DISCUSSION

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The unsteady flow inside compressors has been neglected in most investigations, probably because even the steady flow is sufficiently complicated that few people get near to understanding it. There are some real unsteady issues to be resolved and contributions are naturally welcome. I am nevertheless worried that this paper could give quite misleading results because the numbers of rotor and stator blades are equal.

When the numbers of rotor and stator blades are unequal, the interaction between the two can be visualized as a disturbance wave, which moves around the circumference so that the net flow, averaged around the circumference, is almost steady. The disturbance rotates with higher speed than the rotor. If the number of rotor and stator blades is equal all the blade interactions take place simultaneously around the circumference, and *in this case the average flow around the circumference is not steady.* What happens is that the mass flow (and the pressure rise) will vary in phase for all the blade passages and it seems likely that the unsteady flow measured in this case will be different in significant ways from the more typical case. The in-phase disturbances are a source of noise and vibratory excitation and for this reason equal numbers are generally not used for compressor or turbines; equal numbers are the basis of the design of a siren. In fact the difference in Figs. 5 and 6 between the maximum and minimum velocity midway between the wakes would seem evidence of this effect. Moreover the movie of the calculations shown at the presentation of Gundy-Burlet et al. (1991) showed clearly that there are axisymmetric waves propagating off downstream, just as one would expect from this very special choice of numbers.

It is possible that the data the authors have presented are not seriously compromised by the equal number of rotors and stators, but this must be confirmed. This could be done with a number of circumferentially spaced hot wires to see if there is strong correlation between them; if a substantial correlation exists ahead of the inlet guide vanes it will be evidence that there is good reason to mistrust the data.

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Authors' Closure

The authors would like to thank Professor Cumpsty for raising a valid and insightful concern in his discussion. There are several perspectives from which to address this concern.

The postulated axisymmetric waves would result in a periodic variation in the mass flow, or C_x. In order to examine the data for evidence of such axisymmetric waves, the axial velocity, C_x, was averaged circumferentially, i.e., across the stator pitch, at each time increment. The relation between the axial velocity, C_x, and time over one blade passing period was thus obtained. This temporal variation of the circumferentially averaged C_x is very nonsinusoidal and has an rms of $0.0025U_m$, or about 0.5 percent of the average C_x. The axial velocity, C_x, was also *time averaged at each measurement location across the stator* pitch, thus removing the temporal dependency. The result is a time-averaged C_x versus stator pitch relation. This is a nearly sinusoidal curve due to the stator potential field, with a period equal to one stator pitch and an rms of $0.0145U_m$, or about 2.9 percent of the average C_x. Comparing these two values, the variation due to the stator potential field is nearly six times the temporal variation in average mass flow. Thus, it can be *said that airfoil-to-airfoil variations, typical of turbomachinery* airfoil potential flow fields, are the dominant part of the difference seen between the maximum and minimum curves in Figs. 5 and 6.

Secondly, Fig. 11 shows that the maximum and minimum differences agree very well with predicted stator potential field variations. There is no indication of other significant variations, such as a temporal variation.

Lastly, it is not clear that such a phenomenon would affect the primary purpose for which these data were acquired, i.e., the assessment of time-accurate turbomachinery flow codes.