

# The Vortex and The Jet

Reiner Decher

# The Vortex and The Jet

A Journey into the Beauty and Mystery  
of Flight

 Springer

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*To all who look up in wonder  
to see an airplane fly  
and those who ponder  
how and why.*

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## A Note on Images

As an educator, I rely on images to help illustrate the physics of the subject in this book. The Internet is a wonderful resource for finding illustrations that an ordinary writer might not be able to generate. The sources I used are identified in the image captions, where available. Permission to use them may or may not be available. I contacted and received permission from the owners of many of the images used here. The list of individuals who graciously permitted image use includes Bob Garrard, Ron Parker, Werner Horvath, Ron Kellenaers, Ron Lindlauf and Barry Latter—to them, a grateful thanks. I especially want to thank corporate entities who made images available: The Boeing Company and General Electric. Contributions were also derived from sources associated with US governmental agencies. These include the National Air and Space Administration (NASA and its predecessor, the National Advisory Committee on Aeronautics, NACA), branches of the US military services and civilian agencies.

I sincerely hope that the use of images from the Internet identified as being in the public domain is appropriate because finding original contact information for the photographer was, in a few cases, impossible. The names are identified in the captions when they could be found. Images from the publication *Flight Literacy* were included in this writing, with permission.

To all individuals and people associated with agencies, a sincere thanks for my ability to use images to strengthen arguments made with the written word.

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# Abbreviations

ac	Aerodynamic Center
APU	Auxiliary Power Unit
BPR	Bypass Ratio
CET	Compressor Exit Temperature
CPR	Compressor Pressure Ratio
EPR	Engine Pressure Ratio
GE	General Electric
GPS	Global Positioning System
ICE	Internal Combustion Engine
IGV	Inlet Guide Vane
$I_{sp}$	Specific Impulse
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NIMH	Nederlands Instituut voor Militaire Historie
NOAA	National Oceanic and Atmospheric Administration
NPR	Nozzle Pressure Ratio
P&W	Pratt and Whitney
psia	Pounds Force Per Square Inch (absolute)
RPM	Rotations Per Minute
SSME	Space Shuttle Main Engine
TET	Turbine Exit Temperature
TIT	Turbine Inlet Temperature
VG	Vortex Generator