Probing fundamental interactions by precision measurements of β–ν correlations

M. Hass[1], O. Heber[1], T. Hirsh[2,] Y. Mishnayot[3], I. Mukul[1], M.L. Rappaport[1], S. Vaintraub[2],
1 Weizmann Institute of Science, Rehovot, Israel
2 Soreq Nuclear Research Center, Yavne, Israel
3 The Hebrew University, Jerusalem, Israel
Contact email: *michael.hass@weizmann.ac.il*

One of the possibilities to study fundamental interactions and the underlying symmetries is via precision measurements of the parameters of beta decay of trapped radioactive atoms and ions, thus probing the minute experimental signal that originates from possible tensor or scalar terms in the weak interaction of beyond-the-standard-model nature. For precision measurements of this correlation, traps are mandatory since the recoiling nuclei, subsequent to the beta decay, are at sub-keV energies.

We have embarked on an experimental scheme to study the beta-neutrino correlation by measuring the decay of trapped light radioactive ions inside an Electrostatic Ion Beam Trap (EIBT). This is a novel use of such a device, extensively used in atomic and molecular physics, exhibiting several advantages compared to other commonly used trapping schemes in terms of concept, efficiency and ease of operation. The entire apparatus has been constructed at the Weizmann Institute, with commissioning experiments using stable ^{4}He ions. The specific radioactive isotopes under study, ^{6}He and ^{16}N, will be produced by energetic neutrons impinging on a porous, hot BeO target via the ^{9}Be(n,α)^{6}He and ^{16}O(n,p)^{16}N, respectively. The fast neutrons are delivered by a commercial (D+T) 14 MeV neutron generator and by use of a D beam from the 2.5 MV Van de Graaff accelerator at the WI.

On a parallel track, we also are preparing measurements using a dedicated MOT trap for Ne isotopes, being commissioned presently at the Hebrew University in Jerusalem. The first nucleus in the chain of several neon isotopes will be ^{23}Ne, produced via the ^{23}Na(p,n_23Ne reaction.

At a later stage, the program will utilize the neutrons from the intense ~1 mA, 5.5 MeV d beam of the newly constructed super-conducting LINAC, "SARAF Phase I", at the Nuclear Research Center, Soreq. The construction of the target room for SARAF-I will take place during 2015/16. Both setups, the EBIT trap, the EBIS ion source and the high-temperature oven with the porous BeO target (for ^{6}He and ^{16}N) and the MOT trap for Ne will be transferred to the new target room as soon as possible in order to commence experiments thereof.

The SARAF I, delivering up to 2 mA beams of protons and deuterons at ~5MeV, is being extended to the full design of SARAF-II at 40 MeV. Such a facility is very similar in scope, albeit at lower current, to the planned IFMIF

We report the results of commissioning runs and progress in this project.