The cosmological constant Λ was first added to the gravitational field equations in 1917 by Albert Einstein. Einstein preferred the static universe, whereas field equations without the cosmological constant did not allow for such a scenario. A series of later observations mainly by Slipher, Lemaitre and Hubble showed the universe to be dynamic, which led to the cosmological constant being neglected from Einstein's field equations. In the early 1990s, it became clear that the expansion of the universe accelerates and the cosmological constant emerged in the field equations again, as an explanatory element. Based on a study by Perlmutter and Riess who observed distant type Ia supernovae, the cosmological constant is positive with a value of $10^{-56} \quad cm^{-2}$. The 2011 Nobel Prize was awarded for this discovery. Within the limit of weak gravitational fields and low velocities, Einstein's theory of gravitation must be reduced into Newtonian theory of gravity, the so-called Newtonian limit of Einstein equations. The full Einstein equations of the gravitational field, in the Newtonian limit, are not reduced exactly to Poisson's equation of Newtonian theory of the gravitational field. The Newtonian limit contains two additional terms with the cosmological constant, which the classical theory of gravity does not account for. The potential difference between the Poisson equation and the Newtonian limit must be at non-cosmological distances (typical distances of the solar system) negligible. The numerical solution of the given potentials shows changes in the differences with respect to the choice of density profiles.