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Nuclear rainbow in the inelastic nucleus-nucleus scattering

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The nuclear rainbow, observed in the elastic α-nucleus and light heavy-ion (HI) scattering at medium energies, is proven to be due to the refraction of the incident wave by the attractive nucleus-nucleus optical potential. The rainbow pattern is usually associated with a broad oscillation of the Airy minima in elastic scattering cross section, as a result of an interference of the refracted far-side trajectories. A similar refractive scattering pattern is naturally expected to be seen also in the inelastic scattering of the nucleus-nucleus system that exhibits a pronounced rainbow pattern in the elastic scattering. Some feature of the nuclear rainbow in the inelastic light HI scattering has been observed so far in experiments, like the measurement of the inelastic 16O+12C scattering at refractive energies by the Kurchatov-institute group. As variance with the elastic channel, the obtained data show a much weaker rainbow pattern in the inelastic scattering cross section, with the Airy structure much suppressed and smeared out. To investigate this effect, a method of the decomposition of the inelastic scattering amplitude into subamplitudes is proposed in the present work to explicitly reveal the coherent partial-wave contributions to the inelastic cross section. Based on the new decomposition technique, our coupled channel analysis of the elastic and inelastic 12C+12C , 16O+12C , and α+90Zr scattering at refractive energies has shown unambiguously that the suppression of the Airy structure of nuclear rainbow in the inelastic nucleus-nucleus scattering is due to the multipole mixing of different partial waves that give rise to the inelastic cross section.

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