Determination of surface thickness of ^{208}Pb at MAMI

For the first time the surface thickness of ^{208}Pb will be determined in parity-violation electron scattering at MAMI. These data will remove the dominant model dependence in the method to extract the neutron-skin thickness from parity-violation experiments, thus paving the way for a firmer determination of the symmetry energy of the EOS in the laboratory.

Literature:

J. Piekarewicz and F. Fattoyev Physics Today **72**, 7, 30 (2019)
M. Thiel et al, J. Phys. G: Part. Phys., **46**, 093003 (2019).
B. T. Reed at al. Phys. Rev. C **102**, 064308

1. The EOS of nuclear matter: Astro vs. Lab measurement
2. Neutron Skin of Nuclear: Experimental methods and their limitation
3. Surface thickness measurement
4. Experimental set-up (A1@MAMI)
5. Proposal for a measurement at MAMI

- Expected rates (based on luminosity, interaction rate etc)
- Target requirement (cooling, frame etc)
- Radiation, beam losses, beam dump

Possible extension:

4. Preliminary simulation

- Sensitivity from theory
- Simulation of the experimental setup

5. Target development

- Cooling

6. Commissioning of the experiment (target and electronics)
7. Data taking and data analysis

<u>Input to 1. to 3.</u>

The size of the neutron sphere in ^{208}Pb is set by a balance between surface tension, which favors a compact configuration, and symmetry pressure, an outward push caused by having more neutrons than protons.

The competition between those forces is captured in the nuclear equation of state, (EOS) which relates the density of nuclear matter to the outward pressure it generates.

The equation is also important for describing neutron stars because the same symmetry pressure that determines the neutron skin in a nucleus also supports the stars against collapse.

Despite being 18 orders of magnitude different in size, nuclei and neutron stars are governed by the same physics enshrined in the EOS.