Shape and Angular Distribution of the 4.438-MeV Line from Proton Inelastic Scattering off ^{12}C

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The emission of the 4.438-MeV γ-ray line in proton inelastic scattering off ^{12}C has been investigated in detail. For this, two independent descriptions of the correlated scattering and emission process have been developed, one for the direct reaction mechanism and the other for the compound-nucleus (CN) component. Direct reactions are calculated in the framework of the optical model of nuclear reactions, while the CN component is described as a superposition of separate resonances with definite spin and parity, treated with the angular momentum coupling theory. The calculations are compared to a comprehensive data set on measured line shapes and angular distributions in the proton energy range $E_p = 5.44$–25.0 MeV. In the range $E_p \approx 12$–25 MeV a good agreement is obtained in calculations assuming direct reactions. At lower energy, the data are reproduced by incoherent sums of the direct component with typically one CN resonance. Based on these results, predictions for line shapes and γ-ray angular distributions are made and applied to line-shape calculations in solar flares and proton radiotherapy.