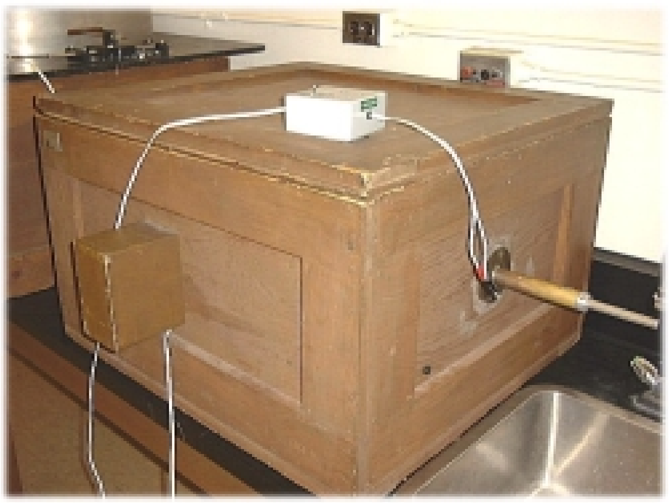
# THE ACOUSTIC INTERFEROMETER

## REFERENCES

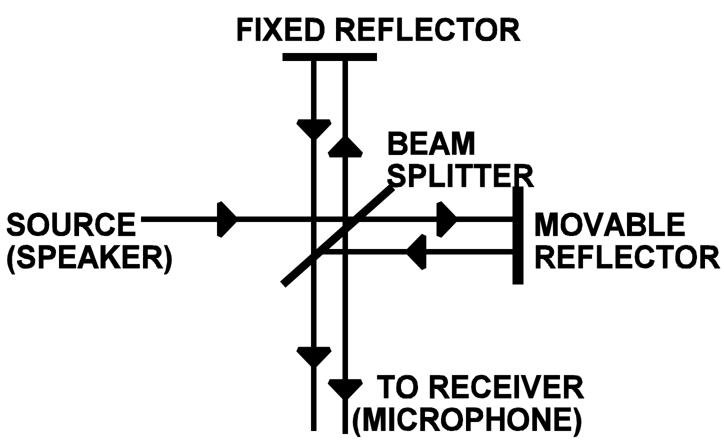
Reference to the theory of Michelson-type interferometers may be found in almost any standard text on optics (*e.g.*, Sears-Optics).

Chapter "Commonly Used Instruments" on *The Oscilloscope* of this Lab Manual

## THE EXPERIMENT



The apparatus is the acoustic analogue of the Michelson optical interferometer. In our case, the beam splitter is a sheet of paper. The source is a "tweeter" (loud speaker) driven by an oscillator; it has a range from ~ 3 kHz to 10 kHz. Each time the movable reflector is displaced through ½λ, so that the path length changes by λ, the interference in the recombined beam going to the receiver is the same.



Thus locating the points of minimum signal allows a measurement of $\lambda$, and hence the velocity of sound in air. At the lowest frequencies detectable some second harmonic is observed. This should be disregarded.

A simple way to locate the minima in the received signal is to make a plot of the amplitude of this signal as a function of the position of the moveable reflector. The frequency of the acoustic waves can be measured to great precision using a frequency counter (available at the **R**esource **C**entre). The velocity of sound in air can be determined to about 1% at the lower frequencies. Some second harmonics may be detected, but should be disregarded and will not interfere with the experiment.

The velocity of sound in a gas is given by $V = \sqrt{\frac{\gamma RT}{M}}$ where $R$ is the gas constant,

$T$ the absolute temperature, and $\gamma$ is the ratio $\frac{C_p}{C_v}$ where $C_p$ is the specific heat of the gas at

constant pressure, and $C_v$ is its specific heat at constant volume. $M$ is the molecular weight.

Theoretical values of $\gamma$ are:

- For a monatomic gas, $\frac{5}{3}$ ;
- For a diatomic gas of freely rotating molecules, $\frac{7}{5}$ ;
- For a diatomic gas of rotating and vibrating molecules, $\frac{9}{7}$ .

Deduce what you can from experimental results remembering that air is approximately 21% $O_2$, and 77% $N_2$, the rest being 0.9% each of argon and water vapour, and traces of carbon dioxide and the other inert gases. Determine the effective value of $\frac{\gamma}{M}$ for air.