

This Week's Citation Classic

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Coles D. The law of the wake in the turbulent boundary layer. *J. Fluid Mech.* **1**:191-226, 1956. [Guggenheim Aeronautical Lab., California Inst. Technology, Pasadena, CA]

The mean-velocity profile in the turbulent boundary layer is represented by a linear combination of two universal functions. One is the well-established law of the wall. The other, called the law of the wake, is interpreted in terms of the large-scale structure in the flow. [The *SCI*[®] indicates that this paper has been cited over 155 times since 1961.]

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"After I received the PhD degree from Caltech in 1953, I moved from JPL to the campus with an appointment as research fellow. I had done considerable reading and thinking about turbulent boundary layers in low-speed flow, and I had become convinced that work on similarity laws was the solid core of the literature. However, this core seemed to me to be somehow incomplete. There was no explicit connection between similarity arguments for boundary layers and for free shear flows such as jets and wakes. The lack of connection was particularly evident in defect laws for $(u_\infty - u)/u_T$, where u_T is the friction velocity for a boundary layer, and for $(u_\infty - u)/u_o$, where u_o is the centerline defect velocity for a wake (say). The quantities u_T^2 and u_o^2 were linked by their use as reference quantities for describing the distribution of turbulent energy, but in no other way. As a practical matter the next step to be made was essentially in the air, and it fell to me to make it in this paper. In effect, the turbulent boundary layer was viewed as a continuously evolving wake modified in a definite way by the presence of a wall. Many authors have since found this point of view useful

for cataloging and interpreting the behavior of a wide variety of boundary-layer flows, thus accounting for the paper's frequent citation.

"At Caltech, in 1953, I had the singular advantage of being able to think and work for almost a year without being obliged to show that I was doing anything very useful. This advantage was due entirely to the forbearance of Clark Millikan and Hans Liepmann, to whom I was responsible at the time. Such freedom is now rare at the postdoctoral level, partly because quantity of publications now often outranks quality in any battle for academic promotion, and partly because changes in the nature of research support have made the taking of risks a luxury which many universities choose not to afford.

"By coincidence, my paper happened to be ready at the time that George Batchelor was preparing the first volume of his new *journal of Fluid Mechanics*. Batchelor thought that the paper in its original form was somewhat diffuse, and he requested a longer introduction. My attempt to comply resulted in the extended introduction and summary called 'Compendium,' and the revision was accepted although it was not completely satisfactory either to author or editor. Batchelor also assigned considerable weight to my survey of the experimental literature, and he thought that the survey ought to be represented in the title of the paper, perhaps by the phrase 'law of the wall.' My position, which prevailed, was that surveys are most useful when they lead to new insights, and that the original title should stand because it emphasized the new contribution. On re-reading the paper today, I find very little that I would want to change. The terms 'law of the wake' and 'wake region' have apparently become so thoroughly understood and accepted that they are now part of the standard terminology of the subject and are often used without attribution."