The asymptotic concept presented in [1] and [2] provides a starting point for further progress in the rational description of turbulent boundary layers undergoing separation: in these contributions the fundamental triple-deck problem governing turbulent marginal separation for infinite global Reynolds number *Re*, that is, in the formal limit $Re^{-1} = 0$, was derived by means of an asymptotic analysis of the Reynolds-averaged Navier–Stokes equations in terms of the small (positive) parameter α, which measures the slenderness of the turbulent boundary layer and is, remarkably, seen to be essentially independent of *Re*. That latter, basic characteristic results in an asymptotic splitting of the flow that is described by means of a two-parameter expansion of the flow quantities. The primary limit $\alpha \to 0$ addressed in [1] then allows for a fully self-consistent description of the separation process, which is substantially governed by the locally strong interaction of the boundary layer with the potential flow induced on its top. The underlying triple-deck problem can be cast in canonical form, such that it is fully characterised by a single non-dimensional parameter, $\mathit{\Gamma}$. This parameter accounts for the deviation of the imposed pressure gradient from its critical value, where the marginal separation singularity arises in the solution of the non-interactive boundary layer equations. As a most representative result, closed reverse-flow regimes are seen to occur for a certain range of values of $\mathit{\Gamma}$. Interestingly, and in striking contrast to what is known from laminar marginal separation, the limiting case referring to very large deviations from the aforementioned critical state, is, at least in the light of the present research, seen to be associated with firmly attached flow.

Hence, the question arises if that limit is accompanied with the onset of double-valued solutions for a single value of $\mathit{\Gamma}$. That branching could result from the coexistence of attached flow and massively separated flow, respectively. The latter type of flow, which is undoubtedly of great importance for engineering applications, is the topic of a subsequent research project to be proposed. As a first step, it has been demonstrated that the boundary layer solutions terminate in a singularity if the imposed pressure gradient belongs to a potential flow that is sought in the class of solutions exhibiting a free streamline which departs smoothly from the surface, see [3]. Most important, here a self-consistent rational description of the separation process seems feasible if the strength of the pressure gradient is chosen such that the position of that singularity coincides with the location of inviscid flow detachment in the aforementioned limit $Re^{-1} = 0$ and $\alpha \to 0$.

In addition, it is shown in [3] that an asymptotic description of a turbulent boundary layer that undergoes separation requires a streamwise velocity deficit of $O(1)$ in the fully turbulent main part of the initially attached oncoming flow. In [1] and [2] the rationale for the asymptotic time-mean scaling of the boundary layer merely relies on semi-heuristic arguments and dimensional reasoning. Still, a current question of interest is how the scaling and the multi-layered structure of turbulent boundary layer flow can be traced back to a minimum number of physical assumptions in a more stringent manner and, in turn, be ‘derived’ from first principles. Progress in this direction, also by taking into account the effects due to high but finite values of *Re*, is outlined in [4]. First results in the attempt to deduce the internal scaling proposed in [1] from the Navier–Stokes equations are presented in [3]: amongst others, it is shown that in the limit $Re^{-1} = 0$ near the surface a sublayer having a thickness of $O(\alpha^{3/2})$ accounts for the constrained movement of the large-scale eddies with a diameter of the same magnitude. Interestingly, the analysis then corroborates a common finding of the time-mean analysis, namely, that the mixing length varies linearly with distance from the wall at the base of that layer.

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[2] SCHEICHL, B. & KLUWICK, A. 2007 Turbulent Marginal Separation: A Novel Triple-Deck Problem for Turbulent Flows. In *Progress in Turbulence II* (ed. M. Oberlack et al.). Springer Proceedings in Physics Vol. 109, Springer (in print).

[3] SCHEICHL, B. & KLUWICK, A. 2007 Asymptotic Theory of Turbulent Bluff-Body Separation: A Novel Shear Layer Scaling Deduced from an Investigation of the Unsteady Motion. Accepted for publication in *Proc. IUTAM Symposium on Unsteady Separated Flows and Their Control. June 18–22, 2007, Kerkyra (Corfu), Greece*. Springer.

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