Stellingen

Behorend bij het proefschrift

Sterile neutrinos in the early Universe

1. The combination of Big-Bang Nucleosynthesis and previous accelerator bounds for sterile neutrinos that describe neutrino oscillations closes the parameter space below the mass of the π-meson.

   (*Chapters 2 and 3*)

2. Existing accelerator bounds do not exclude the possibility that the influence of sterile neutrinos on the evolution of the lepton number is very different for different lepton flavours.

   (*Chapter 2*)

3. The instability towards the development of the long-wavelength magnetic fields in the presence of chiral asymmetry exists even for massive particles in the regime when the wavenumbers of magnetic fields are much smaller than the mass of the particle.

   (*Chapter 4*)

4. The Chiral Magnetic Effect for massive particles is a non-equilibrium phenomenon. In equilibrium, the parity-violating nature of fundamental interactions *does not* lead to chiral asymmetry and no instability of the magnetic fields is developed.

   (*Chapter 5*)

5. In renormalizable gauge theories different contributions to the parity-odd part of the free energy of the electromagnetic field in a high-density medium cancel each other.

   (*Chapter 5*)

6. A great deal of theoretical and experimental efforts is dedicated to searches of new fundamental physics at high energies (for example, at the Large Hadron Collider). However, new physics can be found at *low* energies instead, in which case a special strategy of searches should be implemented.

   M. Anelli et al., arXiv:1504.04956

7. Although new particles can interact with ordinary matter even much weaker than neutrinos, they drastically change the state of the Universe at the early stages of its evolution.

   S. Alekhin et al., arXiv:1504.04855

8. Straightforward applications of methods of quantum field theory at finite temperature may give convergent results for observable quantities that are however ill-defined.

   M. Dvornikov, Phys. Rev. D **90** (2014) 041702

9. Cosmological and astrophysical observations are as important for our understanding of the Universe at the fundamental level, as the direct accelerator searches are.

   A. Boyarsky, O. Ruchayskiy, M. Shaposhnikov, Ann. Rev. Nucl. Part. Sci. **59** (2009) 191-214

10. Our current understanding of fundamental physics can be formulated in a compact set of elegant equations. However, a real understanding of their meaning and of how many different phenomena they imply, comes only after years of effort and experience.

Artem Ivashko
Leiden, 9 December 2015