Fluids can flow in subsonic conditions, when the fluid velocity is lower than the local speed of the acoustic wave propagation, in transonic conditions, when the velocity is slightly lower or slightly higher than the speed of sound, or in supersonic conditions, when the velocity of the fluid is significantly higher than the speed of sound. The speed of sound in a fluid depends on the susceptibility of its density to changes in pressure. In liquids, i.e. fluids in which density changes very slightly with changes in pressure, the acoustic wave propagates at enormous speeds. In practice all liquid flows encountered in nature or technology are subsonic. The situation is completely different in the case of gas flows, where transonic and supersonic flows occur in many technical applications. Such flows are primarily found in aviation. The passenger planes currently in use travel at subsonic speeds. The supersonic airliner were the Concorde and Tupolev Tu-144, which were withdrawn from service. Fighter planes, missiles and shuttles entering the Earth's atmosphere move at supersonic speeds. A supersonic gas flow can occur not only in external flows, such as around the fuselage or wings of an aircraft, but also inside flow channels. Examples include the Scramjet (Supersonic Combustion Ramjet – a ramjet engine with a supersonic combustion chamber) and the last stages of steam turbines. It is obvious that a thorough knowledge of the physics of supersonic flows is very important in the design of many machines and contributes to improving their efficiency, safety and operational properties. Subsonic and supersonic flows are fundamentally different. The best example is the behaviour of a gas stream flowing in a de Laval nozzle, consisting of a convergent part, where the cross-sectional area decreases in the flow direction, and a divergent part. If the gas stream enters the de Laval nozzle at a subsonic speed, then, according to the principle of mass conservation, the stream will accelerate in the convergent part. If the speed of the gas stream is lower than the speed of sound at the narrowest point of the nozzle, in the nozzle throat, then the divergent part will slow down the stream, which is accompanied by an increase in pressure. The flow pattern changes completely if the gas velocity in the throat is equal to the speed of sound. In the divergent part the gas stream then accelerates further, with a parallel drop in pressure. If the pressure in the divergent part drops below ambient pressure at the nozzle outlet, then at some point the gas is compressed rapidly. This rapid compression of the gas is called a normal shock wave. In the shock wave, the pressure, density and temperature of the gas increase rapidly, while its velocity decreases to a subsonic value, and in the further diverging part of the nozzle the jet slows down and the pressure increases further. The shock wave is the result of the superposition of waves propagating before the shock at different velocities, which results in a very rapid pressure jump over a very short distance comparable to the mean free path between collisions of gas molecules. Using the second law of thermodynamics, the principle of the increase in entropy, it can be shown that a shock wave can only be generated in supersonic flows. If the flow in which the shock wave is formed is close to a solid wall, it is obvious that the wave cannot reach the wall because due to the gas viscosity, its velocity on the wall drops to zero. At a certain distance from the wall, the velocity of the gas changes from supersonic to subsonic, and the shock wave disappears. This phenomenon is called the interaction of the shock wave with the boundary layer. This interaction is very complex, due to rapid changes in the flow parameters in the shock wave, but also due to the complex physics of the turbulent flow in the boundary layer, characterized by the presence of vortex structures of very different sizes. In addition, the increase in pressure in the shock wave usually results in the boundary layer separation, in which the fluid adhering to the wall is suddenly moved away from it, which in turn causes a backflow at the wall, called a separation bubble. These phenomena have been the subject of intensive theoretical and experimental research as well as computer simulations for many years in many scientific centres around the world. It does not mean, however, that all the questions concerning the shock wave interaction with the boundary layer and the separation bubble have been fully and ultimately answered. It was recently observed that this interaction was characterized by some low-frequency oscillations, which caused a significant displacement of the shock wave, despite the stationary nature of both the inlet and outlet conditions in the nozzle. The source of these oscillations is therefore within the flow. The researchers investigating this phenomenon have still not reached a consensus on the reasons for these oscillations. Some of them claim that the shock wave oscillates in response to vortex structures conveyed in the boundary layer upstream of the shock wave. The second group argues that, on the contrary, these oscillations result from the periodic growth and contraction of the separation bubble downstream of the shock wave, acting upstream. The third, on the other hand, believes that both causes coexist, without giving an answer whether they are independent of or interrelated with each other to some extent. It is obvious that by understanding the mechanisms that cause shock wave oscillations in interaction with the boundary layer we will be able to propose new methods of controlling this phenomenon to either suppress or amplify it, depending on the application. The proposed research project takes up the challenge of finding answers to the above questions.