The goal of the project is to study processes which strongly determine evolution of massive stars and are not fully understood. Massive stars, i.e., the stars with masses greater than about 8 solar masses, are the progenitors of the core-collapse supernovae and are responsible for most of the Universe enrichment in heavy elements. Massive stars are also the main source of ultraviolet radiation and play an active role in evolution of the chemical composition and structure of galaxies. Owing to their high luminosity, massive stars provide useful probe of the distance of galaxies. Moreover, the explosion of supernova can trigger the formation of new stars. Evolution of massive stars and conditions at the onset of the explosion as core-collapse supernovae are strongly determined by element mixing processes, internal rotation and mass loss.

These processes are not enough understood to provide calibration for stellar structure and evolution models. For example, we do not know the efficiency of element mixing near the convective core. This mixing has a strong influence on the evolution of the star because it brings a fresh, rich in hydrogen matter into the core. Then the nuclear reactions fuse hydrogen into helium and produce energy, which changes the internal structure and affects the lifetime of the star. Also, it is difficult to derived the internal rotational profile. The studies of some stars indicate that stellar cores rotate faster than envelopes, but the phenomenon is not well known. On the other hand, it is now recognized that efficient angular momentum transport from the core to the envelope is needed to slow down the core rotation, otherwise it would reach the critical (break-up) rotational velocity. For years the uncertainties of the mass loss caused be the stellar wind has been known. The amount of mass loss modifies substantially the evolution and the fate of the star.

Constraints on these processes will be achieved by the analysis of pulsations of massive star. The pulsations are a manifestation of the presence of hydrodynamical waves in interiors of some stars and cause a periodic expansion and contraction, cooling and heating the stellar surface. The effects of these phenomena are observed as changes of the brightness, radial velocity or the shape of spectral lines. The analysis of time series of such observations allows to extract eigenfrequencies corresponding to pulsational modes. The frequencies, which can be derived with a very high precision, and types of excited modes depend directly on the physical conditions inside of the wave propagation zone. Different modes have various propagation zones, thus by analysing a number of pulsational modes, we can look into the star layer by layer. In a similar way, geophysicists probe the structure of Earth, i.e. by analysing the propagation of elastic waves caused by earthquakes.

In recent years, a number of detected frequency peaks have increased enormously thanks to satellite missions like MOST, CoRoT and Kepler. Owing to the micromagnitude precision and long timebases, the space data are a goldmine for studying pulsating stars. Moreover, observations from the BRITE space mission, in which Poland also participates, have just become available. The precision of the BRITE data is much lower but this is the first space mission yielding the two-colour photometry which is crucial for mode identification, i. e., for association of the observed frequencies with pulsational modes. Space observations as well as ground based data will be used in the project.

In order to derive constraints on the above mentioned processes we will construct so-called *seismic models*, i.e., models which reproduce, within the observational errors, the observed frequencies of pulsations. This new field of astrophysics is called *asteroseismology* and it provides by far the most precise tests for the theory of stellar structure and evolution. Moreover, using this technique we will also test an input from microphysics data, in particular opacities. The values of opacities are of great importance as they determine the transport of energy through matter. Therefore the revision of these data is vital for all branches of astrophysics. The pulsations of massive stars are extremely sensitive to the opacity data. In turn, the opacity depends on the properties of the atoms and ions. There are strong indications that the currently used atom models can be inaccurate. Our aim is to explore what is still missing in the opacity data.

The innovative nature of the project involves the simultaneous determination of seismic corrections to the model, the profile of internal rotation and opacity. In the case of stars pulsating in at least over a dozen of modes we will attempt to determine these corrections by solving the so-called *inverse problem.* Such an approach will be applied for the first time to stars other than the Sun. In other cases, we will make seismic analysis by solving the so-called *forward problem*, i.e., a direct fitting of the theoretical frequencies to the observed ones.