Predicting boundary layer transition

in conventional hypersonic wind tunnels

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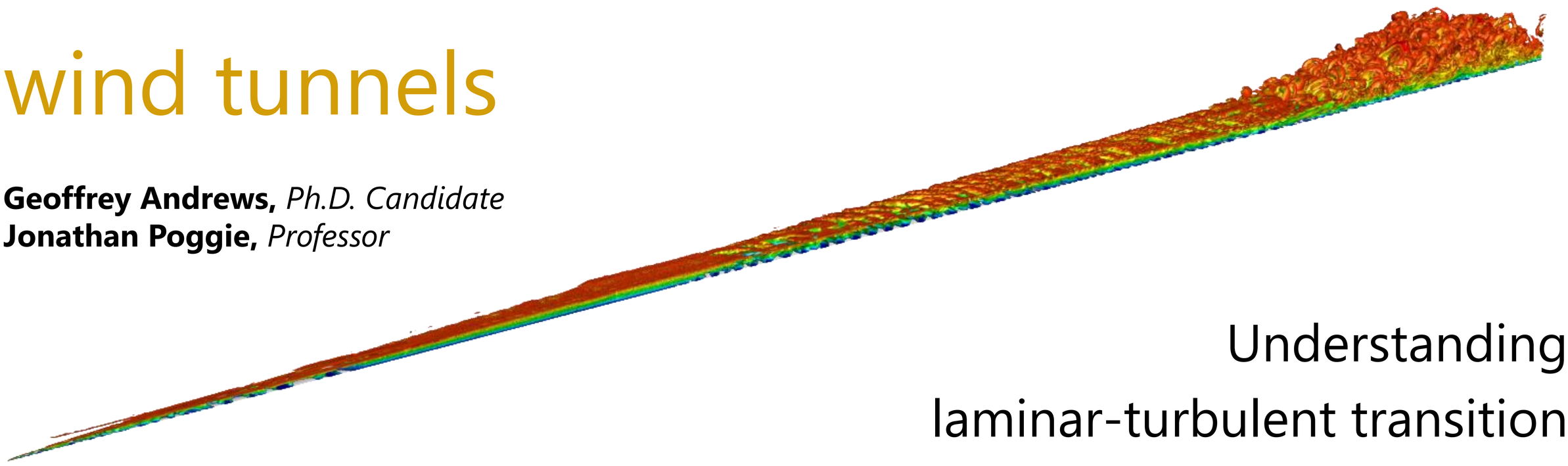


Understanding
laminar-turbulent transition
is critical for developing hypersonic flight vehicles.
Yet facility noise in wind tunnels makes prediction very challenging.

Background

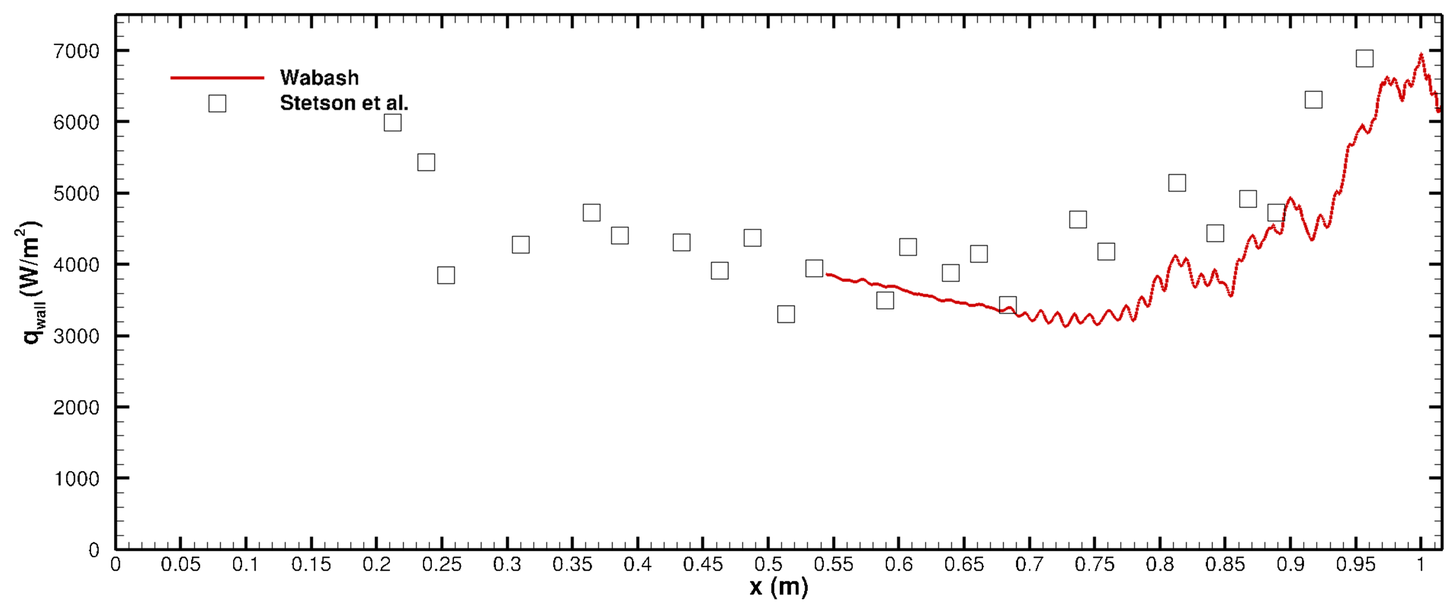
- Low-frequency acoustic noise produced within wind tunnels can trigger premature transition in hypersonic boundary layers.
- In conventional tunnels, transition occurs later on cones than on plates, contradicting stability theory (and quiet tunnel results).

Our Work

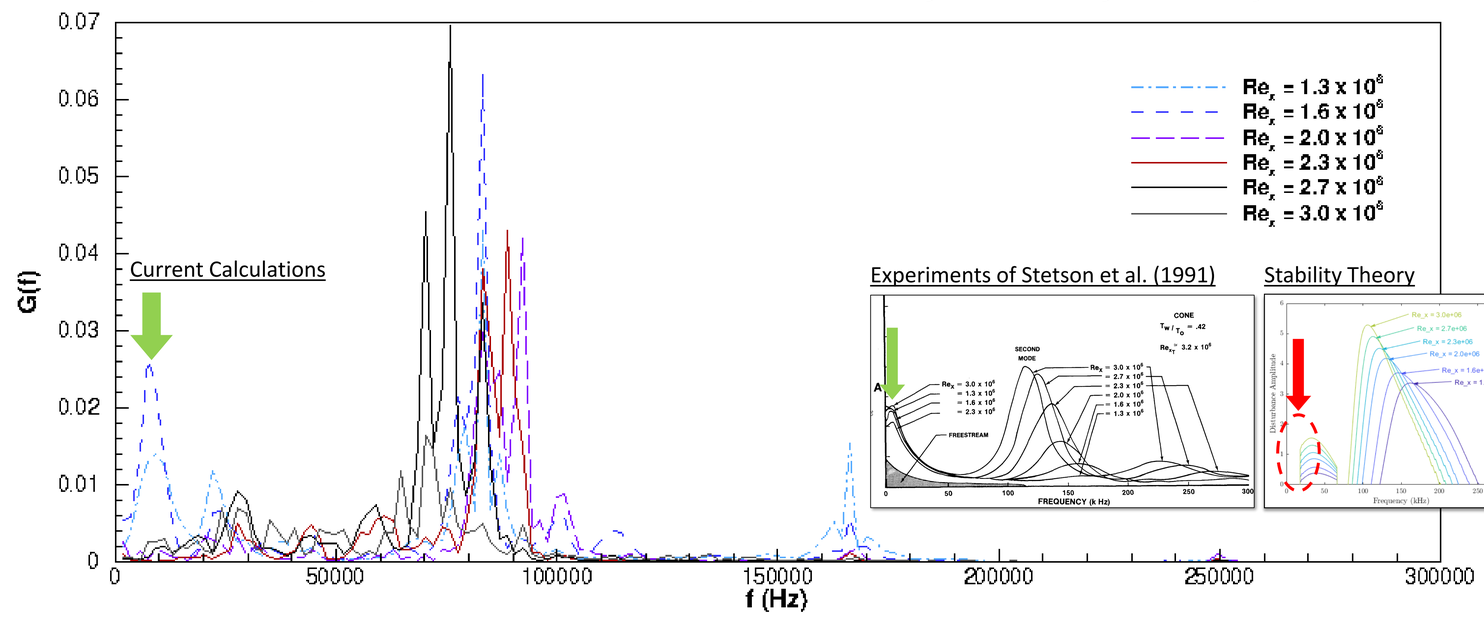
- We are simulating planar and conical boundary layers at Mach 8, following experiments in the Air Force's AEDC VKF Tunnel B.
- Our calculations employ a plane wave acoustic forcing model for facility noise formulated from measurements of Tunnel B.

Results (for conical boundary layer)

- Simulations show agreement with experimental transition location.



- Total temperature spectra show low-frequency instability growth observed in experiments but not captured by stability theory.



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