Use of Michelson Interferometer for FT-IR

Report

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Use of Michelson Interferometer for FT-IR

Principle

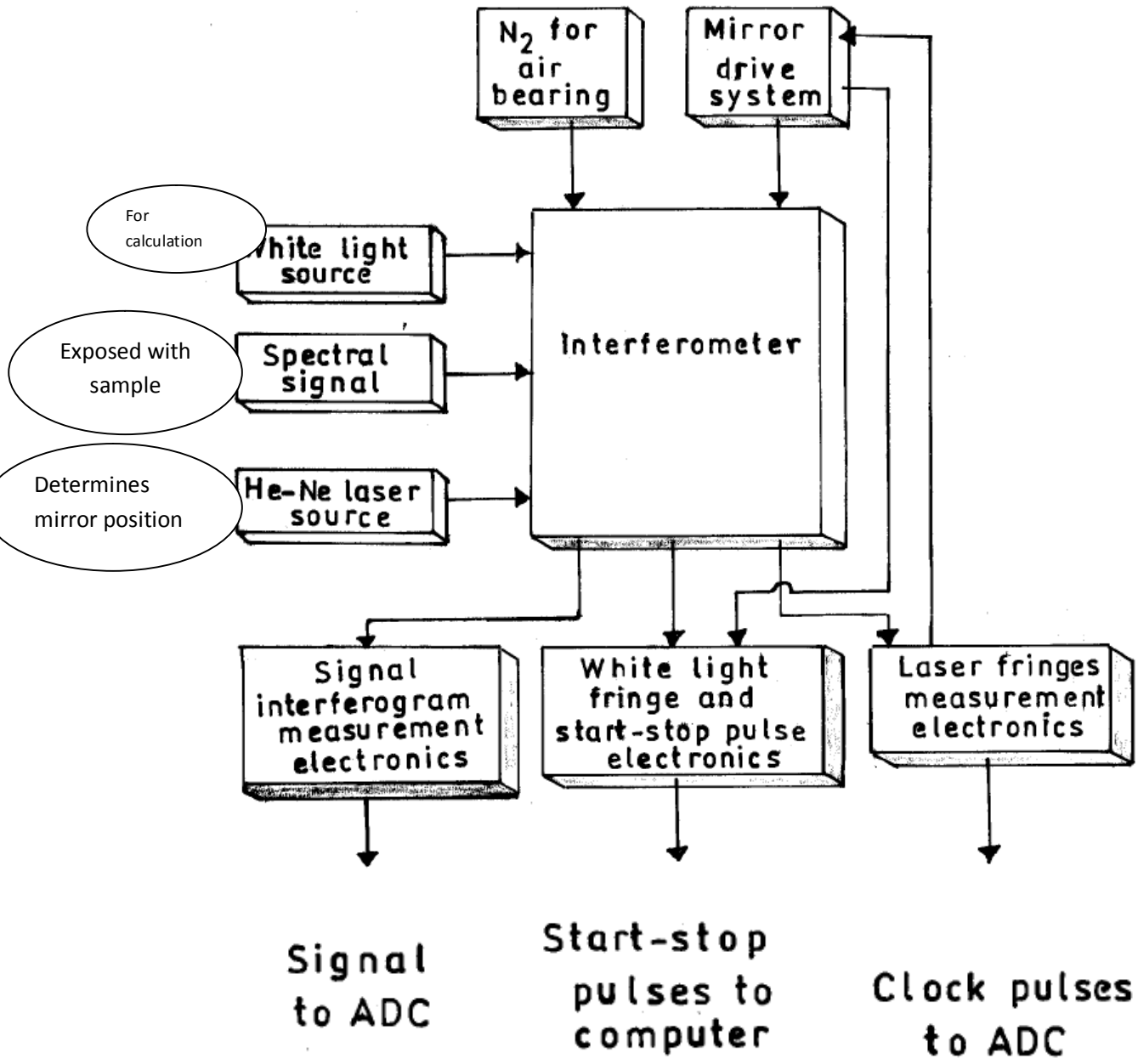
The basic principle involved in this approach can be given in the following way:

- Each molecule absorbs a particular wavelength of the whole spectrum.
- Sun can be considered as an IR source for the earth. Earth radiates back IR rays to the instrument.
- The IR rays which the instrument receives, have passed through the atmosphere, i.e. they are exposed to the gases in the atmosphere.
- Each molecule leaves a unique spectral signature on the rays. It absorbs a wavelength characteristic to the molecule.
- By studying the spectral signal obtained, we can have a qualitative analysis about the gases present in the atmosphere.
- We can also have a quantitative analysis by studying how much absorption has occurred for the particular wavelength. This can give us the concentration of the gas in the atmosphere.

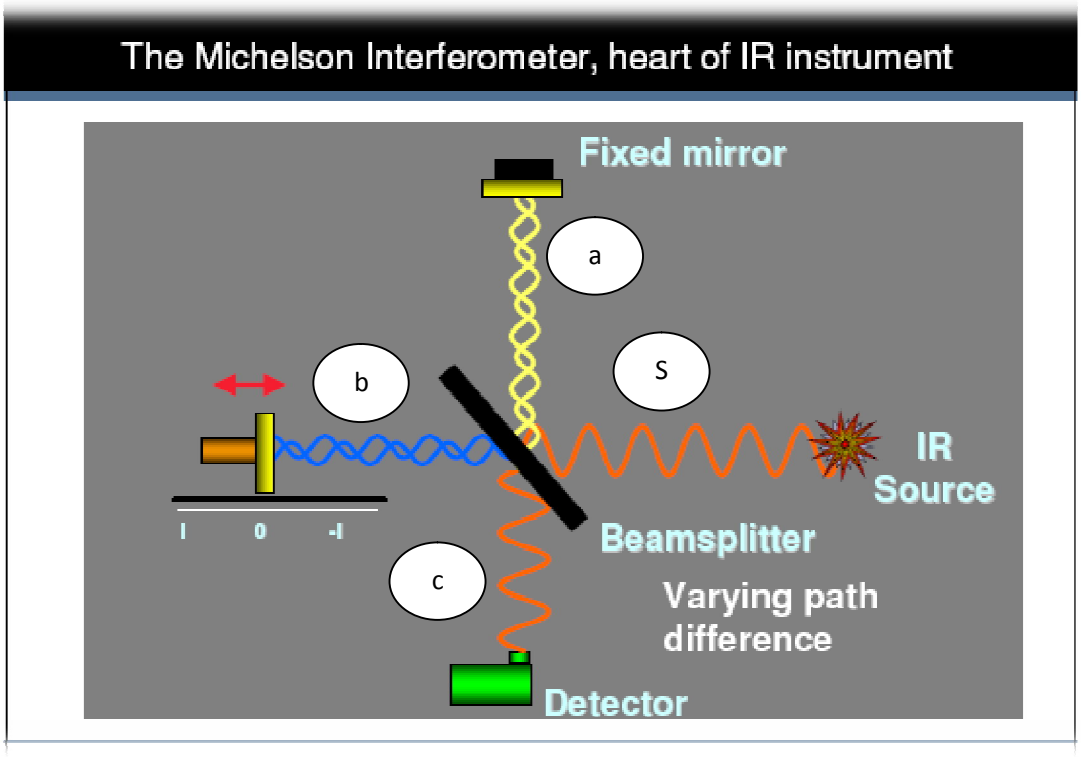
Working

- Infrared Rays from the sun cause heating of the earth's surface.
- Earth also then radiates back energy towards the outer space.
- Some part of the energy radiated back from the earth is reflected towards the earth itself by the greenhouse gases.
- Rest of the energy, in the form of IR Rays goes towards outer space. The interferometer also receives these as a source signal.
- The interferometer is fed with three signals: source signal(in our case, it will be already exposed to sample), white light(needed for calibration of the instrument), He-Ne laser(used for determining mirror position: since He-Ne laser has a very standard interferogram).

Basic Block Diagram



Details about Michelson Interferometer



1. The basic idea involved is that we create interference pattern using the IR rays from the source.
2. The signal (S) received from IR source passes through a beamsplitter which causes the beam to split into two perpendicular paths—(a) and (b).
3. Beam (a) goes to fixed mirror and is reflected back, similarly for Beam (b) which is reflected from a moving mirror; these again traverse through the beamsplitter, hence of the total entered energy, 50% is received by the detector and 50% goes back towards the source.
4. Purpose of moving mirror:: It creates path difference for desirable interference.
5. Therefore detector gets a signal in the form of a intereferogram. This signal allows us to study the absorption as a function of path difference.
6. The signal is sent to an Analog to Digital Converter and further calculations can be performed by a computer.
7. When a Fast Fourier Transform is applied to the above signal, we can analyse the absorption as a function of the wavenumber and hence the wavelength as well.

Advantages

- We use beamsplitter instead of grating method so, we do not have to study each wavelength one by one. Instead, we get an interferogram of the whole spectrum i.e. all the frequencies can be taken into account simultaneously.
- The actual process of generating interferogram and comparing it for absent wavelengths is done in a relatively short period of time. Hence this is more accurate over a specific region of earth as the sample does not change.
- The instruments on the whole are more sensitive and give higher optical throughput.

Conclusion(s)

- FT-IR instruments have many advatages over other methods, enabling more accurate observations and that too at a faster rate.
- He-Ne laser is used for internal calibration of the instrument. So no need for further calibration.
- We are interested in the application of the instrument as a payload for our satellite. Though these techniques have been previously used for observing Atmospheric Pollution and also Study of Planetary Atmosphere, we are yet to find out how these cases differ from the laboratory use; i.e. what all factors come into play when the rays are already exposed to the sample.