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Statistical State Dynamics based Study of the Roll-Streak Instability in Rotating, Stratified, and Shearing Flow. EOJIN KIM, BRIAN FARRELL, Harvard University — Rolls and Streaks are coherent structures frequently observed in nature(e.x. Hurricane Boundary Layer Rolls and Elongated Streamwise Rolls in Channel Flows). Some Flows can support laminar mean flow instability. And, many of previous studies attempted to ascribe Roll-Streak formation to instability of laminar mean flow. While a normal dynamical system can only support instability through an eigenmode of the mean state, shear flows are highly non-normal and can support strong transient growth. Pseudospectra Theory tells us transient optimals coming from non-normality can be very easily destabilized via Reynolds Stress Torque. This instability arising from destabilization of transient optimal, through interaction of mean flow and perturbation about it, is analytical only within the framework of S3T(Stochastic Structural Stability Theory) and presents to be different from instability of laminar mean flow . We report studies on interaction between these two instabilities when various physics(e.x. Rotation, Stratification, and Shear) are present. In various scenarios, we try to answer which one of these instabilities is dominant and whether they compete or synergize each other. And, interaction of these two instabilities can be studied analytically only within the framework of S3T. Some of the examples include Reynolds-Tiederman Profile which does not support any unstable eigenmode to Orr-Sommerfield equation and Squire equation. Others include Slowly Rotating Couette, Ekman Layer, and Density Front which already supports or can support, via some choice of parameters, mean flow instability.

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