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Collective deformation of neutron distribution in nuclei probed by proton inelastic scattering

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The electromagnetic probes such as electrons and γ-rays are very useful tool to study proton distribution and its deformation in nuclei.
However, the neutron distribution and its deformation are almost insensitive to the electromagnetic probes and one needs
to use hadronic probes, such as protons and composite nuclei.
In this paper, we propose a grobal method to extract information about the deformation of neutron distribution in nuclei,
over the whole range of nuclear chart, using proton inelastic scattering which is analyzed by a microscopic coupled-channels method based on a complex G-matrix interactions.

In this method, a collective model is assumed for transition densities for protons and neutrons and the deformation
length for neutrons is the only parameter to be determined from the comparison of calculation with experimental data for
the proton inelastic scattering, whereas the proton deformation length is expected to be known independently from electric transition probability, $B(\mathrm{E}\lambda)$, obtained e.g. from the γ-ray measurements.
All the diagonal/transition pontetial for the proton inelastic scattering are calculated by folding the JLM complex G-matrix
interaction [1] with the diagonal/transition densities. The proton and neutron density distributions are assumed to have a simple Fermi form factor and its geometrical parameters are fixed so as to reproduce the rms charge radii
for protons, while for neutrons the parameters are fixed so as to adjust the rms radii given by a Hartree-Fock calculation [2].
Therefore, no free parameter is left in this method except for the neutron deformation length to be determinded from the
comparison with the proton inelastic-scattering cross sections.
We have tested this method in proton inelastic scattering by various stable and unstable nuclei, typical examples of which
are shown in Figures. The solid curves for ^{208}Pb target and the dotted ones for ^{20}O target are the results with $M_n/M_p = N/Z$, where M_n (M_p) denotes the r^2-moment of the neutron (proton) transition density.
The solid curves for ^{20}O target show the result with $M_n/M_p = 3.78$ which is much larger than N/Z, indicating
an extra deformation of neutrons in ^{20}O, which is consistent with the result by other method [3].

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