A MODIFIED INTERFERNNETRIC METHOD OF SPECTROSCOPY

By

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Introduction :

An interferometer is used in a modified form in which one of the plates is oscilated by a mechanical vibrator through a distance of the order of a half wavelegth. Although a Fabry-Perot interferometer is used which is known to produce circular rings ; yet multiple beam Fizeau fringes were employed which proved to have many advantages over the Fabry-Perot interferomenter.

A parallel beam falls at normal incidence onto the interferometer, bahind which is a collecting lens. At the focus of this a photomultiplier tube. When the plate of the interferometer is oscillated leads to variations of intensity and therefore of output signal from the photo-multiplier. The current from this is ultimatly displayed on an oscilloscope and this then displayes any structure in the light source.

Optical Advantages :

Now the system we use here uses fringes of equal thickness. For normal incidence; cos Θ is unity in the common formula ($n\lambda = 2t \cos\Theta$), (t) now varies sinusoidally from t to $t \pm N\lambda/2$. N need only lie between 1 & 2,, its actual value is not important and the system in this way is essentially a linear wavelegth filter. For one wavelength (λ) the intensity variation transmitted as (t) changes to $t \pm \lambda/2$, goes precisely through the familiar Airy distribution, i-e the ideal fringe shape of the corresponding Fabry-Perot system.

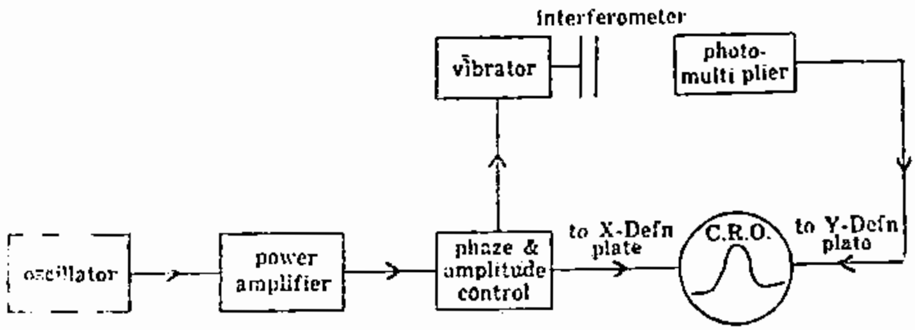
If we have two wavelegths λ & $\lambda + d$, then we get the corresponding displacement in the oscilloscope pattern and structure is revealed.

A stricking advantage of this new system is that there is a linear dispersion within the fringe pattern. As long as the oscillation is sufficiently closely sinusoidal the fringe pattern is linear. We have then the possibility of very accurate measurement of wavelegth differences. Also the display here of the real intensities as recorded by the photo-multiplier is by itself an enormous step forward beyond classical photographic microdensity measurements for intesities.

Furtheremore, a smal local region of the source can be under examination at any time and the whole source image can be in fact be scanned, across the first aperture. Thus local changes are more easily detectable. Furthere, the use of a small aperture at the focus of the collimator lens entirely eliminates seconday images (Tolansky ref. 1).

Apparatus :

The electrically excited mechanicalvibrator is excited at certain frequency say 100 cycles/sec. from an oscillator. A fraction of the oscillator voltage is taken off and used as the X-deflection of an oscill-ograph. The photo-multiplier response is used as the Y-deflection. The interfermmeter has one fixed and one moving plate. The moving plate is mounted on a brass tube and moves parallel to itself on four stiff phosphor bronze strip springs. The mechanical vibrator is attached to the moving plate to start oscillation. Fig. 1 is a block diagram of this apparatus.



Experimental results :

According to the amplitude of vibration, we can alter at will the number of orders of interference in the field of view, and hence the dispersion.

Fig. 2 shows one order using increased dispersion in which the hyperfine structure in the source (for this gap and for the green Hg line 5461 A) is excellently shown up. While in Fig. 3, two orders are shown using 2.5 mm gap and an admirable intensity distribution is secured. The oscilloscope trace is bright and the photograph is re-corded in a fraction of a second. Also some weak components are recorded. The two peaks have the same intensity i-e linear intensity system, are preicted and it will be remembered that the hyperfine structure components are also space linearly.

Fig. 4 shows one order again with the vertical amplification of the oscilloscope increased to reveal more clearly the weak componts.

Fig. 5 shows a Zeeman splitting in a D.c. Cg lamp produced with a field of 2200 oersteds and the clear-cut resolution is still well shown. The Zeeman Splitting produced with a field of 4500 oersteds is shown in fig. 7. It is of course self evident that with intensity distributions of this quality the justifiable resolution exceeds the Rayleight, for a dip of much less than 20% in the saddle is readily accepted.

It is to be noted that our system is readily adaptable to an interferometer with a spectograph and with decided advantage too. It is only necessary to place the receiving photo-multiplier tube at the camera (plate) end of the spectrograph and we then use the whole slit as the source of light. It is not necessary to scan a narrow, horizontal slit mechanically across the length of the line, as would be the case if circular Fabry-perot fringes are being examined.

Since the photo-multiplier intigrates over the slit length, intensity conditions do not suffer appreciably from the use of a small point source for Fizeau Fringes.

Indeed it is clear that intrinsic brilliance does not suffer. Slow scanners have been proposed by jeff (ref. 2 using slowly rotating the interferometer.

References :

1. Tolansly, S., High Resolution Spectroscopy, Methuen, London, 1937.

2. Jaffe, J,H., les Progrés Recéntsen Spéctroscopie interferantielle, C.N.R.S. Paris 1958 Page 89.

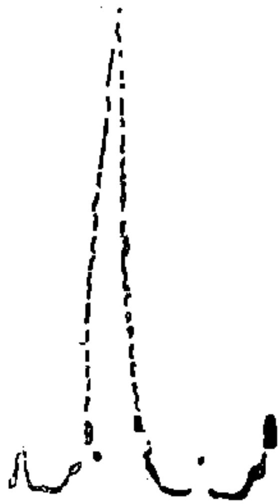


Fig. 2. Hg. 5461A, 1 irder.

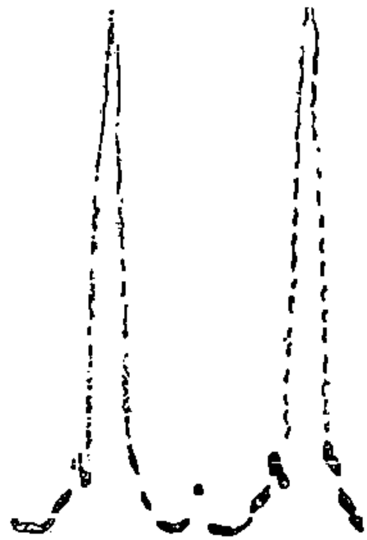


Fig. 3. Hg. 5461A, 2 orders.

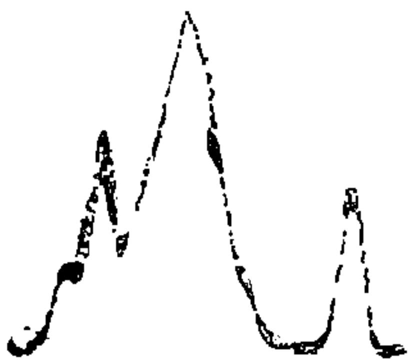


Fig. 4. Amplified hyperfine structure.

Fig. 5. Zeeman splitting 1,200 oersteds.

Fig. 6. Zeeman splitting 1,500 results.

Fig. 7. Zeeman splitting 4,500 oersteds.