It is well known that a field of random waves in a fluid of non-zero resistivity is capable of exciting a large-scale magnetic field through creation of an electromotive force which leads to growth of magnetic energy until the growing Lorentz force reacts back upon the wave field, leading to a saturated state. It is generally found that in the limit of vanishing resistivity of the fluid many kinematic models lead to non-physical results; the applicability of such a theory to natural physical systems is then questionable.

The aim of this project is to relax standard simplifying assumptions of stationarity and homogeneity of turbulence and apply recently identified non-equilibrium dynamo mechanisms to the geodynamo theory. These mechanisms are fully dynamic, i.e. incorporate the effect of back reaction of the Lorentz force on the flow, for which the growing magnetic field remains smooth during the whole dynamo process. This results from a random superposition of distinct waves, such as the so-called MAC waves generated in the Earth's core by the Magnetic, Archimedean and Coriolis forces and the Rossby waves well known from the theory of atmosphere dynamics which are also present in the Earth's core. Particularly effective is the wave-beating effect or non-stationarity of the turbulence wave field, which leads to very fast amplification of the mean magnetic field. Such mechanisms not only efficiently amplify the magnetic field, but also lead to slow time dependence of the large scale electromotive force and turbulent magnetic diffusivity and through that provide an interesting and potentially promising explanation of the well-known dynamical process of geomagnetic excursions and reversals. The results of the project can therefore shed some light on the physics of geomagnetic reversals and provide highly desired picture of a turbulent process, which could be responsible for the observed long-term behaviour of the geomagnetic field.