Constraining the 6.05 MeV 0^+ and 6.13 MeV 3^- cascade transitions in the $^{12}C(\alpha,\gamma)^{16}O$ reaction using the asymptotic normalization coefficients

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The $^{12}C(\alpha,\gamma)^{16}O$ reaction plays a fundamental role in astrophysics and needs to be known with accuracy better than 10%. Cascade γ transitions through the excited states of ^{16}O are contributing to the uncertainty. We constrained the contribution of the 0^+(6.05 MeV) and 3^-(6.13 MeV) cascade transitions by measuring the asymptotic normalization coefficients for these states using the α-transfer reaction $^6Li(^{12}C,d)^{16}O$ at sub-Coulomb energy. The contribution of the 0^+ and 3^- cascade transitions at 300 keV is found to be 1.96±0.3 and 0.12±0.04 keVb for destructive interference of the direct and resonance capture 4.36±0.45 and 1.44±0.12 keVb for constructive interference, respectively. The combined contribution of the 0^+ and 3^- cascade transitions to the $^{12}C(\alpha,\gamma)^{16}O$ reaction cross section at 300 keV does not exceed 4%. Significant uncertainties have been dramatically reduced.

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