Readers' Forum

Brief discussions of previous investigations in the aerospace sciences and technical comments on papers published in the AIAA Journal *are presented in this special department. Entries must be restricted to a maximum of 1000 words, or the equivalent of one* Journal *page including formulas and figures. A Discussion will be published as quickly as possible after receipt of the manuscript. Neither the AIAA nor its editors are responsible for the opinions expressed by the correspondents. Authors will be invited to reply promptly.*

Comment on "Second-Order Accurate Boundary Conditions for Compressible Flows"

G. Moretti*
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THE article in question[1] is about 15 years outdated, despite its reference to a few recent papers. The statement that "the method commonly used to apply boundary conditions on a solid surface is to consider additional mesh points at the interior of the body" was true in the 1960's but not any more. The figures published in support of the author's technique are wrong. The many excellent codes (see, e.g., Ref. 2) that we have at our disposal today show that the flow about a circle at $M_\infty = 0.4$ is barely critical at $\theta = 90$ deg and is perfectly symmetrical. None of the curves of Fig. 3 (at $M_\infty = 0.35$) is even symmetrical, and Figs. 4 and 5 show a supersonic region at $M_\infty = 0.4$ that does not exist. Again, whether such poor results depend on a poor code or merely on a programming error, they show that the author may not be aware of the calculations performed in the last 15 years with second-order accuracy.

References

[1]Sparis, P. D., "Second-Order Accurate Boundary Conditions for Compressible Flows," *AIAA Journal*, Vol. 22, Sept. 1984, pp. 1222-1228.

[2]Jameson, A., "Transonic Potential Fow Calculations on Arbitrary Meshes by the Multiple Grid Method," *Proceedings, AIAA Computational Fluid Dynamics Conference*, July 1979, pp. 122-146.

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Reply by Author to G. Moretti

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THE purpose of the present paper[1] was to amplify the negative effects of lower order accurate boundary conditions, as the so-called "reflection principle," on the solution accuracy. Dr. Moretti will be surprised to realize the number of people still using the "reflection principle" today, in spite of his early warnings[2] 15 years ago. For these people, the paper offers an improved version of the "reflection principle" that can be very easily implemented in the existing codes using dummy points, and can offer second-order accuracy incorporating the effect of the local radius of curvature, that is, a first-order effect.

As far as the lack of symmetry of the $M_\infty = 0.35$ solution, it should be clear to a CFD analyst that, due to the symmetry, it cannot be caused by the boundary conditions, but most probably by the action of excessively strong artificial viscosity terms. However, since the same terms were used in all cases, the comparison is rather fair. The important result illustrated in Fig. 3 is that the lower order accurate boundary condition methods yield reduced maximum velocities at $\theta = 90$ deg.

Finally, I do not quite understand Dr. Moretti's argument with respect to the $M_\infty = 0.4$ solution. The proposed method predicts that for $M_\infty = 0.4$ there is a small supersonic region that extends for a very small number of mesh points in the r and θ directions, while other codes predict that for the same Mach number the flow is barely critical. In the author's opinion, these two results are in good agreement in view of the coarseness of the mesh. The supersonic region in my computation extends in the radial direction only for a distance of two mesh points. Although I am not familiar with the boundary condition treatment of Dr. Moretti's codes, the appearance of lower flow velocities might be an indication of a lower boundary condition accuracy in the excellent codes developed in the last 15 years.

References

[1]Sparis, P. D., "Second-Order Accurate Boundary Conditions for Compressible Flows," *AIAA Journal*, Vol. 22, Sept. 1984, pp. 1222-1228.

[2]Moretti, G., "Importance of Boundary Conditions in the Numerical Treatment of Hyperbolic Equations," *The Physics of Fluids*, Supp. II, Dec. 1969, pp. 11-20.

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Comment on "A Class of Bidiagonal Schemes for the Euler Equation"

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THE class of bidiagonal schemes introduced in Ref. 1 seems to be a very promising class of methods for solving the Euler equations and, as mentioned by the authors, includes both MacCormack's explicit and implicit schemes[2,3] as particular choices of parameters.

The explicit MacCormack scheme corresponds to $\theta = 0$, $\xi = 1/2$. However, the identification of parameters for Mac-

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