As an emerging new class of electronics, spintronics is projected to have a strong socio-economic impact and implications that can bring revolutionary changes in our society. Spintronic devices utilize electron spin for significantly enhanced or fundamentally new functionalities. Accomplishments of the present project impact both the field of spintronic device technology and the theory of fundamental many-body physics. Our calculations, the predicted new effects and methods provide important information for controlling spin and for measuring its behavior in semiconductor nanostructures. These are the current main challenges of spintronics. The project results are directed for solving these basic problems and certainly contribute to the European excellence and competitiveness. Particularly, the key contributions include:

- Developing a *new method* for calculations of the Lindhard polarization function in the presence of Rashba+Dresselhaus spin-orbit interaction (R+D SOI);
- Revealing a *doubly singular* behavior of the static polarization function, induced by R+D SOI. This new fundamental feature of the polarizability can lead to many novel phenomena in the many-body response of a two-dimensional electron system.
- Prediction of a new effect of the *beating of Friedel oscillations (*BFO), which can be controlled by an external electric field and observed through the tunneling microscopy imaging of the electron density distribution. The BFO is of general nature of systems with R+D spin-orbit fields and has a strong potential in spintronic device applications;
- Two exact solutions to the problem of spin edge states that generalize the half-century old bulk solution by Rashba to the important for spin transport case of the current carrying spin edge channels. There are only very few exact solutions of such problems and all of them are very instructive.
- Introduction of a new effect in electronic bilayers--the *spin Hall drag*--which consists of the generation of spin accumulation across one layer by an electric current along the other layer. The SHD arises from the combined action of spin-orbit coupling and many-body inter-layer Coulomb interaction and provides a unique tool for probing spins in spatially separated layers.

The results of the project provide a more detailed understanding of the basic phenomena that determine the transport of spin from one environment to another and the behavior of spin in many-electron systems in the presence of SOI. These phenomena open up new directions for future developments in semiconductor spintronics and bring completely new functionalities to influence and change the transport and relaxation properties of charge/spin carriers by means of SOI in a controllable manner.

The results obtained within the project have been disseminated by publishing them in the reputable international peer reviewed journals such as Physical Review Letters and Physical Review B and by posting on the condensed matter electronic archive. The Fellow has reports on the results of the project at invited seminar-talks in various well-known scientific institutions in Antwerp, Columbia, and Washington as well as has has oral presentations at prestigious international conferences, particularly organized by the American, European, and German Physical Societies.

The present project has allowed us to undertake several new collaborations and strengthen mutually beneficial co-operations between Regensburg University and other European and US institutions. As an effective mechanism for transferring of worldwide competitive knowledge to Armenia and building human capacity and contemporary society, in order to broaden the cooperation between the Yerevan State University and the University of Regensburg, Prof. Badalyan's PhD student from the Yerevan State University has been involved in the works of the project and during the project has successfully defended his thesis. The Fellow has successfully collaborated with one of our group members, Dr. Alex Matos-Abiague, who an expert on low-dimensional semiconductor systems, mesoscopic dynamics, and many-body effects in semiconductors. The Fellow has also initiated and strengthened various successful external collaborations. Our project has especially benefitted from the close scientific cooperation with Giovanni Vignale from the University Missouri-Columbia, who is one of the world leaders in studying the behavior of spin in many-electron systems in strong external fields, confined geometry and/or reduced dimensionality. During the project Prof. Vignale has visited Regensburg University and the Fellow has an extended visit to the University of Missouri-Columbia. Recently the faculty in the Physics Department has unanimously approved the Fellow's Adjunct Professorship at the University of Missouri-Columbia. During the project S. M. Badalyan has visited also University of Antwerp and continues successfully collaboration with Francois Peeters, who has great expertise in studying carrier transport in hybrid ferromagnetic-semiconductor nanostructures, especially in structures with nonhomogeneous magnetic fields. Recently the Fellow has visited the US Naval Research Laboratory and established a new collaboration with Alexander Efros who is an expert in studying device structures for utilizing the solar energy.