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Comment on "Effects of Freestream Disturbances on Boundary-Layer Transition"

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THE following comments are directed to the authors of Ref. 1. Reference 2 presents a rather comprehensive investigation of the effects of periodic disturbances of a single frequency on flat plate boundary-layer transition. In that work Miller and Fejer found that the transition Reynolds number was a function only of the disturbance amplitude, whereas the disturbance frequency dictated the transition length. Figures 1 and 2 summarize those results.

Although the minimum amplitude of disturbance investigated by Miller and Fejer was an order of magnitude greater than the maximum disturbance amplitude of Ref. 1, one would a priori expect the same phenomenological behavior at the lower amplitudes. As was predicted by Liepmann[3] in 1945, most data tend to indicate that the value of the maximum rate of shear occurring within the boundary layer dominates the transition mechanism. More recently, Greenspan and Benney[4] have confirmed this notion analytically. Thus, since one would expect the maximum instantaneous value of shear in the boundary layer to be proportional to the disturbance amplitude, one may conclude that the results reported in Ref. 2 are physically justifiable, whereas Spangler and Wells[1] offer no explanation in terms of fundamental phenomena for their rather surprising findings.

Further consideration of the experiment of Ref. 1 brings to mind that the real indicator of transition is the appearance of turbulent bursts in the late Tollmien-Schlichting flow, a phenomenon rather difficult to detect with the smoke filament technique described by Spangler and Wells. Indeed, it may well be that a careful hot-wire traverse of the transition regime will indicate results more in consonance with those previously reported. Moreover, detailed information on the distribution of the intermittency factor would be a valuable product of such an investigation.

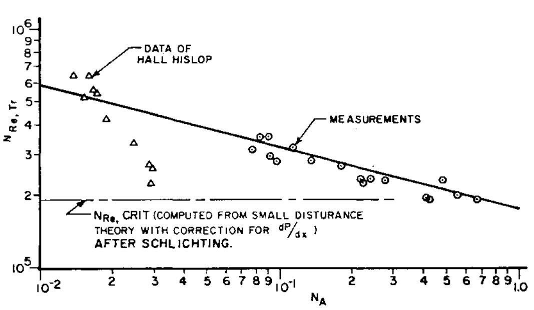

Fig. 1 Effect of the amplitude parameter $\Delta U/U_\infty$ on the transition Reynolds number.

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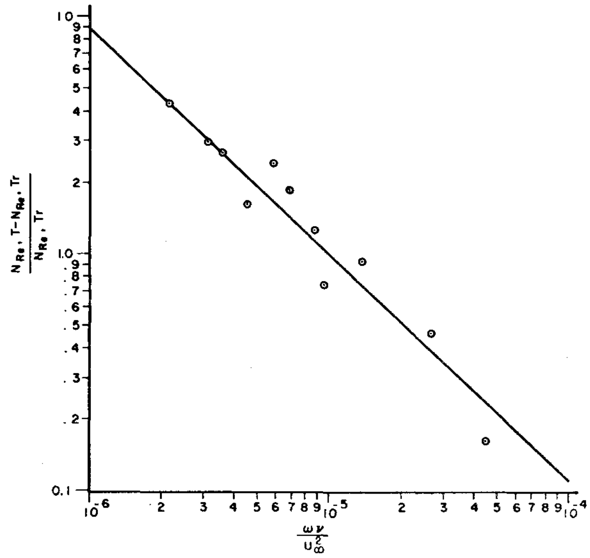

Fig. 2 Effect of the frequency parameter $\omega\nu/U_\infty{}^2$ on the transition length.

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Reply by Authors to J. A. Miller

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THE authors are familiar with the investigations of Miller and Fejer[1] concerning boundary-layer transition induced by periodic disturbances. Although on the surface the two investigations appear similar, there is one important difference that we feel explains the disparity in results. That difference is the magnitude of the freestream disturbances that induced transition. Miller and Fejer studied the effects of sinusoidal freestream disturbances ranging in amplitude from 8.0 to 67.0% of the freestream velocity, whereas our disturbances ranged from 0.04 to 0.33% of freestream, some two orders of magnitude smaller.

Transition may indeed be a function of disturbance amplitude only and not of frequency, as was found by Miller and Fejer, when the freestream disturbance is large enough to impose directly on the boundary layer a rate of shear high enough to cause breakdown. The validity of the role of maximum shear rate in the transition process has been recognized by many. Liepmann,[2] van Driest and Blumer,[3] and Rouse,[4] among others, have all considered this point. Unfortunately, no one as yet has been able to predict correctly or to measure experimentally the value of the maximum shear rate preceding transition. Consequently the minimum value

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