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Experiments on the stability of supersonic laminar boundary layers

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The present paper reports an experimental study of the development of plane monochromatic waves in the boundary layer on a flat plate at Mach number $M = 2.0$. The wave characteristics of the plane waves are obtained. Three-dimensional disturbances with an angle of the wave vector to the flow $\chi = 50$–$70°$ are found to be the most unstable. It is shown that the disturbances, consisting of vortical and compressible modes, are engendered in a supersonic boundary layer by a local source of artificial disturbances. It is found that an increase in the bluntness of the leading edge of a plate stabilizes three-dimensional disturbances of a vortical mode.

1. Introduction

For a number of applications it is important to know the location of the laminar–turbulent transition. At present it is generally recognized that the onset of turbulence is connected with the loss of stability of the initial laminar flow. Successful development of the stability theory of compressible flows, the formulation of new problems (Mack 1969; Gaponov & Maslov 1980; Zhigulev & Tumin 1987; Erlebacher & Hussaini 1987), has stimulated experiments. This applies to the study of wave processes in the region before the laminar–turbulent transition. In this connection the comparison of the results of calculation and experiment is of special interest (Reshotko 1975; Maslov 1985).

The wave processes in the boundary layer at $M > 1$ are known to be more varied than at $M < 1$; their wave structure is more complex (subsonic, supersonic disturbances, etc.). At present, the development of natural disturbances has been extensively studied experimentally (Laufer & Vrebalovich 1960; Kendall 1975; Lysenko & Maslov 1984). However, the studies on the stability of natural disturbances at supersonic speeds cannot help in answering a number of important questions, the first of which is how plane waves develop in the boundary layer. Modelling wave processes using controllable artificial disturbances allows one to study the development of eigenwaves. This has been successfully applied to studying the stability of incompressible flows (Kachanov, Koslov & Levchenko 1982). However, experiments by Laufer & Vrebalovich (1960), Demetriades (1960), Kendall (1967) have exposed the difficulties that arise when studying the stability of supersonic and hypersonic boundary layers with the help of artificial disturbances. They failed to study the development of the two-dimensional wave of the first mode ($\chi = 0°$) in a boundary layer, and the results obtained by Kendall at $M = 4.5$ for the first-mode disturbances ($\chi = 55°$) and for the second mode ($\chi = 0°$) are unique. Thus, only the results obtained by Kendall can be regarded as successful, and up to now many conclusions of the linear stability theory of supersonic boundary layers have not been verified experimentally.

Achievements in studying the development of plane monochromatic waves in a subsonic boundary layer are substantial and universally recognized. The experiments on the development of spatial wave packets in a boundary layer excited by a local harmonic source can be considered as a recent success (Kachanov 1985).

The first results obtained in this direction for supersonic flows were presented at the IUTAM Symposium in Novosibirsk (Kosinov & Maslov 1985). The results of the experiments confirmed the conclusions of the theory of hydrodynamic stability. The theoretical analysis of these data has been executed by Zhigulev & Tumin (1987). However, the behaviour of artificial disturbances with angles of propagation $\chi < 30°$ has remained obscure. In experimental disturbance–amplification curves a scattering of points, resembling a modulation, was observed.

The experiments described in this paper are devoted mainly to the study of reasons for this phenomenon. Moreover, the first results of an experimental study of the influence of flat-plate leading-edge bluntness on the development of three-dimensional waves in a supersonic boundary layer are presented. The influence of bluntness on the disturbances in the boundary layer is very important for applications, but it has not been sufficiently studied: there appears to be only one relevant theoretical work, that of Reshotko & Khan (1979), for two-dimensional disturbances. Experimentally, it has only been studied with respect to the development of natural disturbances (Lebiga, Maslov & Pridanov 1979).

2. Experimental equipment

The experiments were performed in the supersonic wind tunnel T-325 of the Institute of Theoretical and Applied Mechanics of the Siberian Division of the USSR Academy of Sciences, with test section dimensions 200 × 200 mm, at Mach number $M = 2.0$ and unit Reynolds number $Re_1 = (6.5 \pm 0.2) \times 10^6\ \mathrm{m}^{-1}$. The measurements were carried out in the boundary layer of a flat steel plate the leading edge of which was bevelled at an angle of 14.5°. The plate thickness was 10 mm, width 200 mm, and length 450 mm. The leading-edge thickness was $b = (0.02–0.35)$ mm. The model was fixed horizontally in the central plane of the wind tunnel test section at zero angle of attack.

An electric discharge taking place inside the model was used as a source of artificial disturbances (figure 1). The hole diameter was 0.5 mm. The source coordinates were $x = 18$ mm, $z = 0$, where x is the streamwise coordinate, z is the transverse coordinate. The discharge was ignited periodically with frequencies $f = 10$, 20, 30 kHz. The power of the source was regulated smoothly by the voltage fed to the electrodes.

The disturbances in the flow were measured with a constant-current hot-wire anemometer. Probes of gilded tungsten wire, 6 µm in diameter and 1.2 ± 0.1 mm long, were employed. The probe moved in the three coordinates x, y, z, and the measurement accuracy in the x- and z-coordinates was to within 0.1 mm.

A selective amplifier was used as a frequency filter. The amplitude of disturbances within a band $\approx 1\%$ was recorded with a root-mean-square voltmeter. A two-channel oscillograph synchronized with the discharge was used to determine the phase of the signal under study with respect to the source of disturbances.

When the probe moved in the x- and z-directions, the voltage across the diagonal of the hot-wire anenometer bridge was maintained constant (this was achieved by moving the probe in the y-direction). In this case all the measurements were performed at the same velocity. The measurements were carried out with overheat

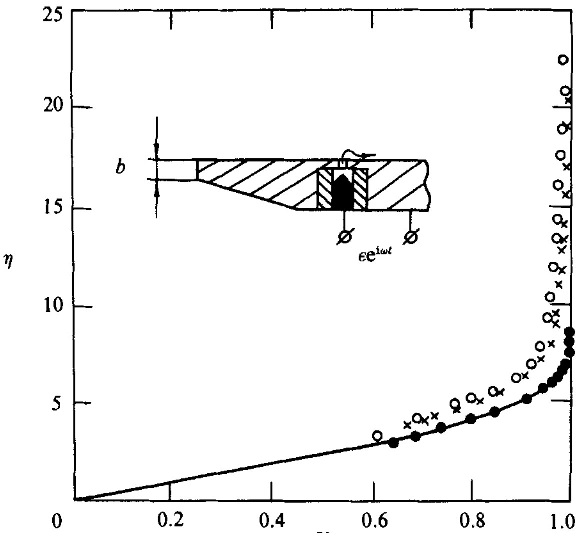

FIGURE 1. Schematic diagram of a source of disturbances and the mean velocity distribution across the boundary layer; $Re = 650$: ——, calculation for a sharp plate; experiment: ○, $b = 0.31$ mm; ×, 0.20; ●, 0.02.

of the probe wire to $a_w = 0.8$. Measurements performed by the method of Kovaznay (1953) diagrams have shown that for such overheating the hot-wire signal is determined by 90% of mass flow fluctuations.

The measurements were executed at $y/\delta = 0.5$–0.6, where δ is the boundary-layer thickness. The processing of the measurement results consisted in estimating the complex Fourier spectra (discrete Fourier transformation in the z-coordinate). The amplitude distributions of artificial disturbances in the z-direction took zero values at the ends of the interval (for $|z| > |z_0|$) which permitted one while integrating use finite limits,

$$\hat{P}(x,\beta) = \int_{-z_0}^{z_0} \hat{A}(x,z) \exp(-\mathrm{i}\beta z)\,\mathrm{d}z,$$

where $\hat{A}(x,z) = A(x,z)\exp[\mathrm{i}\Phi(x,z)]$, and $A(x,z)$, $\Phi(x,z)$ are the amplitude and the phase of artificial disturbances, respectively, β is the wavenumber in the z-direction.

Then, the amplitude and phase spectra in β are determined by the following expressions:

$$S_A = \mathrm{mod}\,[\hat{P}(x,\beta)],$$
$$S_P = \arg\,[\hat{P}(x,\beta)].$$

It is necessary to make use of special weighting functions (spectral windows) in order to determine the Fourier spectrum of the discretely prescribed function, if only a part of the distribution is known (Harris 1978). In this case it becomes possible to give an estimate of the distribution spectrum close to the real one.

The α_r-spectra are obtained in a similar way in the present work (the Fourier transformation in the downstream x-coordinate). The Kaizer–Bessel spectral window has proved to be the most effective one for such a case (Harris 1978).

The angle of wave incidence relative to the main flow was determined via the formula $\chi = \arctan(\beta/\alpha_r)$, and the phase velocity of disturbances in the x-direction was found as $C_x = 2\pi f/(\alpha_r U_e)$, where f is the disturbance frequency.

The estimate of the amplification rates of the vortex mode of Tollmien–Schlichting waves (T–S waves) was obtained from the relationship

$$-\alpha_i(\beta, Re) = 0.5\frac{\partial \ln [S_A(Re,\beta)]}{\partial Re},$$

where $Re = (Re_1\, x)^{\frac{1}{2}}$ is a Reynolds number is based on the boundary-layer thickness and $S_A(Re,\beta)$ is the amplitude of the T–S wave.

3. Results

3.1. *Selection of initial disturbance intensity*

The main object of the work was to verify the conclusions of the linear theory of hydrodynamic stability, which is why the amplitude (A) of artificial disturbances must be as small as possible. At the same time it should be considerably greater than the amplitude (A_F) of the background disturbances. The measurements showed that for $A/A_F \leqslant 15$ and $Re \leqslant 1000$ the distributions of the amplitude $A(z)$ and spectra $S_A(\beta)$ of artificial disturbances are similar at $Re = \text{const}$, for different initial intensities, and the phase velocities and the amplification rates coincide. This testifies to the fact that the linear process, within the limits of experimental error, is being studied. The experiments described here were carried out at $A/A_F \approx 5$–8.

3.2. *Mean characteristics of the boundary layer*

The use of a source with a hole of diameter $d = 0.5$ mm did not result in any noticeable distortion of the mean flow characteristics of the boundary layer or in any change in the 'natural' background pulsations. The mean characteristics of the boundary layer were measured with a constant-current hot-wire anemometer. The mean velocity profiles were obtained after data processing. Figure 1 illustrates the mean velocity profiles in Blasius coordinates $\eta = y/x Re$.

The main measurements were taken at $400 < Re < 900$. Within this range of Reynolds numbers the η-coordinate is the self-similar coordinate only for velocity profiles on a plate with leading-edge bluntness $b = 0.02$ mm. A strong influence of the leading-edge bluntness on the boundary-layer thickness should be noted. A typical thickness of the boundary layer for the parameters studied is about 1 mm.

3.3. *Analysis of experimental results on the development of spatial wave packets*

Figure 2 shows dependence of the amplitude and the phase of artificial disturbances, for $F = 0.38 \times 10^{-4}$, on the streamwise x-coordinate and the transverse z-coordinate. Here $F = 2\pi f/(Re_1\, U_e)$ is a dimensionless frequency parameter. It is an integral characteristic of the spatial wave packet evolution.

All the other results were obtained after spectral processing of data represented in figure 2, and other similar measurements.

Figure 3 shows a general picture of the amplitude and phase β-spectra evolution. For the amplitude β-spectra with the growth of x there was a growth of wave amplitude with $\beta = 1$ rad/mm and a decrease of the spectral width of the β wave packet. In the integral characteristic the spreading of the wave packet in z corresponds to this fact. The phase β-spectra are indicative first of the fact that the waves with $\beta \approx 0.6$–0.7 rad/mm leave the rest of the waves behind.

It follows from the results presented that the extent in the transverse coordinate is limited, and its β-spectrum is continuous. In the experiment, the measurement

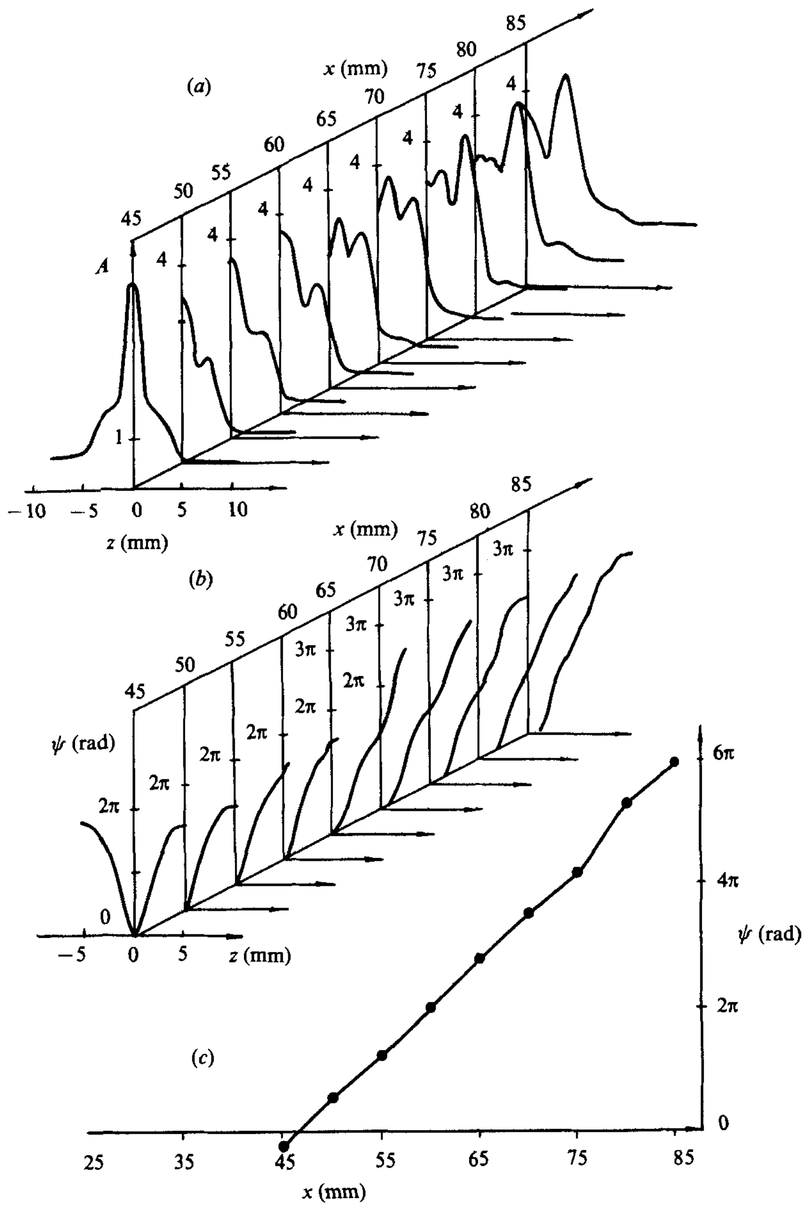

FIGURE 2. Examples of (*a*) the amplitude and (*b*) phase distributions for several cross-sections in the x-direction. (*c*) The dependence of the phase $\psi(x, 0)$ in the centre of the packet upon the streamwise coordinate. $b = 0.02$ mm, $F = 0.38 \times 10^{-4}$ ($f = 20$ kHz).

range is limited also in the longitudinal x-coordinate, and thereby some information on the α_r-spectrum is lost. The region of linear development has physical boundaries. On the one hand, it is a source of disturbances, and on the other hand, it is a transition zone or a zone of essentially nonlinear processes. In a common case it is impossible to estimate the wave process spectrum if the range of measurements is limited (Kay & Marple 1981). It can be done, however, for disturbances developing in a supersonic boundary layer. According to the linear theory of stability, in the supersonic boundary layer the developing disturbances are composed of vortical and

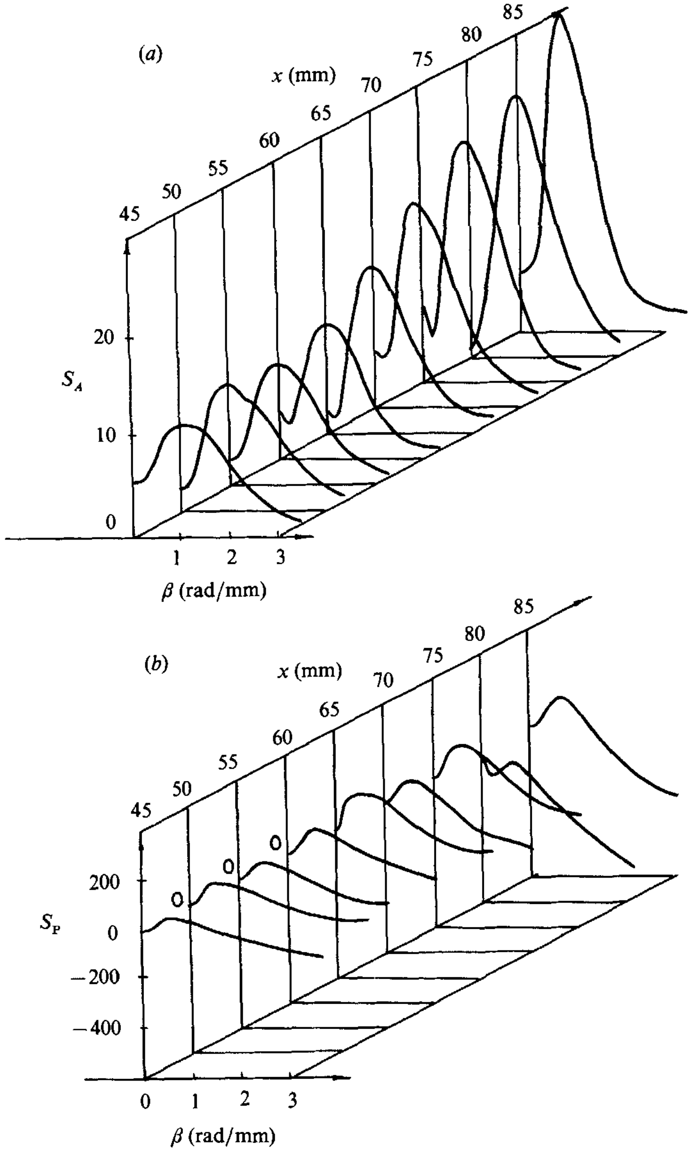

FIGURE 3. Examples of (a) the amplitude and (b) phase β-spectra. $b = 0.02$ mm, $F = 0.38 \times 10^{-4}$ ($f = 20$ kHz).

compressible modes. A vortical mode represents an analogue of the Tollmien–Schlichting waves well studied in incompressible flows. Their phase velocity is $C_x > C^*(C^* = 1 - 1/(M \cos\chi))$. Beyond the boundary layer a compressible mode corresponds to acoustic waves, for which $C_x < C^*$. Wavenumbers α_r are different for these modes. It is impossible to estimate the spectrum of such a wave process with the help of ordinary Fourier methods. However, the task is simplified if the contribution of the compressible mode to the total signal is negligibly small as compared to the vortical one. In particular, when only one plane wave develops in the x-direction (at $\beta =$ const) the limitation on the extent of measurements does not influence the results. In this case, the growth of the wave phase in x is linear, and the wavenumber can be determined from a simple estimate, $\alpha_r = \Delta\Phi/\Delta x$. The

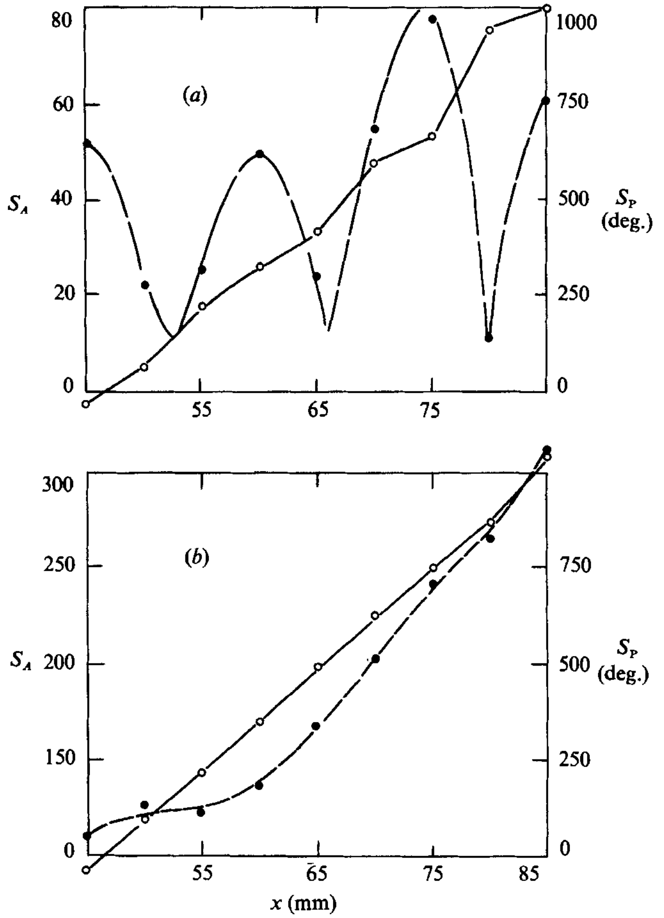

FIGURE 4. Curves of the amplitude (●) and phase (○) variation with the streamwise coordinate; $b = 0.02$ mm, $F = 0.38 \times 10^{-4}$. (a) $\beta = 0$, (b) $\beta = 0.99$ rad/mm, $\chi = 65°$.

dependencies $S_A(\beta)$ permit us to follow the evolution of the amplitude β-spectra in the downstream direction. A pair of wavenumbers (α_r, β) determines a plane wave in the boundary layer.

For the vortical mode, when β and f are fixed, the linear theory of stability predicts, first, a decrease of the amplitude at small *Re*, down to the lower branch of the neutral stability curve, and then a growth up to the upper branch, after which the decrease is observed again. The experiments show that such a pattern of wave amplitude changes is not observed for all β. Consider as an example figure 4. At $\beta = 0$ (figure 4a) it should be noted that the dependence of the wave amplitude on the x-coordinate is of a modulation character, and also that there are significant deviations from linearity in the growth of the disturbance phase. This is indicative of the superposition of several waves with different α_r. At $\beta = 0.99$ rad/mm (figure 4b) the amplitude modulation is hardly noticeable, and with increasing x the phase growth is practically linear, i.e. only one wave, with one $\alpha_r = \Delta\Phi/\Delta x$, is present. A general conclusion is to the effect that, beginning from some β (its value depends on the frequency f and *Re*), the amplitude modulation grows weaker or disappears completely, and the waves develop according to stability theory. It is necessary to carry out a wave analysis in x to understand the causes of modulation.

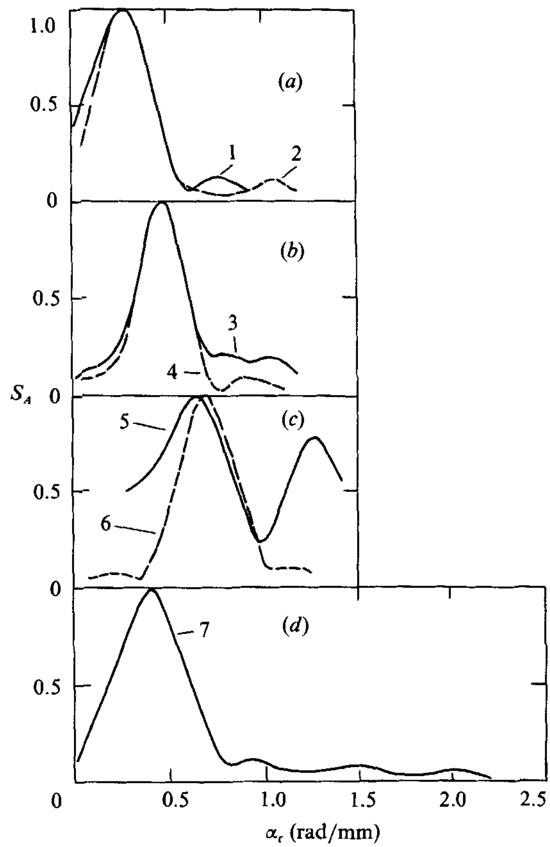

FIGURE 5. The amplitude α_r-spectra; $b = 0.04$ mm, $Re_1 = 6.5 \times 10^6$ m^{-1}: (*a*) $f = 10$ kHz; (*b, d*) $f =$ 20 kHz; (*c*) $f = 30$ kHz; curves 1, 3, 5, 7, $\beta = 0$; 2, $\beta = 0.67$ rad/mm; 4, $\beta = 0.84$ rad/mm; 6, $\beta =$ 0.58 rad/mm.

3.4. *Results of the wave spectral analysis in the longitudinal x-coordinate*

The results of the two-dimensional (in x and z) Fourier analysis of the experimental data for $F \times 10^{-4} = 0.19$; 0.38; 0.55 (10, 20, 30 kHz), $b = 0.04$ mm, as well as the results of processing of analogous experiments performed specially for specifying the wave structure of artificial disturbances, are presented in what follows. When calculating the Fourier integral, the integrand was multiplied by the Kaizer–Bessel spectral window to reduce the influence of jumps in the amplitude distributions.

The α_r-disturbance spectra are shown in figure 5. Curves 1, 2, 5, 6 are obtained by using seven points; 3, 4 by using nine points; and 7 by using 31 points. The maximal amplitude peaks correspond to a vortical mode in all the graphs. The other peaks correspond to the compressible mode disturbances (their phase velocity $C_x \leqslant 0.3$). Consider spectra 1–6. The spectral range of $\Delta\alpha_r$ is limited here by the step in x: $\Delta x = 5$ mm and $\Delta\alpha_r = 2\pi/\Delta x \approx 1.25$ rad/mm. The width of spectral peaks is determined mainly by the length of the realization along x (the spectral window parameters also have some influence). One can see that for $\beta = 0$, the portion associated with the compressible mode in the spectra increases with increase of frequency. If the transformation of disturbances from a source into the boundary-layer waves occurs identically for all the frequencies under study, then it is possible to establish the relationship between the value of an amplitude of the compressible mode and the

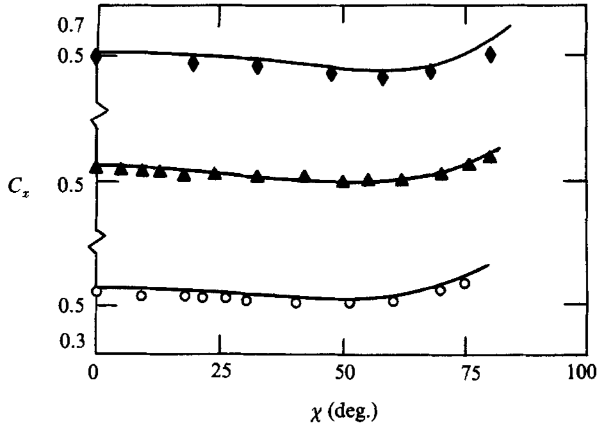

FIGURE 6. The phase velocities of disturbances: $b = 0.04$ mm; $Re = 653$; curves, theory; symbols, experiment (—, ◆, $F \times 10^4 = 0.188$; ----, ▲, 0.371; —·—·—, ○, 0.547).

character of the vortical mode development (for spectra in the vicinity of $\beta = 0$): near the lower branch of the neutral curve ($F = 0.188 \times 10^{-4}$) the vorticity mode intensity is larger, by an order of magnitude than the compressible one; in the region of maximal growth ($F = 0.371 \times 10^{-4}$) it is 5–6 times as large; near the upper branch of the neutral curve ($F = 0.547 \times 10^{-4}$) the vortical mode is 1.5–2 times larger than the compressible one. This testifies to the fact that the waves of the compressible mode grow faster than those of the vortical one at $\beta \approx 0$. In this connection, the reasons for the unsuccessful attempts of Laufer & Vrebalovich (1960) and Kendall (1967) to introduce a two-dimensional T–S wave ($\beta = 0$) into a boundary layer become clear. The large contribution of compressible mode disturbances at this angle of wave propagation did not permit them to follow the evolution of a T–S wave (with *Re*).

For α_r-spectra at $\beta \approx 0.3$–2 rad/mm (figures 2, 4, 6) the relationship between the compressible and vortical modes hardly changes; this means that both types of disturbance grow identically. These conclusions are in good agreement with results obtained by Maslov & Semionov (1987) which are indicative of the fact that the acoustic radiation by a supersonic boundary layer is concentrated in the neighbourhood of $\beta = 0$.

In figure 5(*a–c*) the spectral range is insufficient for a complete representation of the wave spectrum in a boundary layer: the region of measurements constitutes 5–6 T–S wavelengths. This puts a limitation on the minimal width of peaks and on their resolution by Fourier analysis. Figure 5(*d*) illustrates the amplitude of the α_r-spectrum obtained as a result of measuring at 31 points along x, using the smaller step $\Delta x = 1$ mm. It allows us to extend the α_r-spectral range by a factor five ($\Delta\alpha_r \approx$ 6 rad/mm). One can see a few practically equidistant peaks, $\alpha_r^{(n)} \approx n\alpha_r^{(1)}$. Of these the largest peak corresponds to the vortical mode, and the rest of peaks to the compressible ones.

Thus, the source employed in these experiments generates a wide-band disturbance spectrum. It is possible to say that the spectrum is discrete (within the accuracy of the measurements taken). A vortical mode and some compressible ones are excited. The discretization in the x-coordinate imposes restrictions upon the interpretation of spectra: there is no unique answer as to whether there are waves travelling upstream.

The spectrum shown in figure 5(*d*) allows us to outline clearly enough the wave structure of disturbances developing in a supersonic boundary layer. In this

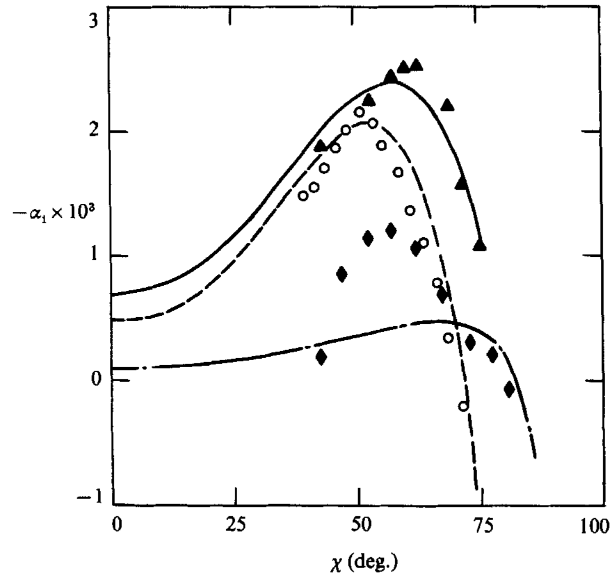

FIGURE 7. The amplification rates of disturbances: $b = 0.04$ mm; $Re = 653$; curves, theory; symbols, experiment (—, ◆, $F \times 10^4 = 0.188$; – – –, ▲, 0.371; –·–·–, ○, 0.547).

connection it is necessary to return to the interpretation of the α_r-spectra presented in figure 5(*a–c*). A large step in the x-direction can lead to a so-called stroboscopic effect, when the short-wave disturbances ($\alpha_r > 1.25$ rad/mm at $\Delta x = 5$ mm) are perceived as longer-wave ones. As a result it is possible that the peaks in spectra in figure 5(*a–c*) can be displaced.

The processing of experimental data has shown that the artificial disturbances excited by a localized source possess a complicated wave structure. They consist of vortical and compressible modes. It is necessary to take this into account when comparing theoretical and experimental data. The analysis of the data shows that there exist ranges of wavenumbers β for which one can neglect the contribution of a compressible mode to the disturbances. This allows us to study the development of T–S waves in detail.

Figure 6 shows the phase velocities of a vortical mode of the boundary layer, and figure 7 presents the values of the disturbance amplification rates. There is good agreement between the calculations of Kosinov, Maslov & Shevelkov (1986) and the experiment for the values of phase velocities. For α_i the discrepancy is significant for $f = 10$ kHz. The reason for such a discrepancy may be connected with the fact that in the stability calculations, the simplest Dunn–Lin equations were used. These do not take account of the effects of non-parallel flow in the boundary layer. The non-parallel effects exert the strongest influence on disturbances in the vicinity of the lower branch of the neutral stability curve, and this corresponds in our case to frequencies close to 10 kHz. It is, further, necessary to note that the calculation was executed for a boundary layer on a sharp plate, whereas a plate with a slightly blunted leading edge ($b = 0.04$ mm) was used in the experiment; this could contribute to the discrepancy.

The investigation of the wave packet development in a supersonic boundary layer may be of special interest, but a proper theory should be developed for analysis of experimental data. In the approximation of the linear development of disturbances it is sufficient to make use of the results of the linear theory of hydrodynamic

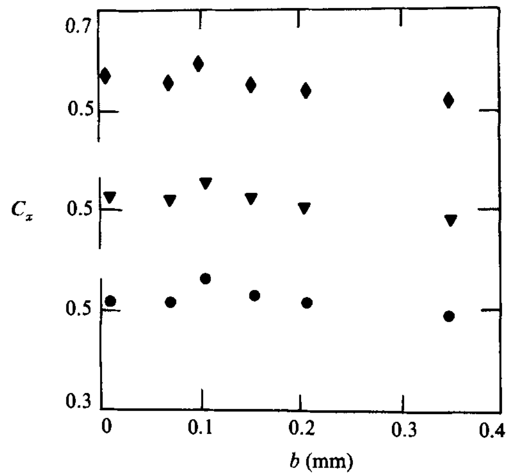

FIGURE 8. Dependence of the disturbance phase velocity on the leading-edge bluntness; $Re = 650$: ◆, $\chi = 70°$; ▼, 57°; ●, 41°.

stability and to consider the wave packet as a superposition of the linearly developing plane waves.

Three-dimensional waves with $\chi < 50$–$60°$ proved to be more stable for supersonic boundary layers. However, in the experiments performed this result was not confirmed quantitatively as we failed to separate the vortical and compressible modes at χ close to zero and to determine their amplification rates.

Above, the energy contribution of different modes to the total pulsational signal as a function of χ has been estimated. Here we confine ourselves to a simple analysis of the amplitude β-spectra presented in figure 3. It is worthwhile noting that for all the measured amplitude spectra, the fraction of the energy at small β is less than at $\beta^* = 1$ rad/mm. With increase of the Reynolds number we observe a significant decrease in the energetic contribution of waves at $\beta = 0$ as compared with waves at $\beta = \beta^*$.

The conclusion of the linear theory of stability, that it is three-dimensional waves that grow faster in the supersonic boundary layer, is confirmed by these experiments.

3.5. *The influence of leading-edge bluntness on the development of three-dimensional waves*

The study of the influence of leading-edge bluntness on the characteristics of three-dimensional disturbances was carried out at frequency 20 kHz, which corresponds to a dimensionless frequency parameter $F = 0.375 \times 10^{-4}$.

The amplitude and phase disturbance spectra obtained after Fourier transformation were on the whole similar to those presented above. The maximum of the amplitude β-spectra was observed at $\beta \approx 1$ rad/mm, and with increase of Re it was displaced towards smaller β values. The estimates made of the amplitude α_r-spectra for $b = 0.02, 0.07, 0.11, 0.15, 0.21, 0.35$ mm have shown that for $\beta > 0.3$–0.4 rad/mm the spectra carry information mainly about a single wave with the only α_r corresponding to a vortical mode. For β from 0 up to 0.1 rad/mm there were also peaks with different α_r values. The peaks corresponding to a vortical mode were of comparable amplitude with each other.

Figure 8 illustrates the values of the phase velocity corresponding to the largest peak in the α_r-spectra, as a function of bluntness b. One can see that with the growth

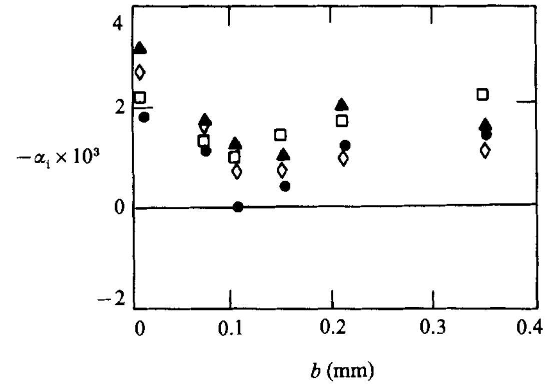

FIGURE 9. Dependence of the disturbance amplification rates on the leading-edge bluntness; $Re = 650$: ◆, $\chi = 41°$; □, 51°; △, 65°; ◇, 70°.

of b the phase velocity decreases weakly. The dependence of C_x on b for other α_r in the angle range $35° < \chi < 75°$ was analogous to the dependence presented in figure 8. The experimental value of C_x gives a good fit to the theoretical one for T–S waves. With good reason we can compare the results on the development of plane waves with a single χ, for different b values.

The amplification rates of plane waves are more convenient for comparing the results of calculation and experiment. The amplification rates (α_i) for a vortical mode presented in figure 9, as a function of b, show the non-monotonic character of the dependence of $-\alpha_i$ on b; $-\alpha_i$ has its minimum for $b \approx 0.12$. A similar 'reversal' of $-\alpha_i$ values could lead finally to the transition 'reversal' that was observed in some studies. The phenomenon of 'reversal' can be explained by the additional influence of the entropy layer on the boundary layer with increase of leading-edge bluntness (Khan & Reshotko 1979), but this question requires special investigation.

4. Conclusions

(i) An experimental study of supersonic boundary-layer stability on a flat plate at Mach number equal to 2, relative to three-dimensional Tollmien–Schlichting waves, was carried out using artificial disturbances. The conclusion of the linear theory of hydrodynamic stability, that the most rapidly growing disturbances in a supersonic boundary layer correspond to the three-dimensional waves ($\chi > 0$) is corroborated.

(ii) A study of artificial-disturbance wave structure established that a source used in experiments generates disturbances in the boundary layer consisting of vortical (the analogue of the T–S waves) and compressible waves. The vortex waves of the boundary layer predominate in the amplitude α_r-spectra at angles of wave inclination $\chi > 30°$. This makes it possible to estimate their amplification rates.

(iii) The influence of small bluntness of a flat-plate leading edge on the three-dimensional eigenwave stability characteristics in the linear zone of the disturbance development in the boundary layer has been investigated. It was shown that an increase in the bluntness of the flat-plate leading edge exerts a stabilizing influence on the development of three-dimensional disturbances in a supersonic boundary layer. A non-monotonic variation of the amplification rates with increase of bluntness is revealed.

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