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Electron screening effect in nickel

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For very low projectile energies, far below the Coulomb barrier, the nuclear reaction rate is very low and sensitive to electronic properties of target materials. In this case the projectile tunnels through a wide potential barrier. However, the electrons which are surrounding the reacting nuclei act as a screening potential, which leads to the incoming projectile seeing an effectively reduced Coulomb barrier. This increases the tunneling probability and enhances the nuclear reaction rates. To investigate the electron screening effect we compared γ-ray yields in different environments (Ni –metal and NiO –insulator) for the proton induced nuclear reactions: Ni-58(p,γ), Ni-60(p,γ) and Ni-64(p,nγ). We used a proton beam with energies between 1.08 MeV and 3.08 MeV accelerated by the 2 MV Tandetron accelerator at Jožef Stefan Institute. We also looked for shifts in resonance energy for reactions Ni-58(p,γ)and Ni-58(p,p'γ).

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Elastic scattering of ^{17}O ions from ^{58}Ni and ^{208}Pb at near-barrier energy

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Elastic scattering experiments provide a first information on the overall reactivity of an exotic projectile. We have recently undertaken a research program aimed at measuring the ^{17}O elastic scattering process from different targets, being ^{17}O (S_n = 4.143 MeV) the mirror nucleus of the weakly-bound and radioactive ^{17}F (S_p = 0.600 MeV).

The experiment was performed at the Laboratori Nazionali di Legnaro with an ^{17}O beam impinging on a ^{58}Ni (150 μg/cm^2) target at 2.5-MeV steps from 42.5 to 55 MeV and on a ^{208}Pb (200 μg/cm^2) target at 5 energies in the interval 78-87 MeV.
We used three modules of the EXPADES detector array. Two 300-μm thick Double Sided silicon Strip Detectors (DSSSDs) were placed symmetrically to the beam axis to cover the angular range θ_{lab} = [36°-74°]. A DSSSD telescope (40+300 μm) was placed at backward angles to cover the range θ_{lab} = [95°-125°]. The results were analyzed within the framework of the optical model to extract the reaction cross sections.

Quite unexpectedly, the reaction cross sections, after being scaled for the different projectile atomic number, result to be larger for the stable well-bound ^{17}O rather than for the weakly-bound radioactive ^{17}F. Therefore, we can conclude that for the pair ^{17}O-^{17}F nuclear structure effects play a more

crucial role than the projectile binding energy in the reaction dynamics at Coulomb barrier energies.