

# *Rotational Stagnation-Point Flow\**

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**Abstract.** Hayes' exact linear solution [3] for a three-dimensional stagnation point is found to miss essential features. It appears that higher-degree terms in the velocity influence the inviscid solution decisively; although Hayes' classification  $0 \leq \alpha_0 < 1$ ,  $\alpha_0 = 1$ ,  $\alpha_0 > 1$  (excluded), on the basis of his parameter  $\alpha_0$ , is still valid. A scheme is given for determining the solution correct to any order in distance from the stagnation point. For subquadratic approximation it involves terms of all degrees in the velocity components less than  $4/(1 - \alpha_0)$ . The influence of surface curvature and the special case  $\alpha_0 = 1$  (which is left unresolved) are also considered.

**1. Introduction.** It is well known that there is a class of exact solutions of the incompressible Navier-Stokes equations in  $z > 0$  for which the  $x$ - and  $y$ -components of velocity,  $u$  and  $v$ , are linear functions of  $x$  and  $y$ , their coefficients being functions of  $z$ , while the  $z$ -component,  $w$ , depends on  $z$  only. A subclass represents incoming flow against the plane  $z = 0$  with a stagnation point at the origin.

These solutions, and in particular their inviscid limit, have been investigated by Hayes, the implication being that they simulate general compressible flow near a general stagnation point on a body of finite curvature. However, a cursory inspection reveals that quadratic terms in  $u$  and  $v$ , and their accompanying linear terms in  $w$ , contribute to Hayes' inviscid equations (Watson, [7]). A more detailed investigation, which is the object of the present paper, shows that this invalidates the expansions proposed by Hayes. In other words, there are essential features of stagnation-point flow which the exact solution misses. Our treatment is complete.

The analytical character of the flow is determined by a single non-negative parameter  $\alpha_0$ . (This may be associated with the stretching of vortex lines, as in Hayes' paper. For a fuller account see Boger's thesis [1].) The role of  $\alpha_0$  is shown

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