

ULTRASONIC VELOCITY AND ABSORPTION MEASUREMENTS IN POLYMER SOLUTIONS

S. BHAGAVANTAM AND G. SIVARAMA SASTRY

Physical Laboratories, Osmania University, Hyderabad

ULTRASONIC velocity in solutions of *monomers* (vinyl acetate, methyl methacrylate and styrene) in benzene shows a linear variation with concentration in the range of concentrations studied (0-10% by volume), while the absorption decreases rapidly from that of pure benzene as more of the monomer is dissolved but in a normal and steady manner. On the other hand, solutions of *fractionated polymers* in benzene show the peculiar and hitherto undiscovered phenomenon of rapid fluctuations both in velocity and absorption from the values appropriate to pure benzene, as the concentration is varied. This new result first obtained by us in the case of polyvinyl acetate was later found to exist in the cases of polymethyl methacrylate and polystyrene also.

The variation of velocity and (α/f^2) where α is the absorption coefficient, with concentration is plotted for one fractionated polyvinyl acetate sample in Fig. 1. The 'wobbling' of

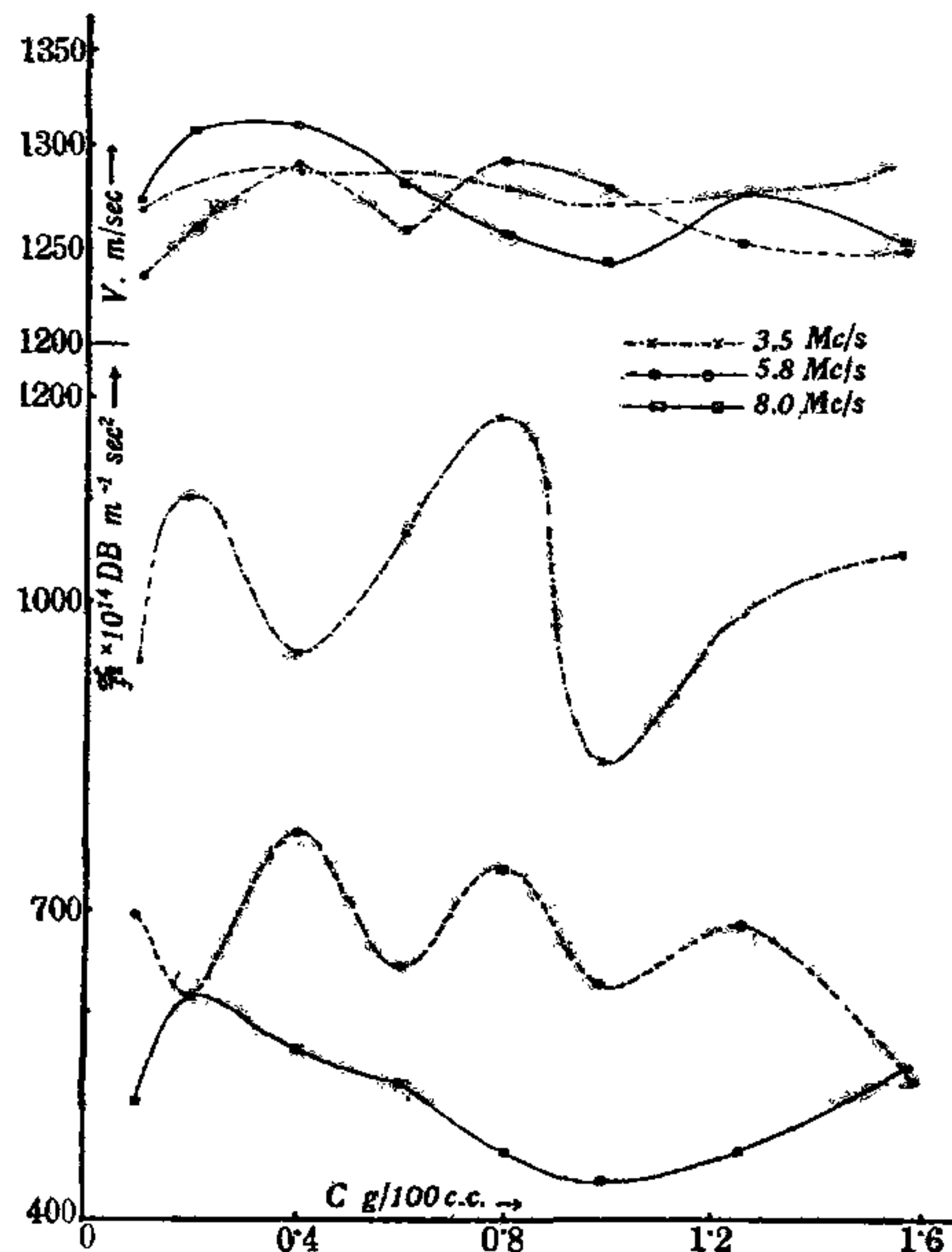


FIG. 1

these factors with concentration is most striking and appears to result from the presence

of a number of relaxation frequencies characteristic of the polymer molecule.

Fig. 2 shows the plot of $\alpha\lambda$ (absorption per wavelength) against the frequency, for one

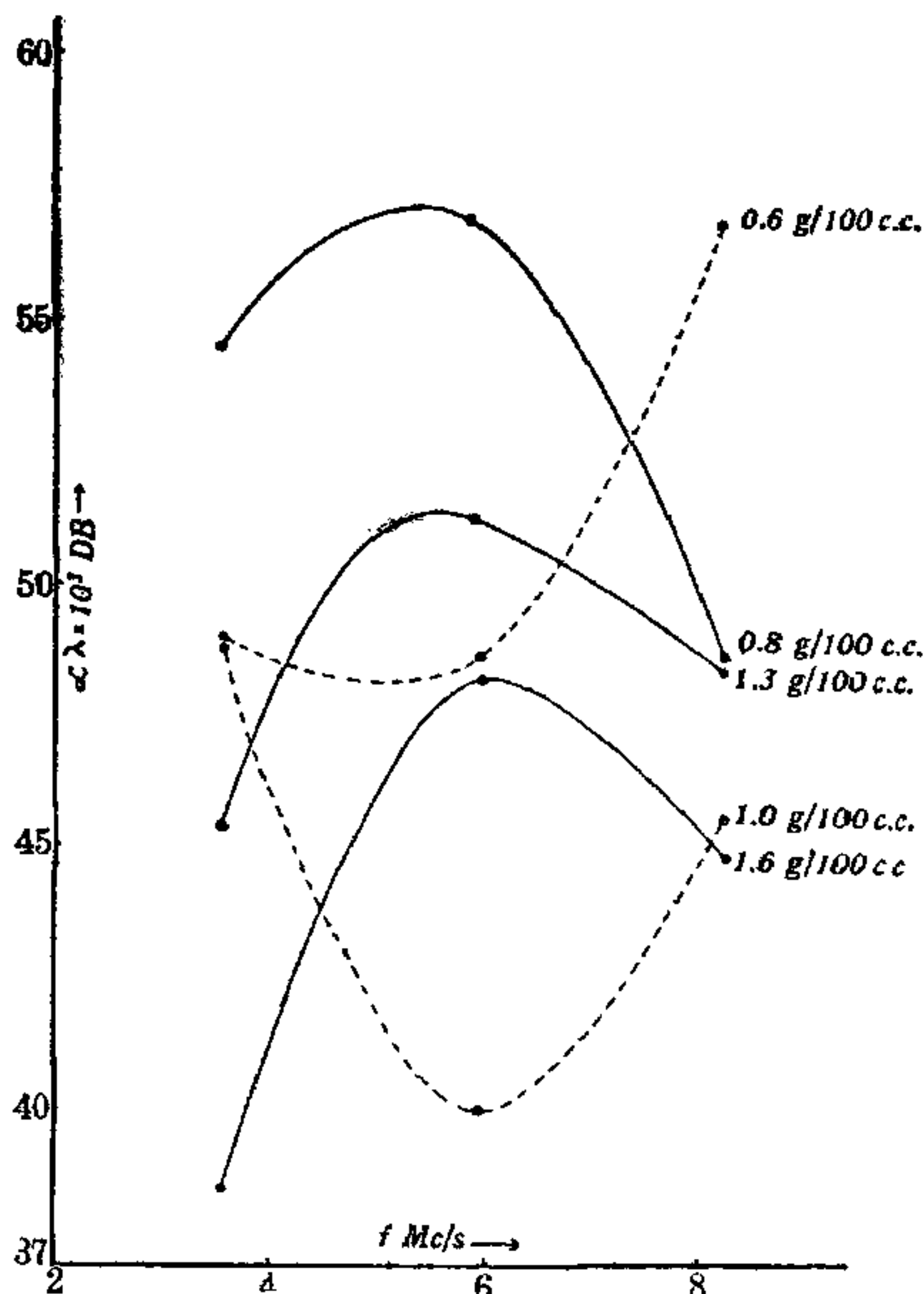


FIG. 2

fraction of polyvinyl acetate as an illustration. Each curve in the graph represents the values for a particular concentration of the solution mentioned alongside the curve. In the range of frequencies studied, there is a frequency at which the maximum for $\alpha\lambda$ is occurring for some concentrations of the solution, while for some others a minimum absorption is observed. The frequency showing the maximum absorption is not the same for all concentrations and is found to vary in an irregular fashion. Fig. 3 shows the variation of velocity with frequency and as in Fig. 2 each curve represents a particular concentration. This graph shows that the velocity is not constant with frequency and also that its variation is erratic. The above results observed in the case of all the different polymer fractions, indicate the presence of

multiple relaxation frequencies. The minima observed for some concentrations in Fig. 2 can only be explained as due to the presence of

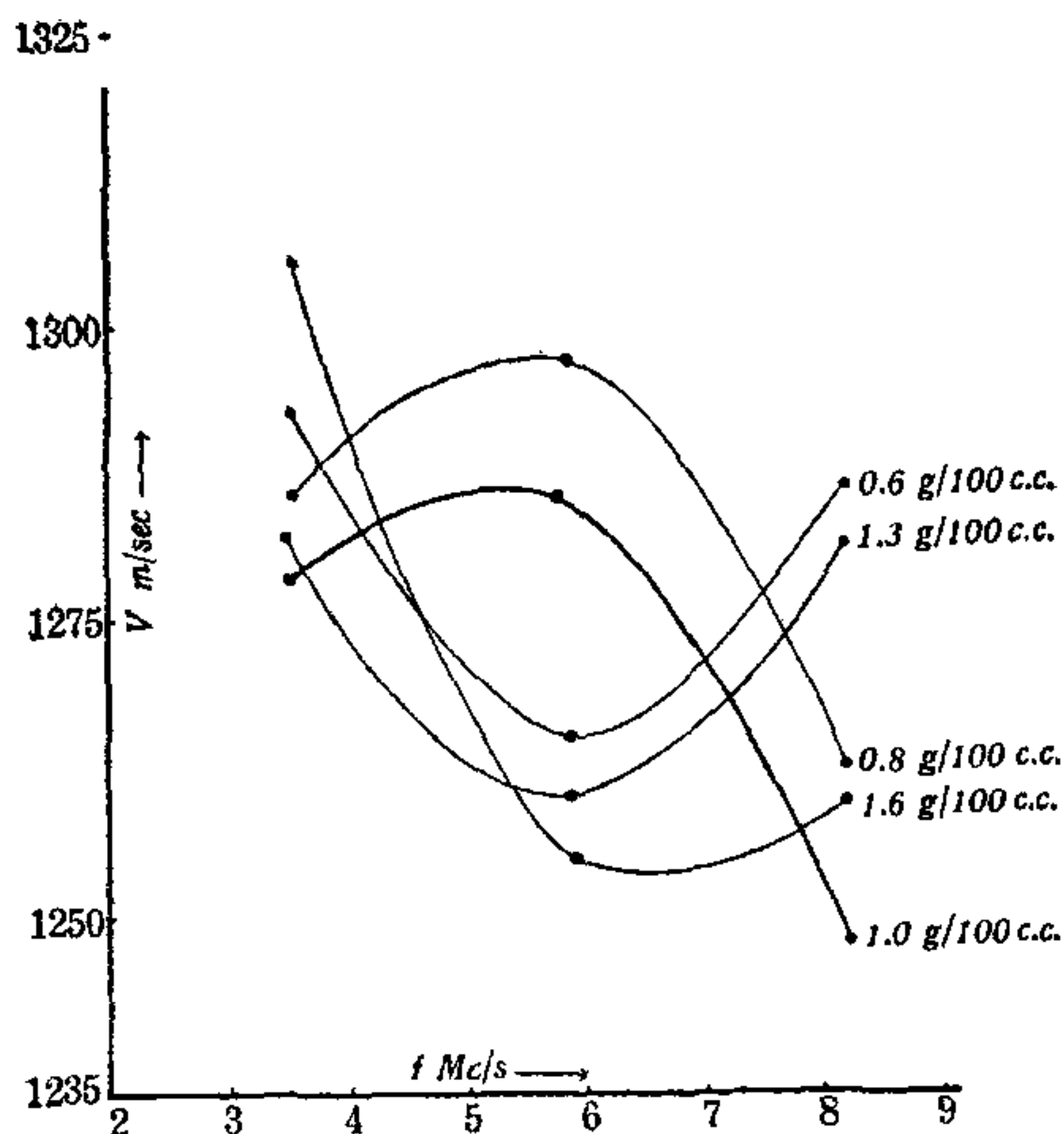


FIG. 3

at least two relaxation frequencies situated very close to each other and on either side of the minimum.

The above phenomena are however, found to be absent when *unfractionated commercial samples* of polystyrene and polymethyl methacrylate are dissolved in benzene. This is in conformity with the result obtained in polymer fractions, namely, that the peaks and depressions occur in such a closely spaced manner for the different fractions of the same polymer. They are apparently cancelled out by superposition in an unfractionated sample.

Moreover, we have found that unlike benzene which is a good solvent, if a poor solvent like ethyl methyl ketone is chosen and measurements are made on a fraction of each of the above polymers these phenomena are not exhibited at all. This has to be attributed to the lack of freedom to the polymer molecule in a poor solvent to assume different configurations as it is then in a completely coiled state, thereby all the relaxation effects having been suppressed.

The temperature during the course of each of the above experiments has been held constant to within $\pm 0.5^\circ \text{C}$.

THERMONUCLEAR EXPLOSIONS AND THE WEATHER

THE poor weather experienced in the British Isles and generally in Western Europe in the summer of 1954 came soon after the announcement by the United States Atomic Energy Commission that a series of thermonuclear explosions had taken place in the Pacific. Perhaps not unnaturally, this coincidence caused speculation (unfortunately, often ill-formed and emotional) on the possibility of 'cause and effect'. An attempt has been made by Sutton (*Nature*, 1955, 175, 319) to examine objectively if any grounds exist for suspecting a unique relationship between the man-made disturbances over the Pacific and the weather of mid-1954 in other parts of the world.

Such an investigation is difficult for a variety of reasons. Weather is the first order perturbation of climate and since the weather of 1954 did not exhibit in the British Isles, any features that cannot be paralleled and even exceeded in past years, it follows that any effects attributable to the explosions must be of magnitude not exceeding that of ordinary weather-producing influences. The detection of such additional effects, therefore, demands careful

statistical analysis that cannot properly be attempted until several years have elapsed, so that existing climatic 'trends' can be recognized and eliminated. An equally serious difficulty is that, so far, it is not known with certainty how many thermonuclear explosions occurred in 1954, or when and where they all occurred. From press reports it is possible to make what is thought to be a reasonable estimate of the order of magnitude of the energy release in the largest of the Pacific explosions; but almost all other details are lacking.

After examining the evidence from meteorological records, Sutton concludes that both the climatological and aerological evidence are unfavourable to the suggestion that thermonuclear explosions, so far as they are known to have occurred, ruined what might otherwise have been a fine summer. The weather experienced in the British Isles was well within the established climatic range, and taking all facts into account, it is evident that it would be exceedingly difficult, if not impossible, to establish a 'cause and effect' sequence on purely meteorological grounds. What evidence exists points, in fact, to the opposite conclusion.