OVER-THE-WING PROPULSION AT INCIDENCE

On the modelling of the trends in performance

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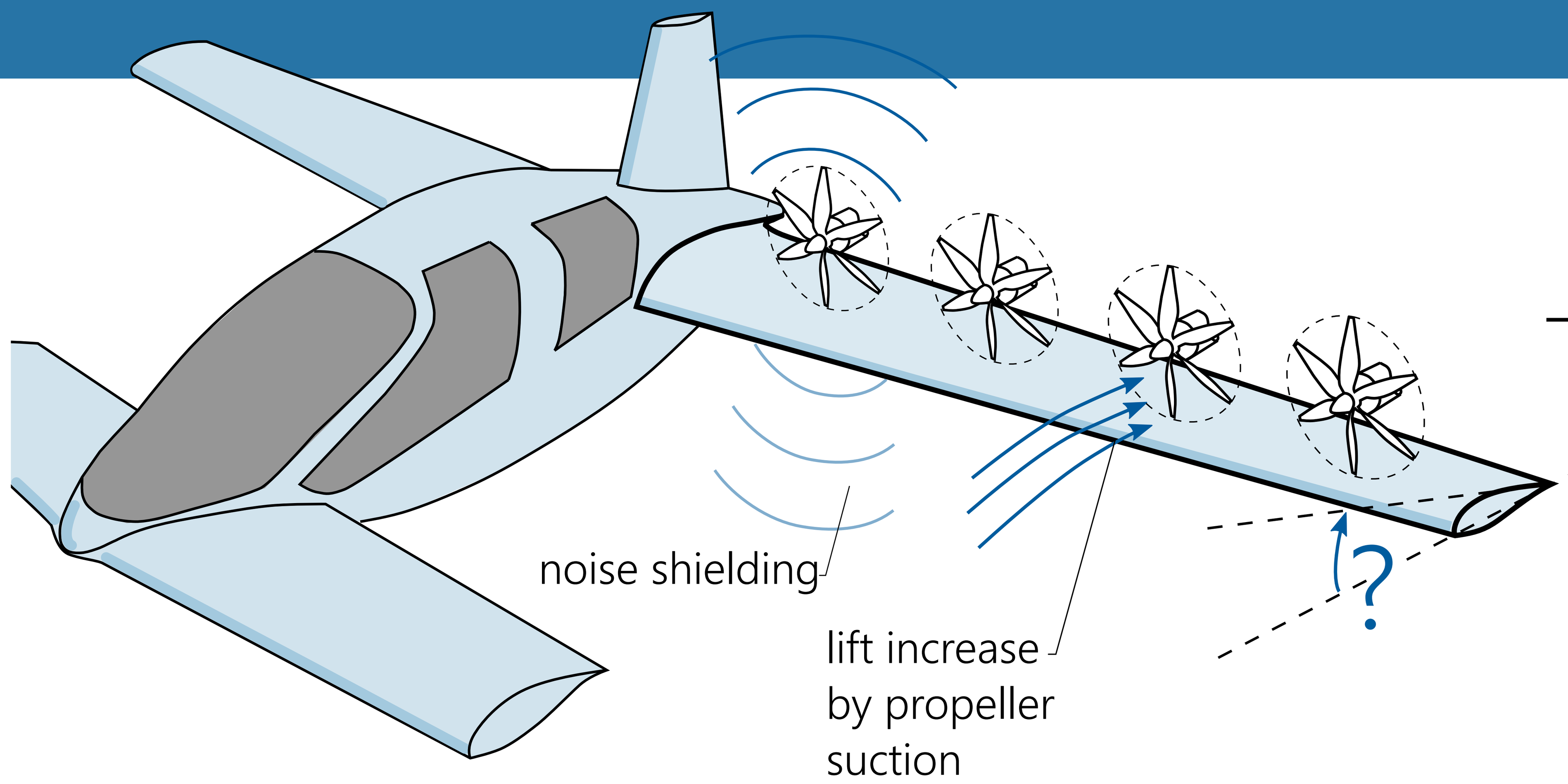
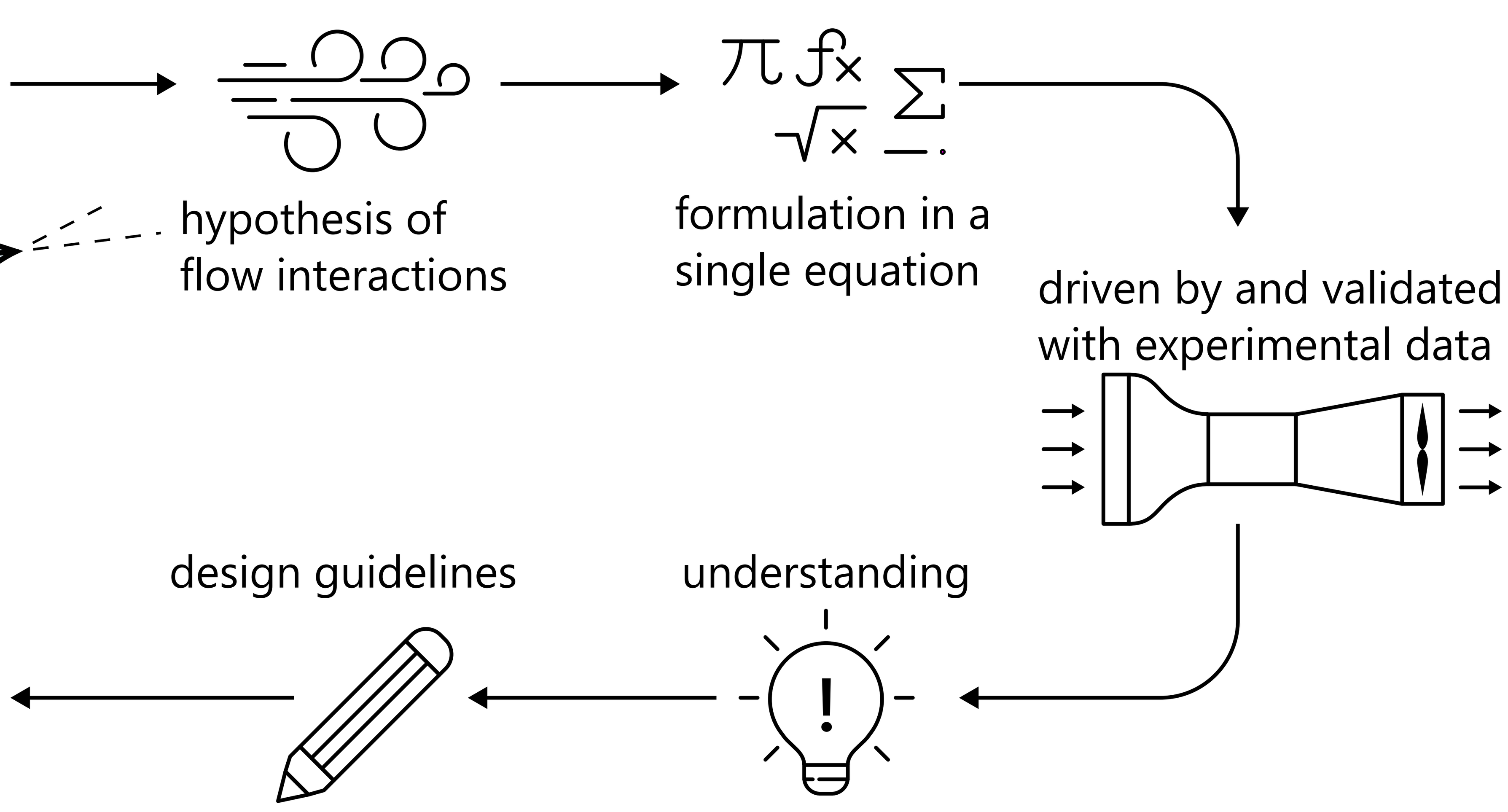


Over-the-wing propulsion promises **reduced fly-over noise** and **improved aerodynamic characterstics** of the wing. Nonetheless, the installation effects in the flight conditions of Urban Air Mobility, where a **high angle of attack** is encountered, remain unknown. In this PhD project the flow physics behind the **installation effects** are investigated using a **low-order model.**

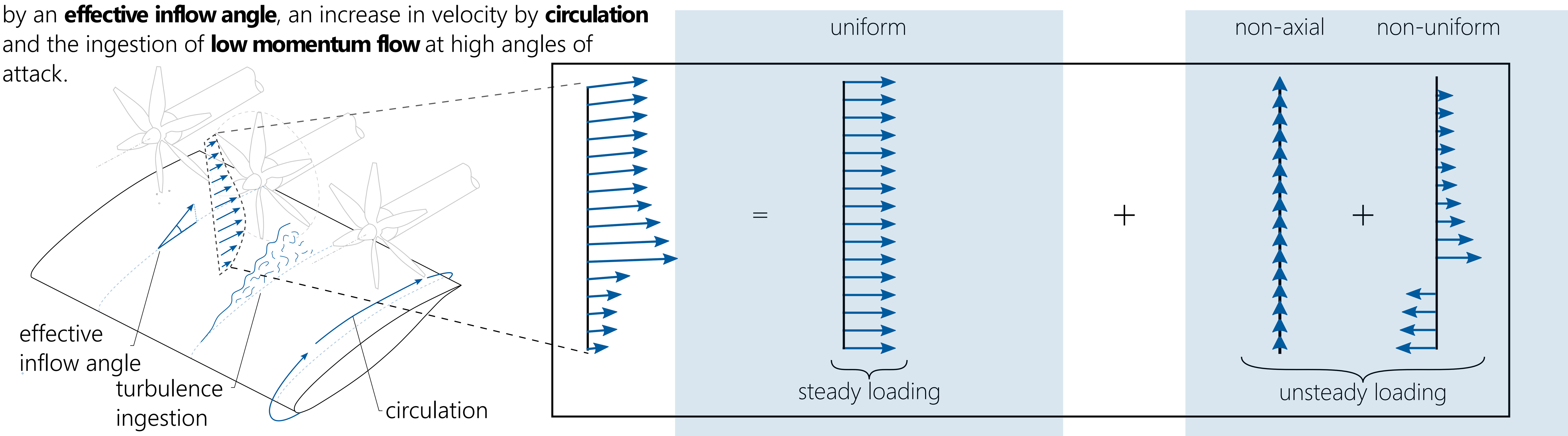
Outline of the research



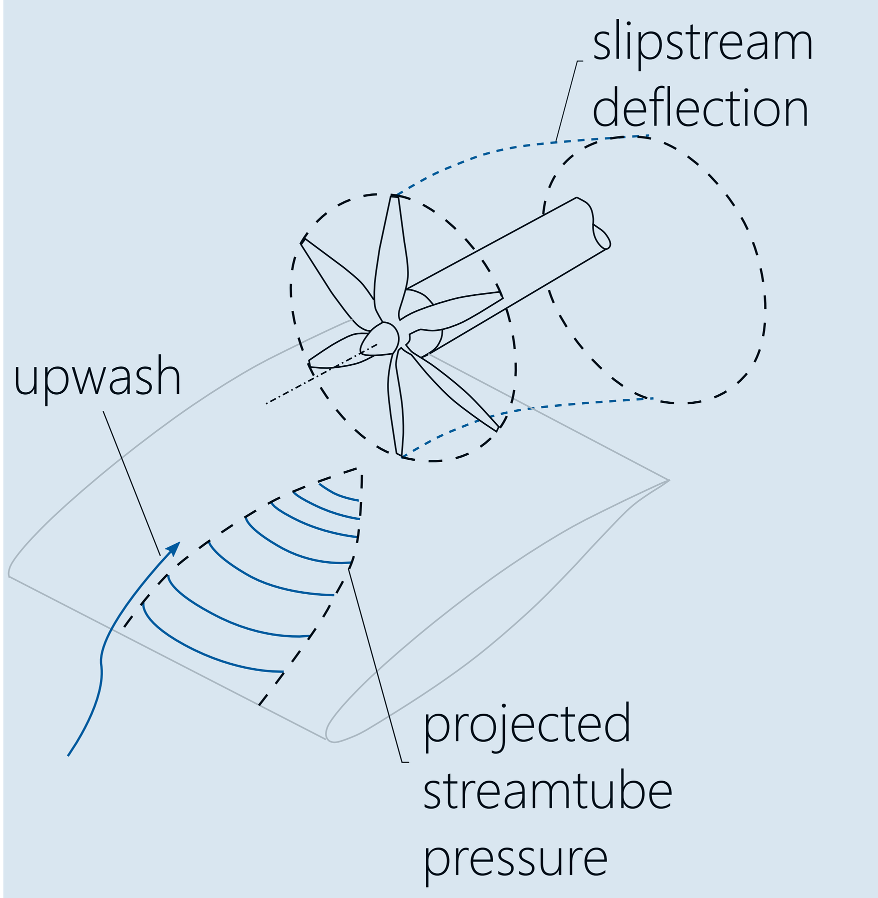
Model outline

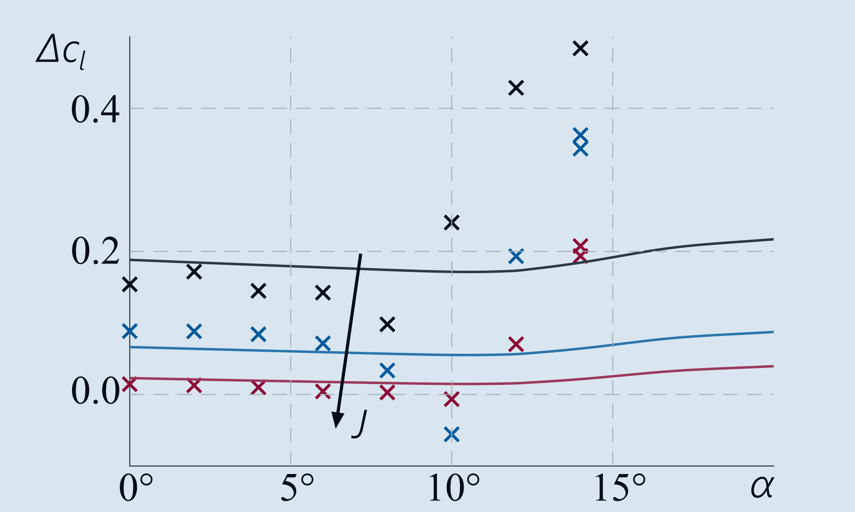
Interactions on the propeller and wing are studied separately in the analysis. The wing changes the performance of the propeller by an **effective inflow angle**, an increase in velocity by **circulation** and the ingestion of **low momentum flow** at high angles of attack.

The **inflow** to the propeller is then **decomposed** into uniform, non-axial and non-uniform contributions



The contraction of the streamtube creates an **upwash** and a **reduction of pressure** upstream of the disk. The propeller slipstream is also **deflected**, causing an additional lift term.





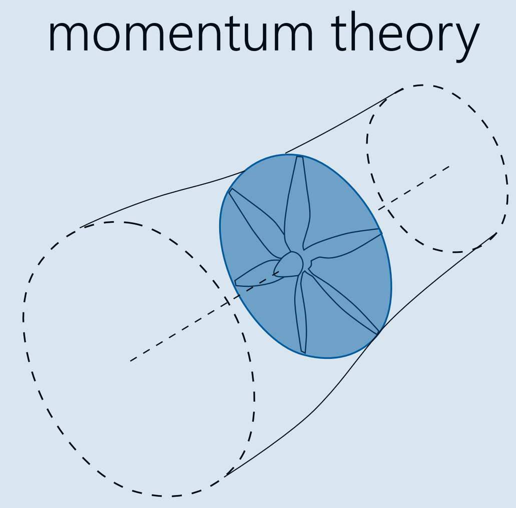
The thrust of the installed propeller is used as an **input** for the **lift** modelling

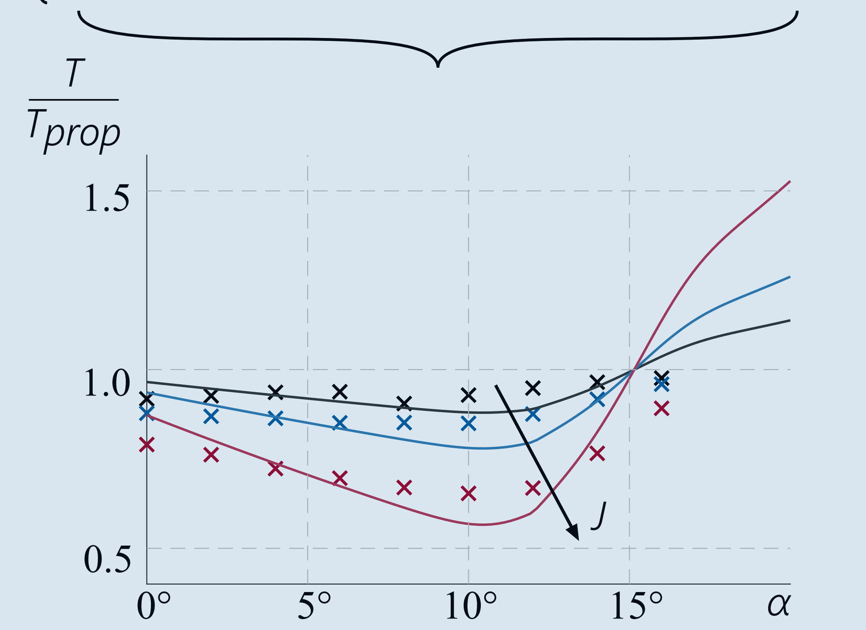
An **advance ratio correction *C*** is derived which is coupled with experimental data of the isolated propeller and momentum theory.

$$C = \frac{J_{eff}}{J} = f(J, \alpha, x_p, y_p, R/c, r/c, c_l)$$

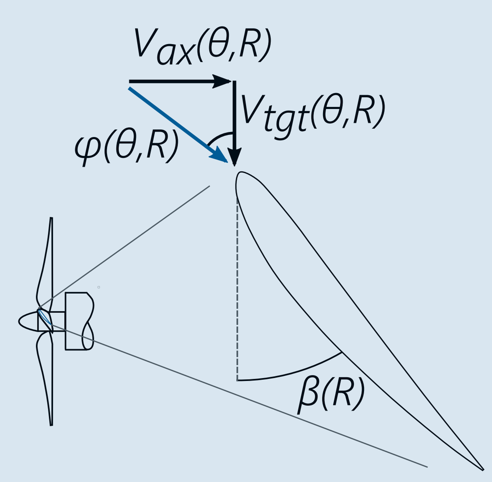
+

momentum theory





Unsteady loading is computed using blade element momentum theory and coupled with **acoustic analogies** to predict the tonal noise.



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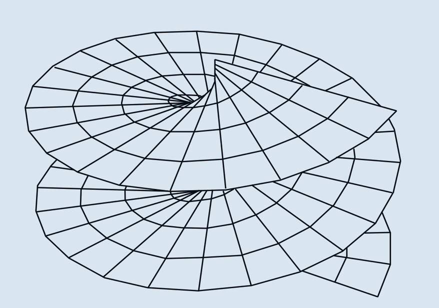
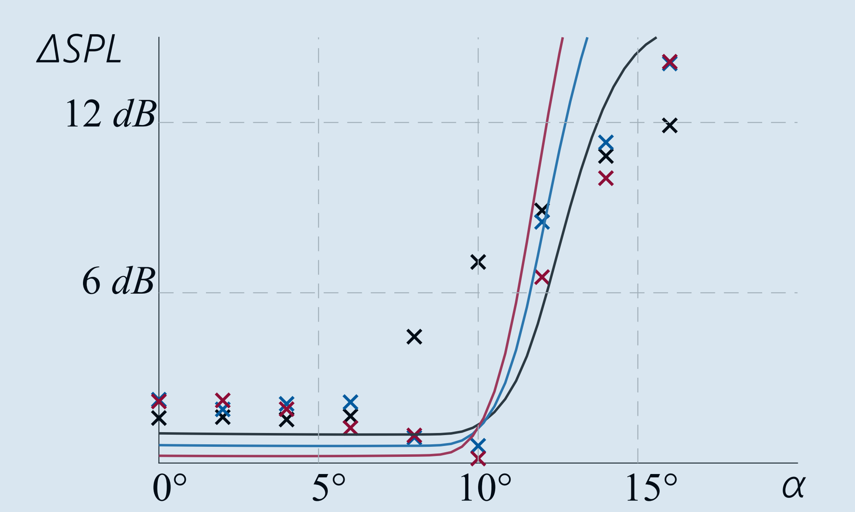
helicoidal surface theory





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