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Degeneracy in the blasius problem
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Abstract
The Navier-Stokes equations for the boundary layer are transformed, by a similarity transformation, into the ordinary Blasius differential equation which, together with appropriate boundary conditions constitutes the Blasius problem, $f'''(n) + 1/2f(n)f''(n) = 0$, $f(0) = 0$, $f'(0) = 0$, $f'(\infty) = i$. The well-posedness of the Navier-Stokes equations is an open problem. We solve this problem, in the case of constant flow in a boundary layer, by showing that the Blasius problem is ill-posed. If the second condition is replaced by $f'(0) = -\lambda$, then degeneracy occurs for 0 < λ < λc ≃ 0.354. We investigate the problem analytically to explain this phenomenon. We derive a simple equation $g(\alpha, \lambda) = 0$, whose roots, for a fixed λ, determine the solutions of the problem. It is found that the equation has exactly two roots for 0 < λ < λc and no root beyond this point. Since an arbitrarily small perturbation of the boundary condition gives rise to an additional solution, which can be markedly different from the unperturbed solution, the Blasius problem is ill-posed. © 2007 Texas State University - San Marcos.

Author Keywords
Blasius problem; Degeneracy; Ill-posed problem; Navier-stokes equations; Wang equation; Well-posed problem

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