Technical Comments

Comment on "Lorentz Drag: An Engineering Approximation"

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IN a recent article, Bass and Anderson[1] presented a simple, approximate method for estimating the magnetoaerodynamic drag experienced by a re-entry vehicle carrying a magnet inside its hemispherical nose. Their approach to the problem is based upon a model that assumes a constant area duct within the shock layer. Using this and several additional simplifying assumptions they arrive at the conclusion that during re-entry the expected increase in total drag from the Lorentz force would be between 7 and 14%.

It is recognized generally at the present that the great complexity of the hypersonic magnetoaerodynamic flow problem permits only approximate solutions. These solutions have varied from the more comprehensive treatments by Levy, Gierasch, and Henderson,[2] and the present writers[3,4] to the simpler ones as exemplified by the work being commented on. Within the limitation that the flowfield is not distorted seriously by the presence of the magnetic field, the approach of Bass and Anderson has its merits. However, this approach is not applicable for large magnetic interactions where the mass flow rate along a constant area duct is reduced appreciably with a consequent increase in shock standoff distance.

The more extensive analyses[2,4] predict the existence of flight regimes where a very dramatic increase in the shock standoff distance is effected by the magnetic field. The shock may be pushed out to a distance several times the vehicle nose radius. Under such conditions the magnetoaerodynamic drag would far exceed the conventional aerodynamic drag.

Although Bass and Anderson plainly point out the gross nature of the approximations involved, the present note is prompted by our concern that their relatively low estimate of the drag levels might create an overly pessimistic outlook on the utility of onboard magnets for re-entry braking and control.

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References

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