Institute of Mechanics MSU

Aerodynamical properties of fragments of a meteor body in the terrestrial atmosphere

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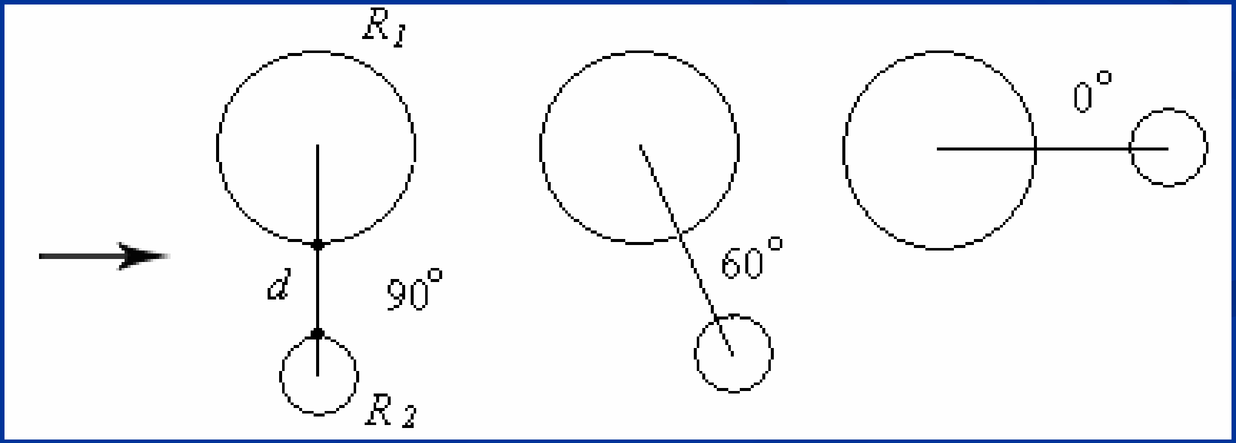
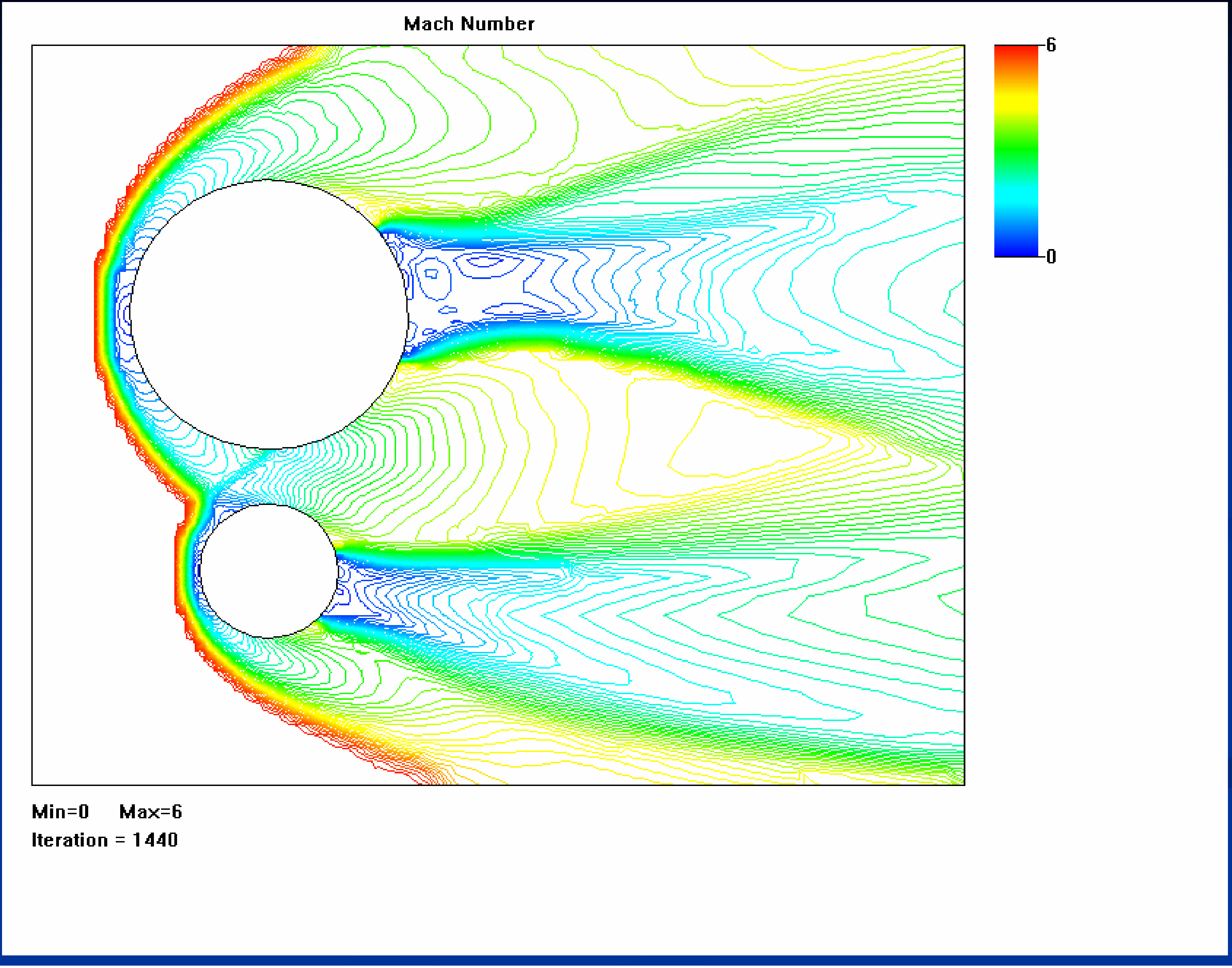
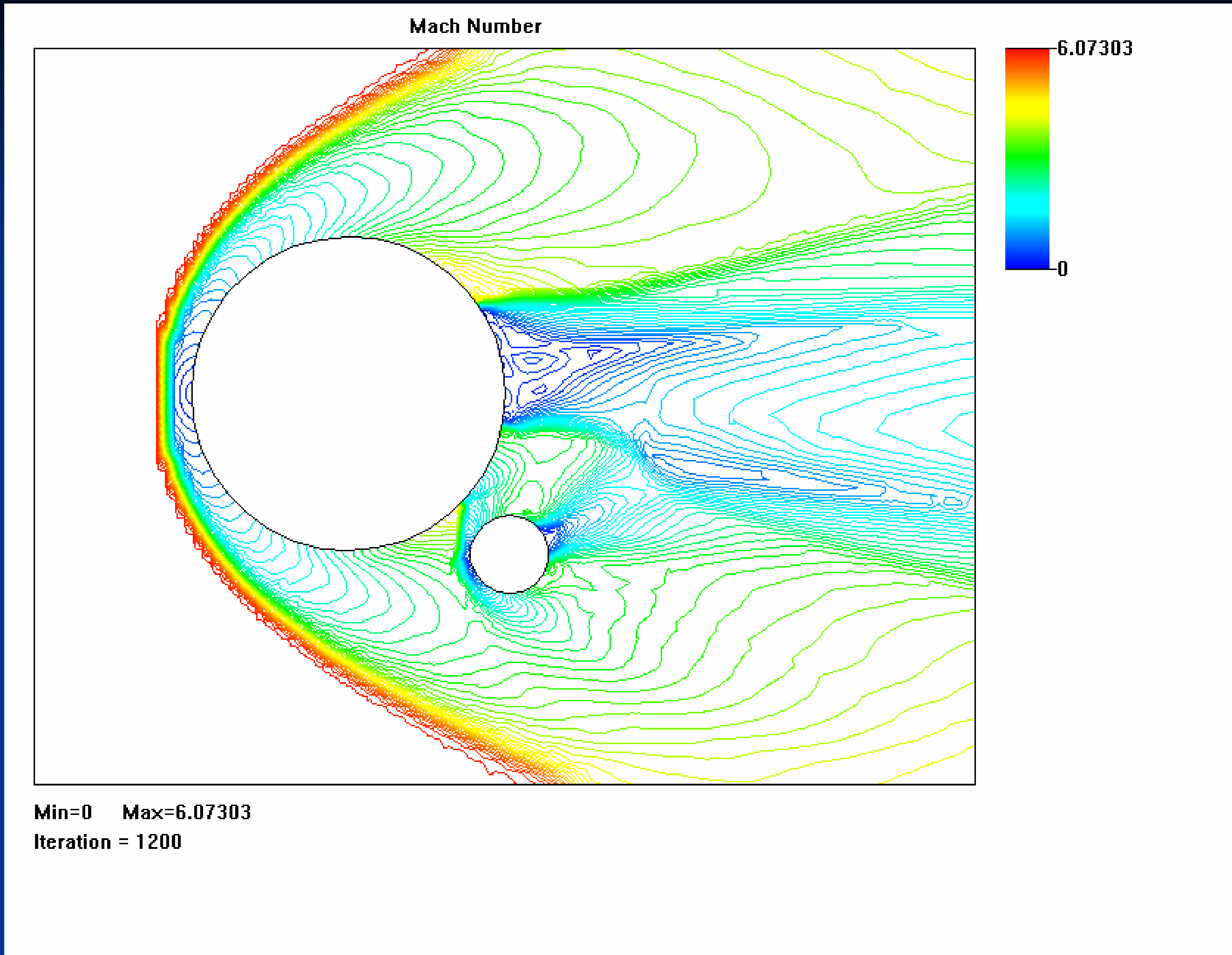
Statement of the problem

- Two variants of bodies sizes are considered: $R_2 / R_1 = 0.25$ and $R_2 / R_1 = 0.5$
- Values of the angle between the center line and an incoming flow
  α - 0, 15, 30, 45, 60, 75 and 90 º;
- Values of the distance between the fragments d - 0, 0.2, 0.4, 0.6, 0.8, 1;
  d - dimensionless quantity, the distance between the fragments related to the radius of the biggest sphere;
- All calculations were carried out at value of Mach number $M = 6$
  and the adiabatic index $\gamma = 1.4$




Mach Number
6
0
Min=0 Max=6
Iteration = 1440

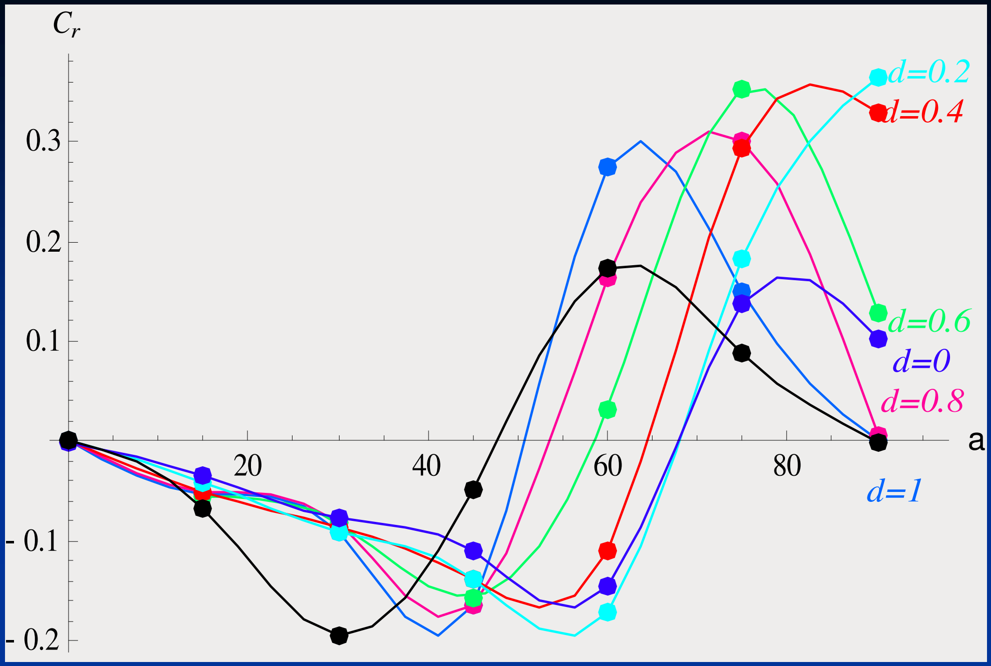

Mach Number
6.07303
0
Min=0 Max=6.07303
Iteration = 1200

Transverse force coefficient

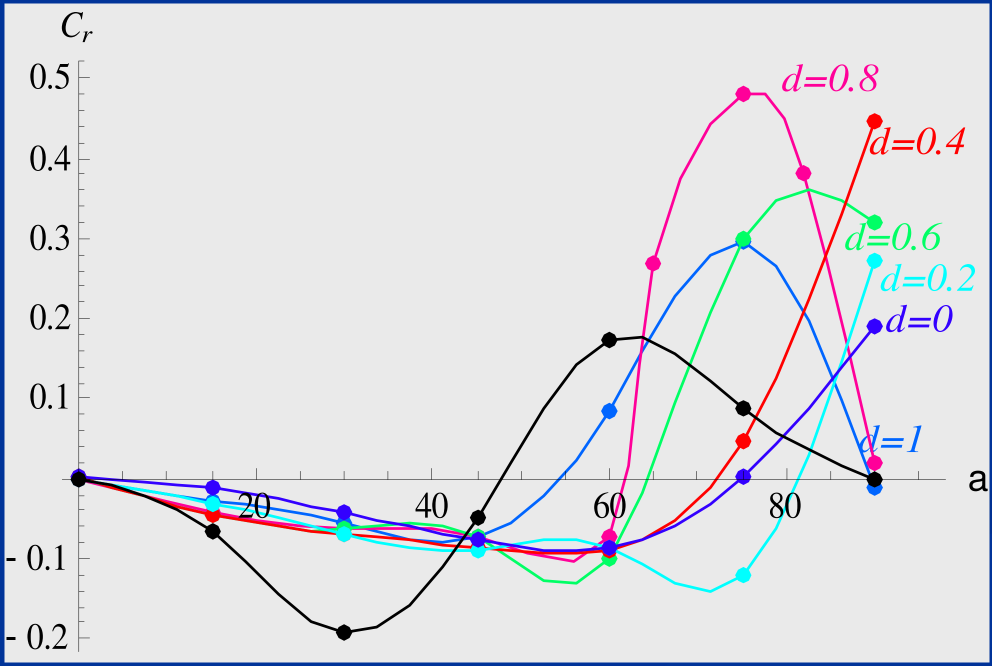
$$C_r = \frac{p_\infty}{0.5\rho_\infty V_\infty^2 S} \int_\Sigma p \sin\theta \, d\sigma$$

$$\rho_\infty V^2 / p_\infty = \gamma M^2$$

p_∞ - pressure in an incoming flow , ρ_∞ - density in an incoming flow, V_∞ - velocity of an incoming flow, S - the area of a sphere's midsection, θ - the polar angle counted from a forward point of sphere.

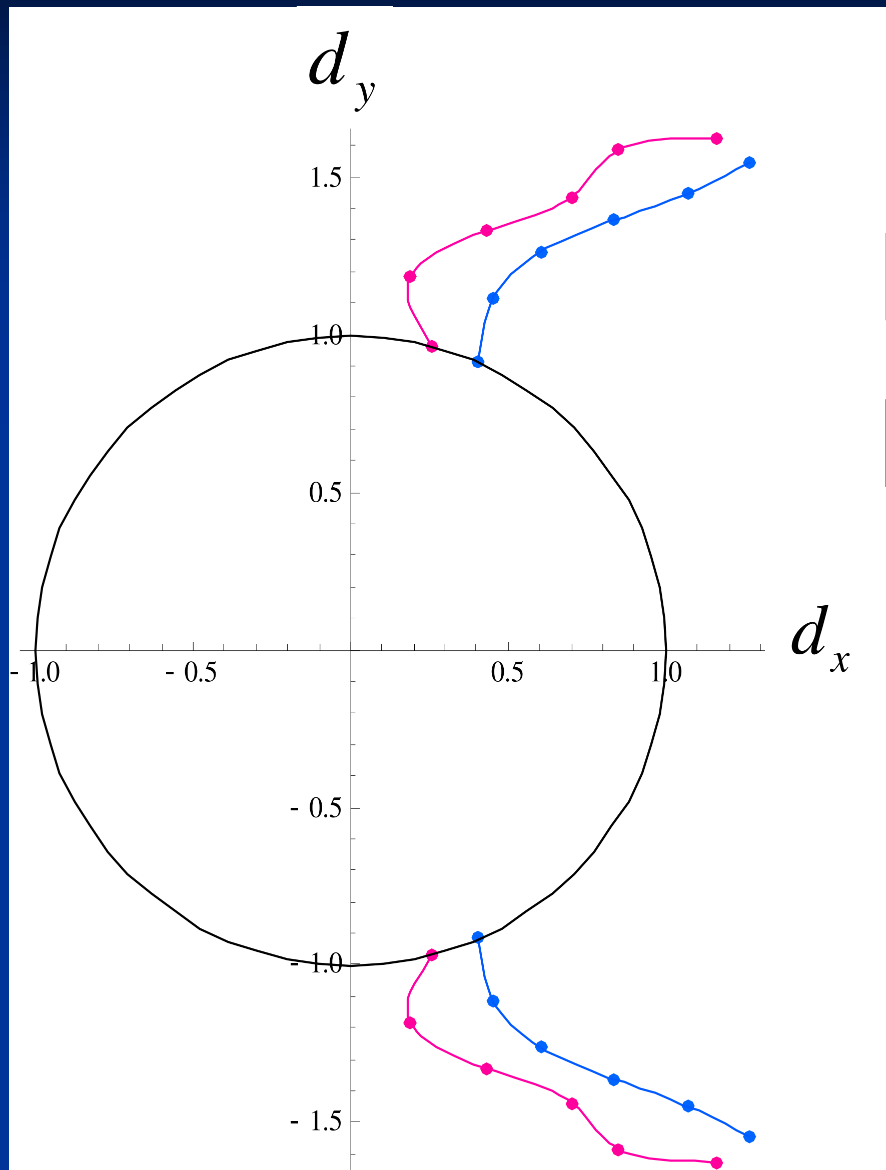


$R_1/ R_2= 0.5$



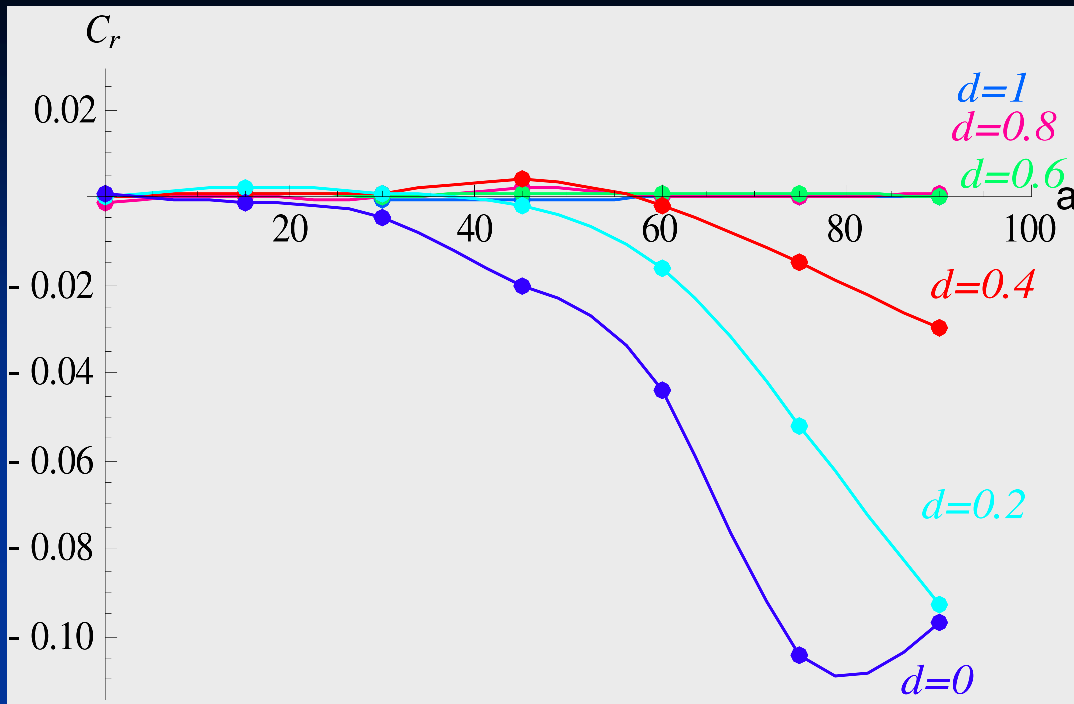
$R_1/ R_2= 0.25$

A display area of the collimation effect



$R_1 / R_2 = 0.5$

$R_1 / R_2 = 0.25$



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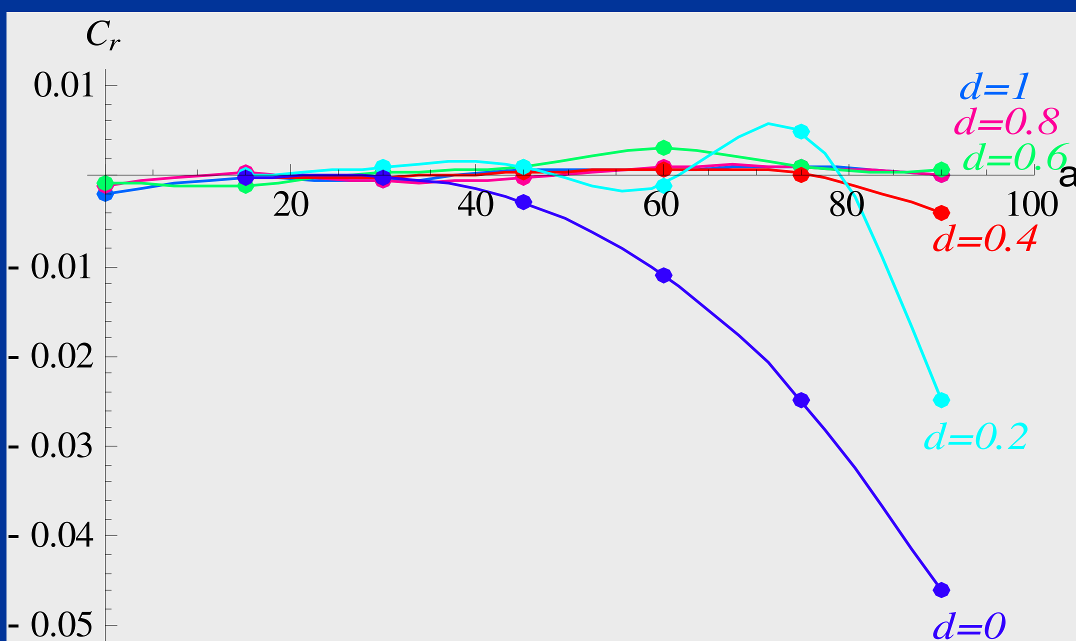


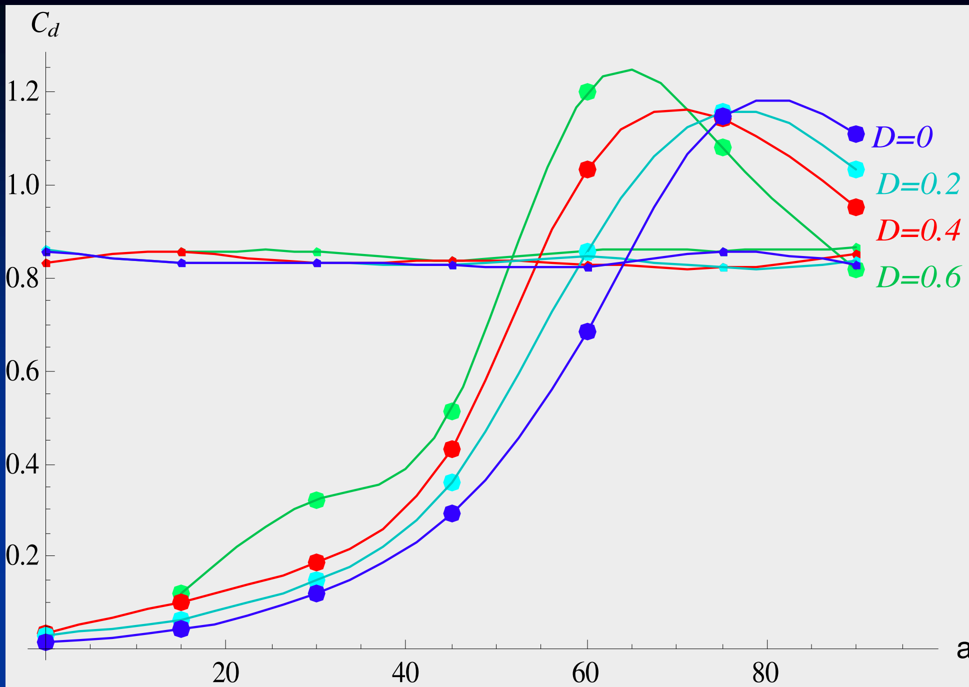
$R_1/R_2 = 0.25$

Drag coefficient

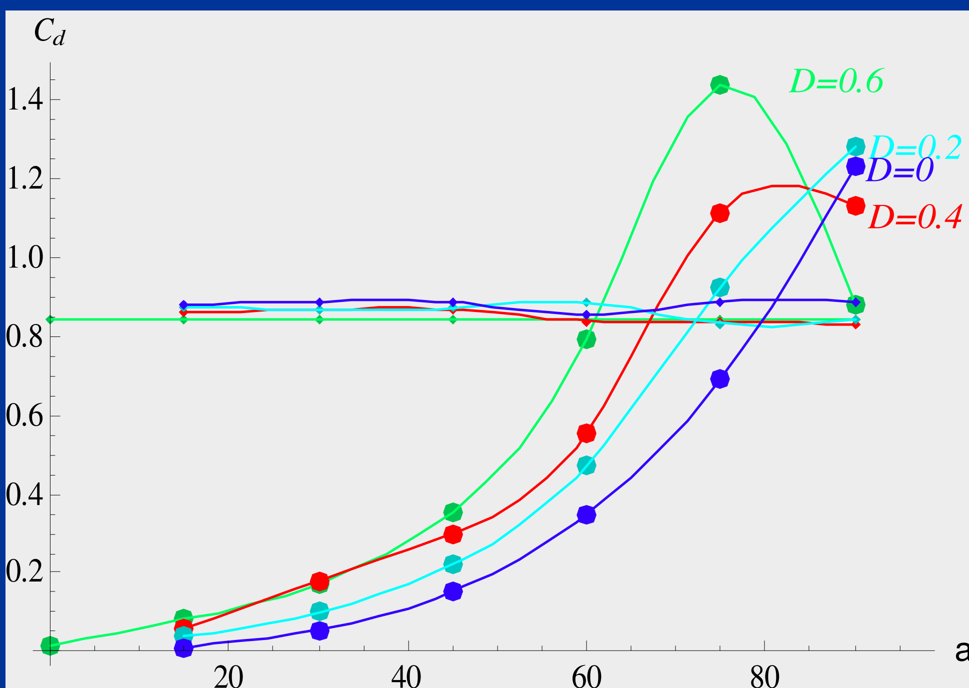
$$C_d = \frac{p_\infty}{0.5\rho_\infty V_\infty^2 S} \int_\Sigma p \cos\theta \, d\sigma$$

$$\rho_\infty V^2 / p_\infty = \gamma M^2$$

p_∞ - pressure in an incoming flow , ρ_∞ - density in an incoming flow, V_∞ - velocity of an incoming flow, S - the area of a sphere's midsection, θ - the polar angle counted from a forward point of sphere.



R1/ R2= 0.5



R_1/ R_2= 0.25

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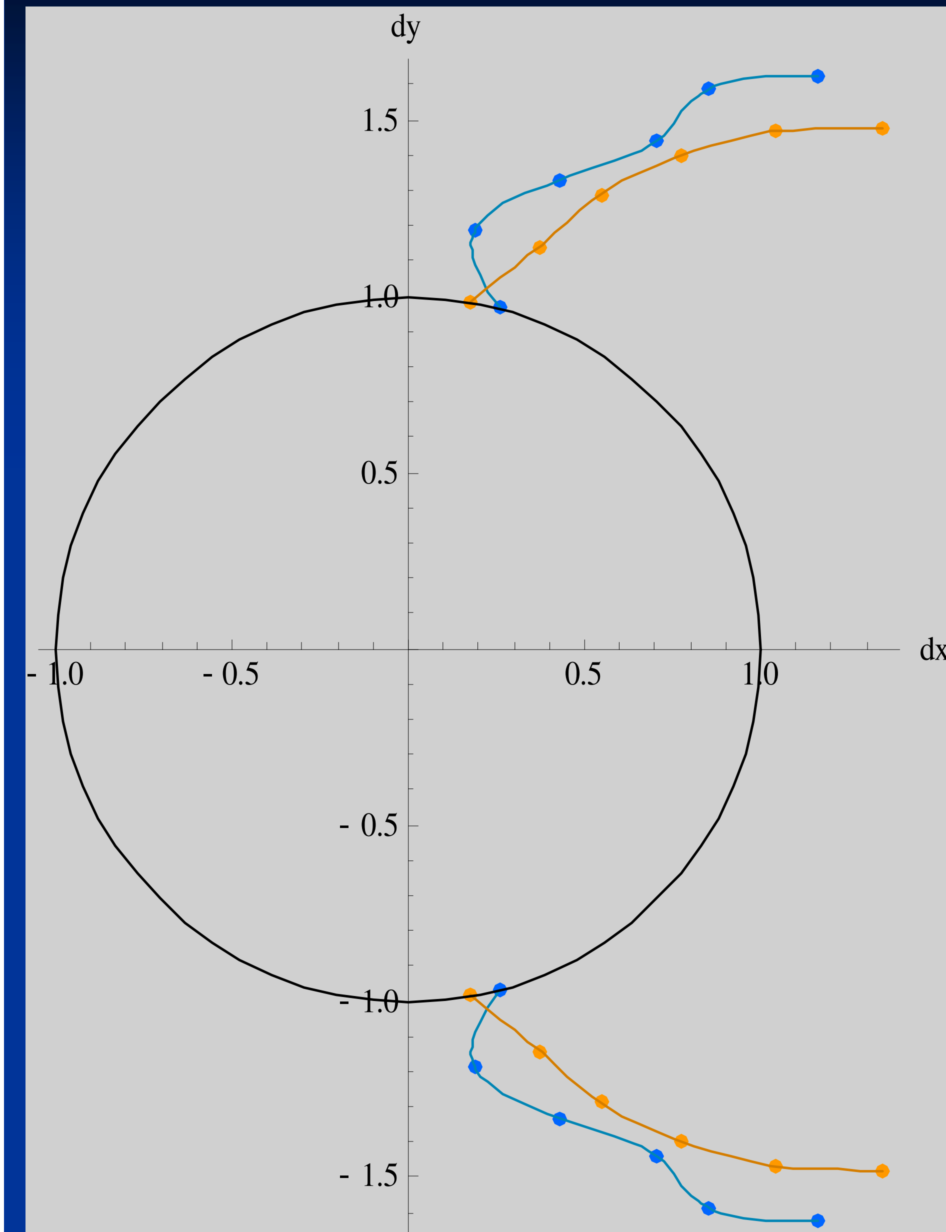
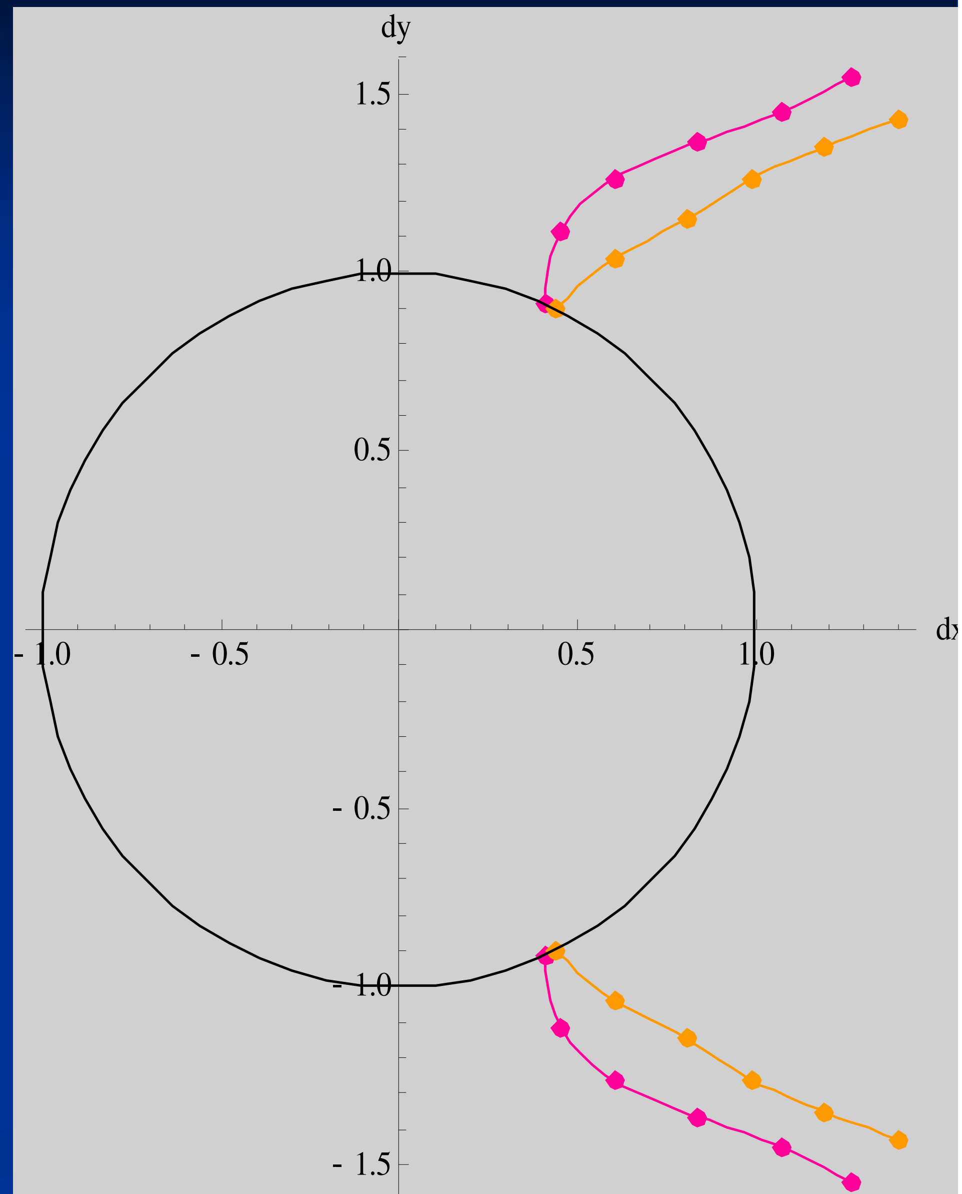
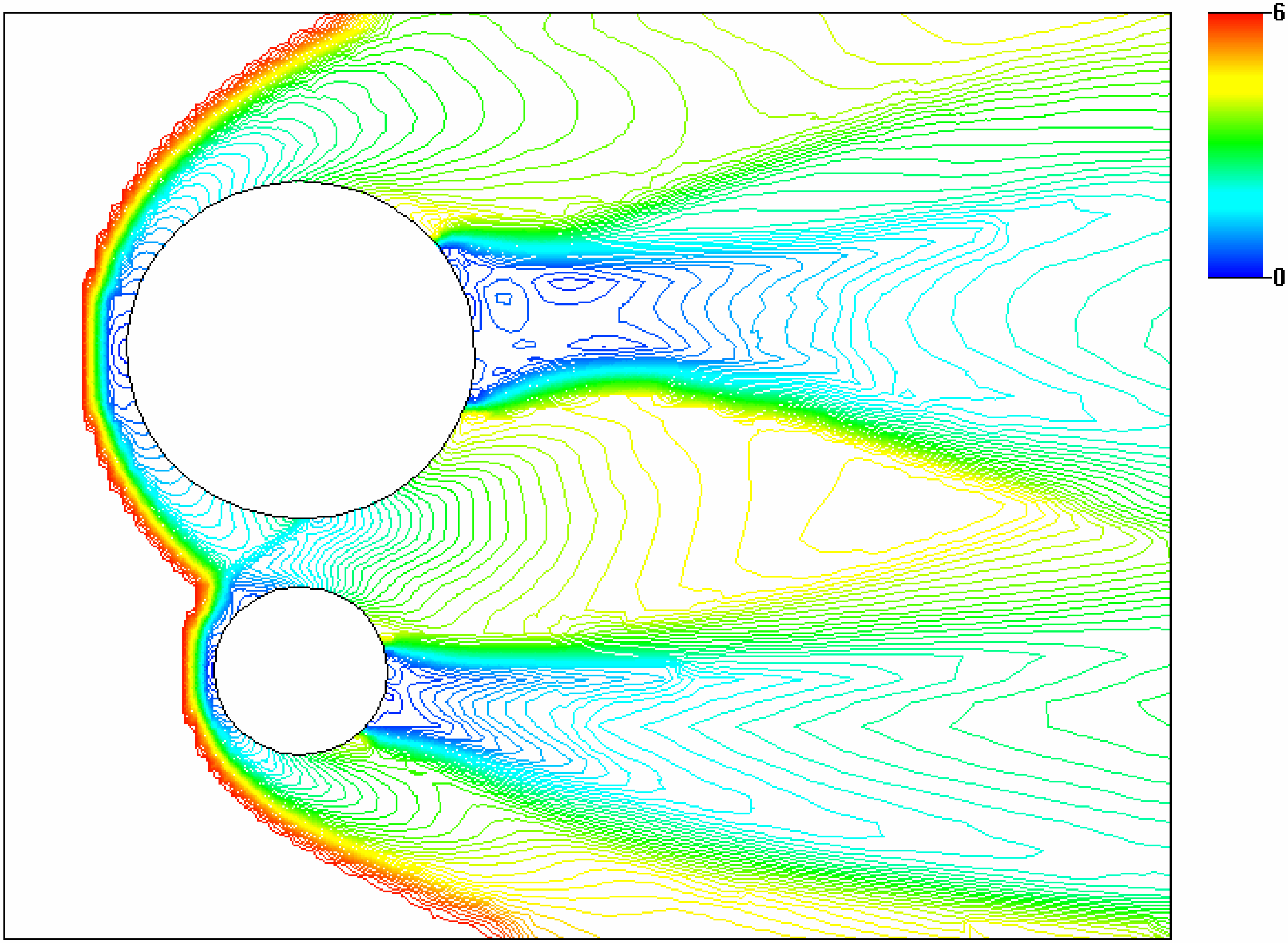


$R_1/R_2 = 0.25$

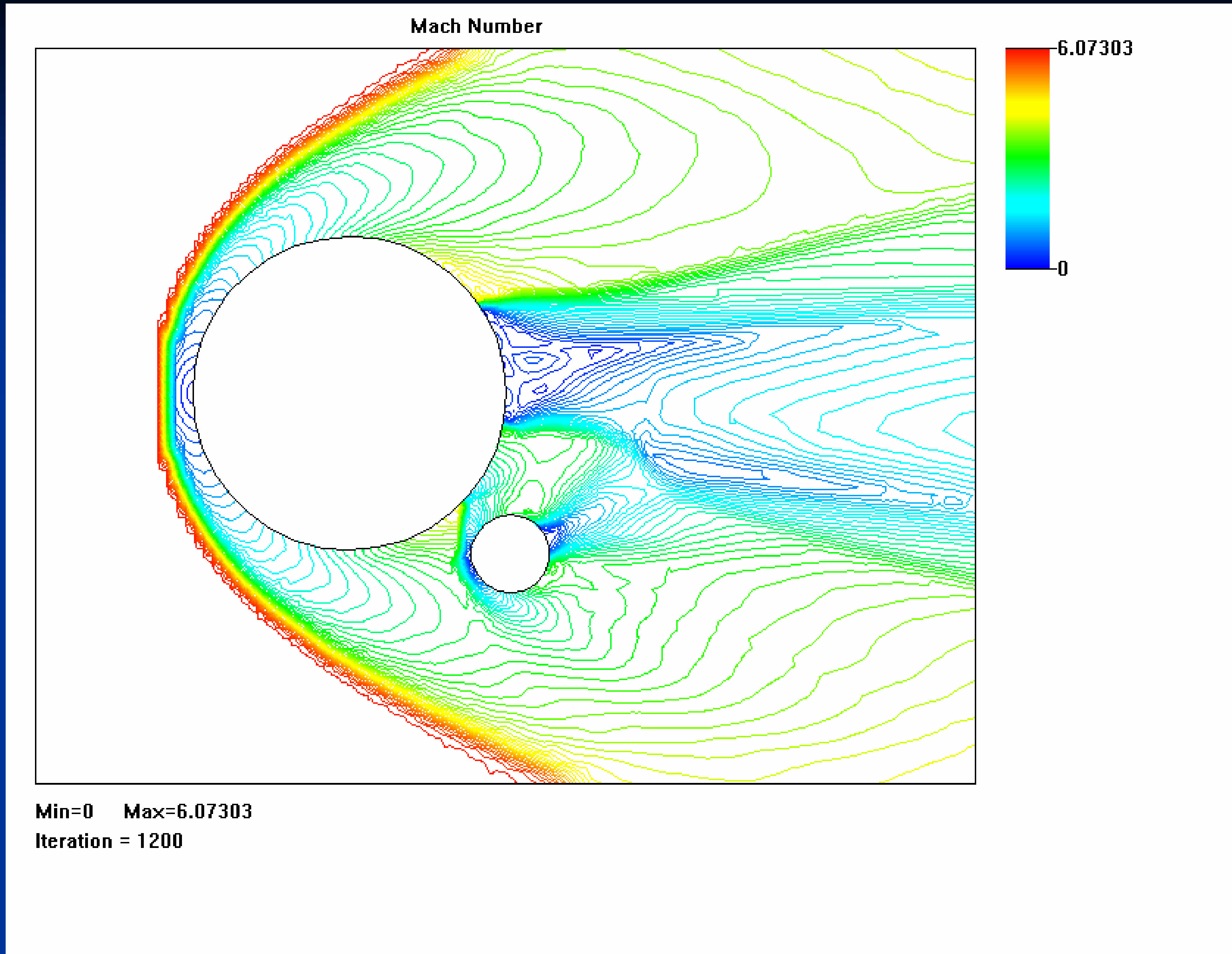


Mach Number



Min=0 Max=6

Iteration = 1440


Mach Number
6.07303
0
Min=0 Max=6.07303
Iteration = 1200

The basic aerodynamic properties of group of bodies in a supersonic flow

- The collimation effect is shown on a certain range of angles, smaller fragments are involved in the wake of the leading one. In case of fragments of the different size the collimation effect shown for smaller bodies on a wider range of angles.

- Resistance of the body in the wake is considerably smaller then resistance of the leading one except for positions where the shock wave of first body falls on the frontal surface of the backward one.

- Primary separation of external fragments from the central part (I.A. Zhdan, V.P. Stulov, P.V. Stulov (2005) 3D configurations of broken body fragments in a supersonic flow. Dokl. Phys. 50(10), 514–518).

Basic configurations in the process of the fragment swarm evolution