Coriolis Force

By equation:

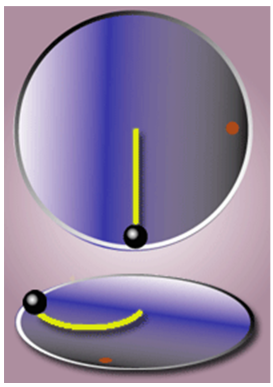
$$\vec{\Lambda} = -2\,m\,\vec{\omega} \times \frac{\mathrm{D}\vec{x}}{\mathrm{D}t}$$

with

$$\vec{\omega} = \omega \begin{pmatrix} \cos(\lambda)\,\cos(AZ) \\ \sin(\lambda) \\ -\cos(\lambda)\,\sin(AZ) \end{pmatrix}$$

and

$$\frac{\mathrm{D}\vec{x}}{\mathrm{D}t} = \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix}$$



it finally follows:

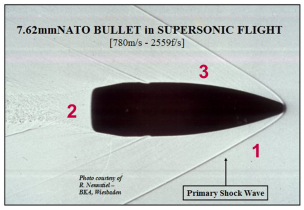
$$\vec{\Lambda} = -2\,m\,\omega \begin{pmatrix} \cos(\lambda)\,\cos(AZ) \\ \sin(\lambda) \\ -\cos(\lambda)\,\sin(AZ) \end{pmatrix} \times \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix}$$

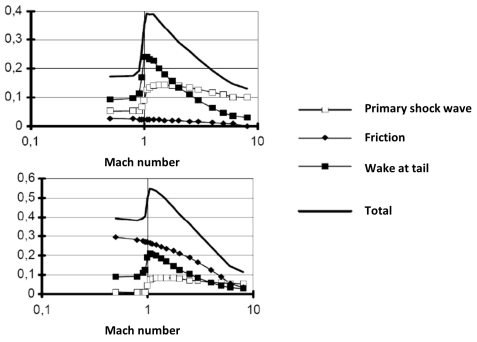
Exterior Ballistics 5.1

Drag

Composition:

1. Pressure by the primary shock wave at the nose (Mach cone)
2. Underpressure at the tail (wake space) accompanied by wake turbulence
3. Friction along the jacket (turbulent boundary layer)





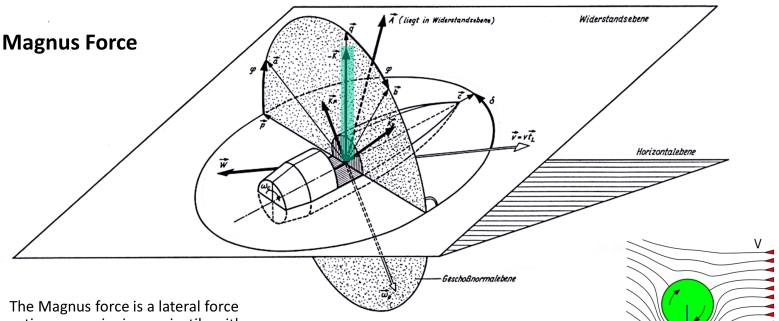
Examples:

Top: spin stabilized projectile

Bottom: fin stabilized projectile

Exterior Ballistics 6.2

Magnus Force



The Magnus force is a lateral force acting on a spinning projectile with a non-zero angle of repose as result of friction at the boundary layer of the air flow.

The air flow around the projectile has the same direction as the air flow along the trajectory at one side and the opposite direction at the other side, causing lateral pressure differences.

$$\begin{aligned}\vec{M} &= -N_{\omega\delta}\,\omega_c\,\sin\delta\,\vec{q} \\ &= \frac{\rho}{2}\,A_{ref}\,D_{ref}\,C_{N\omega\delta}\,\omega_c\,\sin\delta\,\vec{q} \\ &= \frac{\rho}{2}\,A_{ref}\,D_{ref}\,C_{mag-f}\,\omega_c\,(\vec{c}\times\vec{v})\end{aligned}$$

Exterior Ballistics 7.3