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PROPOSAL TO DETERMINE THE QUADRUPOLE MOMENT IN ^{185}Re AND ^{187}Re FROM PIONIC AND MUONIC X-RAYS

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Aim

To determine both the effective quadrupole moment (pions) and the spectroscopic quadrupole moment (muons) from the hyperfine patterns of the X -ray spectrum from a rhenium target.

Required measuring time : 30 shifts

As shown in the accompanying paper nuclear quadrupole-moments can be measured to a rather high precision (1 to 2%) from the hyperfine splitting of the 5 g → 4 f and the 6 g → 4 f pionic X-rays. An additional model-independent determination of the spectroscopic quadrupole moment can be obtained from experiments with stopped muon beams, where one measures e.g. the 5 g → 4 f and 4 f → 3 d muonic X-ray transitions. A combination of the two experiments would make it possible to determine the strong interaction quadrupole constant more accurately and to gain information on the nuclear neutron density distribution and its deformation.

Natural rhenium consists of two isotopes A = 185 (37.5%) and A = 187 (62.5%), both isotopes having a nuclear ground state spin of $J^{\pi} = 5/2^{+}$. Although the quadrupole moments of the rhenium isotopes ($Q \approx 2.4$ b) have not yet been determined very accurately the ratio of the nuclear quadrupole moments has been determined to be $Q^{185}/Q^{187} = 1.0565 \pm 0.0003$ (Sov.Journ.Nucl.Phys.7 (1968) 797 english transl.) by measuring NQR frequencies. As the ratio is so close to unity this allows for an accurate analysis of the hf pattern and a determination of Q with an accuracy of a few percent. Furthermore, the strong interaction monopole shift ε_0 and the width Γ_0 of the 4 f level can be measured and compared with the values obtained from the standard optical potential description of the pion-nucleus interaction.

The equipment necessary for this measurement exists already or can easily be obtained within the budgets of the proposing groups. It would be preferred to work with beams in the muon channel where the conditions regarding intensities, beam purity, etc. are well known to us.

The 30 shifts asked for should be sufficient to carry through the whole experiment both with pions and with muons.

Most of the computing needed will be done outside CERN and we estimate the total need at CERN to be of the order of two hours CP time on the 7600 computer.

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