An increasing scientific activity in case of pressure and temperature studies on liquids can be observed within the most recent years, especially their physicochemical properties. The basic issues which have to be established are so-called thermodynamic response functions and the thermophysical properties of studied materials within the wide range of temperature and pressure. This approach enables revealing any regularities or anomalies occurring in the examined object. These researches lead not only to the development of fundamental studies on the condensed matter but also make possible the precise customization for engineer demands and, what is important in many cases, more economic application in industrial and social areas.

The knowledge of the system thermodynamic response functions, thermophysical properties and phase diagrams occupy a crucial significance in each areas of chemistry, chemical technology and engineering. The basic mathematical relationship which links them is so-called equation of state. It is fundament for every thermodynamic considerations, and its range of the application is greatly wide, not only in chemistry but also in medicine, biology, biotechnology, physics, *etc*. It has been well-established in the literature that the equations of states are derived from the phenomenological thermodynamics. These equations contain several parameters which have been estimated in order to certain group of liquid systems. As a consequence, the studies of a new group of liquids require a new equation dedicated to this specific system. Accordingly, the statistical thermodynamics is used instead of phenomenological thermodynamics which has a broader spectrum of structural analysis and it gives a versatile solution. However, current knowledge on equations of states in the meaning of practical usefulness indicate that the above approach is also not fully right. In example, the latest family of equations of states, SAFT, is characterized of high functionality. Nonetheless, their selectivity and the degree of mathematical nature complication disable wide, easy and fast applicability. It is worth noting that beside all the attempts and efforts devoted to the formulation of versatile equation of state, none of the derived models, up to date, has been found to be efficient enough for the properties prediction of a wide range of liquids in a wide range of pressure changes.

The accomplishment of this project is aimed to the deep recognition of the nature and the thermodynamic response functions of liquids in the wide range of temperature and pressure changes in association with other characteristic features of liquid state, *i.e.* fluctuations of thermodynamics quantities.

The authors of this project are highly convinced on the basis of deep analysis of scientific achievements of other authors up to date that the proposed fundamental studies which are based on liquid aliphatic and aromatic carbohydrates, aliphatic and aromatic alcohols, liquid fuels, technological fluids with unique properties like hydraulic fluids, and especially modern quaternary cation-based ionic liquids solvents, studied with high-pressure acoustic and transitiometric method, supported with equation of state modelling, will contribute to the construction of relatively versatile and predictive equation of state based on the fluctuation and perturbation theories. Correctly constructed mathematical model enables the prediction of the liquids thermophysical properties under high pressure without any previous knowledge of any parameters which are linked to high pressure. Moreover, the proposed studies beside the clear cognitive features where the experimental and modelling results determine an important contribution to the studies of liquids under high pressure, they also include a potential applicability aspects for fluids engineering.

The novelty of presented project is based on the association of unique high-pressure studies with simultaneous thermodynamic modelling which leads to the formulation of easy equation of state predicting the basic quantities, *i.e.* density, isobaric thermal expansion coefficient, speed of sound of liquids under high pressure without any previous knowledge of the liquids nature under pressure.