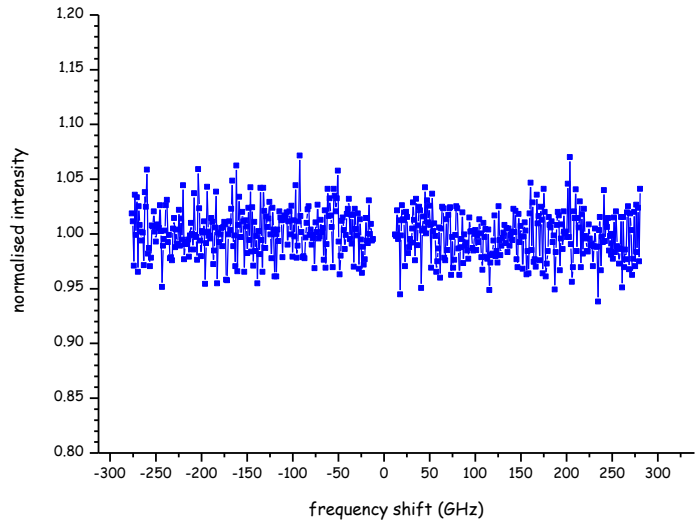
Figure 3 : strong oscillation, obtained by reducing the output aperture of the spectrometer



With this mask still in position, a 3 mm diameter ball lens was placed directly next to the detector (D1 was used for all the measurements) so that the light was strongly convergent on the photocathode. Figure 4 shows that the modulation is then no longer visible.

Figure 4 : spectrum obtained with reduced output aperture, and using a 3 mm ball lens as light concentrator before D1



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Conclusion:

Our conclusion is that in the above measurements the reflections within the glass envelope of the detector caused the observed modulation, probably due to a particularly good parallelism and alignment of its faces. This effect is small in intensity and the period of the oscillation is relatively large, so that the phenomenon was reported only on a very small fraction of the devices. Any other glass plate placed in the path of the light passing through the interferometer could cause a similar effect.

In order to reduce any possible modulation in the transmission function of the spectrometer, care should be taken to fill completely the input f/18 aperture of the spectrometer so that the light falling on the detector is as convergent as possible. If a small effect is still seen, it can be eliminated using a ball lens, or a small short focus lens, immediately before the detector.