First observation of nuclear rainbow scattering in $^{16}O+ ^{40}Ca$ system

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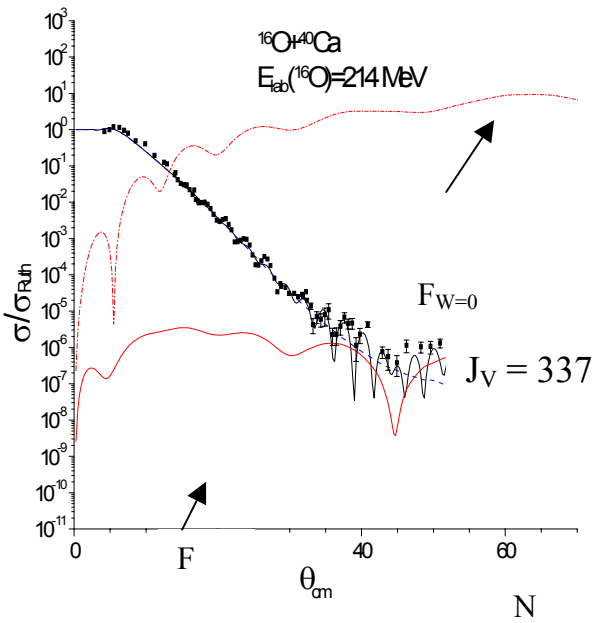
The differential cross-section of the $^{16}O + ^{40}Ca$ elastic scattering was measured at the ^{16}O energy 214 MeV. The aim of the work was searching for the signatures of rainbow scattering in such heavy projectile-target (P-T) combination. As nuclear rainbow phenomenon corresponds to deep interpenetration of the colliding nuclei it is expected that the region of nucleon densities overlap must contain significantly more nucleons in comparison with the systems studied before (the heaviest P-T system for which rainbow patterns were observed until now was $^{16}O + ^{16}O$). Consequently, this would provide some important new information on the dynamics of nucleus-nucleus interaction at small distances and properties of nuclear matter. Several attempts to identify nuclear rainbow scattering in $^{16}O + ^{40}Ca$ were unsuccessful due to extremely strong absorption resulted in domination of diffraction scattering.

The experiment was done at Jyvaskyla cyclotron with the use of Large Scattering Chamber. Two types of detector systems were employed in different angular ranges: ΔE – E telescopes and kinematical coincidence method. The angular distribution was measured up to 60^o cm, and the cross-section level of 10^{-4} –10^{-5}mb/sr was reached.

Though the data demonstrate huge diffraction scattering coming from the interference of near (N) and far (F) components of the differential cross-section there are some definite indications of the presence of rainbow scattering: * quite definite change of slope at $\theta > 40^o$;



* the existence of a minimum (at 45^o), which is repeated by F - component; *predominance of the latter at larger angles; * the existence of a minimum in F – component with the turned-off absorption ($F_{W=0}$) at the same angle.

The preliminary analysis shows that 45^o- minimum is a supernumerary one (probably, of 2^{nd} or 3^d order). It corresponds to the distance of closest approach ~ 3 fm. The volume integrals of the real part of potential lie in the range 290 – 340 MeV*fm^3 in agreement with the existing systematics and normal values of the effective nucleon-nucleon interaction.