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Large Scale Motions and Friction Scaling in Pipes[1] JOSE LOPEZ, DAVIDE SCARSELLI, BALACHANDRA SURI, Institute of Science and Technology (IST Austria), GREGORY FALKOVICH, Weizmann Institute of Science, BJOERN HOF, Institute of Science and Technology (IST Austria) — The scaling of the friction factor in pipe flow is exactly known for low Reynolds number laminar flow and reasonably well understood for high Reynolds number turbulence, where the Prandtl-Karman law is followed. Arguably, the least understood regime is the intermediate one, from $Re \approx 3000$, where turbulence becomes space filling, to $Re \approx 100000$. As shown in our experiments and direct numerical simulations here friction factors fall precisely onto the Blasius power law. However, the structural and dynamical changes related to the scaling transition that occurs at $Re \approx 65000$ and eventually gives rise to the Prandtl-Karman regime, remain elusive. Here, combining experiments and simulations, we argue that the regime change from Blasius to Prandtl-Karman is driven by a structural transition within turbulence. Using tools from information theory (mutual information), it is shown that the change of the friction law is connected to the appearance of large scale motions in the logarithmic layer. Subsequent to the transition these large scale motions exert an increasing dominance on the turbulent drag.

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