Appendix A

Shock-Wave/Boundary-Layer Interaction at M=1.5 Dataset

A selection of DNS flow cases examined in

[1] Sansica, A. (2015), *Stability and Unsteadiness of Transitional Shock-Wave/Boundary-Layer Interactions in Supersonic Flows.* PhD thesis, University of Southampton

is made available to the public. The readed is referred to Sansica (2015) [1] for a fully detailed description of the present dataset and selected flow cases.

A.1 Acknowledgements

If the 2D base flows in the directories D.2.1 and D.2.2 are used, please cite:

[2] Sansica, A. and Sandham, N.D. and Hu, Z. (2014), *Forced response of a laminar shock-induced separation bubble.* Physics of Fluids, Vol. 26, No. 093601; doi:10.1063/1.4894427

If any other part of this database is used, please cite:

[3] Sansica, A. and Sandham, N.D. and Hu, Z. (2015), *Shock-Wave/Boundary-Layer Interaction at M=1.5 Dataset.* Dataset; doi:

A.2 Structure of the Database and Cases Selection

The database is divided into three main directories D.1, D.2 and D.3. Each main directory contains a different number of sub-directories for every specific flow case selected. Grid and flow quantity files are provided for all cases and, for the 3D configurations, a statistics file is added. Further details on how to extract the data are given in Sec. A.3. The selected flow configurations are:

D.1 - Shock-wave/boundary-layer interactions on the ONERA experimental setup presented in Chap. 5 of Sansica (2015) [1]:

D.1.1 - zero-pressure gradient boundary-layer (case ON-1) from Sec. 5.3.1,

D.1.2 - laminar interaction (case ON-2) from Sec. 5.3.2,

D.1.3 - transitional interaction (case ON-3) from Sec. 5.3.2,

D.1.4 - turbulent interaction (case ON-4) from Sec. 5.3.2.

D.2 - Laminar shock-induced separation bubbles used in Chap. 6 of Sansica (2015) [1] for the investigations on the unsteady response:

D.2.1 - 2D small separation from Sec. 6.1,

D.2.2 - 2D large separation from Sec. 6.1,

D.2.3 - 3D transitional separation from Sec. 6.5.2.

D.3 - Laminar and transitional interactions used in Chap. 7 of Sansica (2015) [1] for the study of linear and nonlinear stability:

D.3.1 - 2D marginal separation from Sec. 7.1,

D.3.2 - 2D large separation from Sec. 7.1,

D.3.3 - 3D transitional separation at low forcing amplitude from Sec. 7.2,

D.3.4 - 3D transitional separation at high forcing amplitude from Sec. 7.2.

The structure of the database is schematically represented in Fig. A.1.

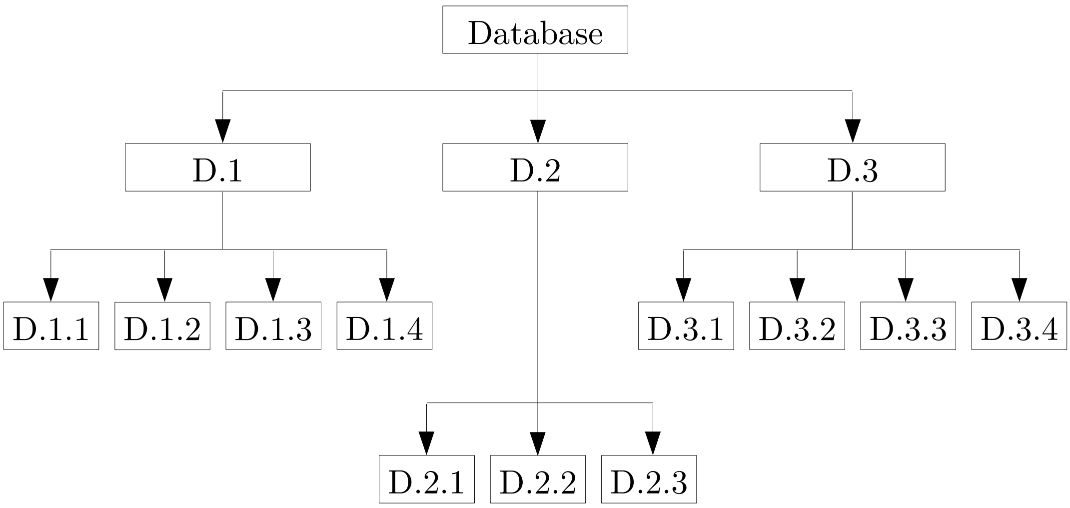

Figure A.1: Structure of the database.

A.3 Data Extraction

All selected flow cases are provided with a grid file called '`grid.bin`' and an instantaneous flow quantity file '`plot3d_q1.$time`', where the variable `$time` varies depending on the selected case. For the 3D cases, statistics files '`Statistics.$time`' are also given.

Structure of `plot3d_q1.$time` and `Statistics.$time`

The structure of the `plot3d_q1.$time` (left) and `Statistics.$time` (right) files is reported in Tab. A.1. The reading of these files is propaedeutic for the extraction of the grid coordinates since they contain the number of grid points (N_x, N_y, N_z) in the streamwise, wall-normal and spanwise directions, respectively. Values of Mach number M, Reynolds number based on the displacement thickness at the inlet $Re_{\delta^*_{1,0}}$ and time are also written. The instantaneous flow quantities q_i (for $i = 1, 2, .., 5$) are $\mathbf{q} = [\rho, \rho u, \rho v, \rho w, E_t]^T$. The statistical quantities q^s_i (for $i = 1, 2, ..., 24$) are reported in Tab. A.2.

Bytes	Data Type	Flow Quantity	Bytes	Data Type	Statistical Quantity
4	Integer	N_x	4	Integer	N_x
4	Integer	N_y	4	Integer	N_y
4	Integer	N_z	4	Integer	N_z
4	Float	M	4	Float	M
4	Float	0 (not used)	4	Float	0 (not used)
4	Float	$Re_{\delta^*_{1,0}}$	4	Float	$Re_{\delta^*_{1,0}}$
4	Float	time	4	Float	time
4	Float	$q_i(1,1,1)$	4	Float	$q^s_i(1,1,1)$
4	Float	$q_i(1,2,1)$	4	Float	$q^s_i(1,2,1)$
⋮	⋮	⋮	⋮	⋮	⋮
4	Float	$q_i(1,N_y,1)$	4	Float	$q^s_i(1,N_y,1)$
⋮	⋮	⋮	⋮	⋮	⋮
4	Float	$q_i(N_x,1,1)$	4	Float	$q^s_i(N_x,1,1)$
4	Float	$q_i(Nx,2,1)$	4	Float	$q^s_i(Nx,2,1)$
⋮	⋮	⋮	⋮	⋮	⋮
4	Float	$q_i(N_x,N_y,1)$	4	Float	$q^s_i(N_x,N_y,1)$
⋮	⋮	⋮	⋮	⋮	⋮
4	Float	$q_i(N_x,N_y,N_z)$	4	Float	$q^s_i(N_x,N_y,N_z)$

Table A.1: Flow (left) and statistics (right) file structures.

i	1	2	3	4	5	6	7	8
q_i^s	$\overline{\rho\rho}$	$\overline{\rho u}$	$\overline{\rho v}$	$\overline{\rho w}$	$\overline{\rho\rho\rho}$	$\overline{\rho uu}$	$\overline{\rho uv}$	$\overline{\rho uw}$
i	9	10	11	12	13	14	15	16
q_i^s	$\overline{\rho vv}$	$\overline{\rho vw}$	$\overline{\rho ww}$	$\overline{u}$	$\overline{v}$	$\overline{w}$	$\overline{uu}$	$\overline{uv}$
i	17	18	19	20	21	22	23	24
q_i^s	$\overline{uw}$	$\overline{vv}$	$\overline{vw}$	$\overline{ww}$	$\overline{p}$	$\overline{T}$	$\overline{pp}$	$\overline{TT}$

Table A.2: Statistical quantities.

Structure of `grid.bin`

The extraction of data from the grid file requires the knowledge of the number of grid points (N_x, N_y, N_z) in the streamwise, wall-normal and spanwise directions, respectively. This can be obtained by reading the first three entries of the `plot3d_q1.$time` or `Statistics.$time` files.

Bytes	Data Type	Grid coordinate
8	Float	$x(1)$
8	Float	$x(2)$
⋮	⋮	⋮
8	Float	$x(N_x)$
8	Float	$y(1,1)$
8	Float	$y(1,2)$
⋮	⋮	⋮
8	Float	$y(1,N_y)$
⋮	⋮	⋮
8	Float	$y(N_x,1)$
8	Float	$y(N_x,2)$
⋮	⋮	⋮
8	Float	$y(N_x,N_y)$
8	Float	$z(1)$
8	Float	$z(2)$
⋮	⋮	⋮
8	Float	$z(N_z)$

Table A.3: Grid file structure.