

Comment on H Brysk's article on multiphoton absorption

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COMMENT

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S Jorna

Physical Dynamics Incorporated, PO Box 556, La Jolla, California 92038, USA

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Abstract. It is shown how Brysk's expansion for the function F can be obtained directly by analytic continuation of its series representation.

Brysk's expansion for the function F can be obtained straightforwardly by analytic continuation of its series representation (Brysk 1975, equation (7)):

$$F = \frac{3}{4} \sum_{k=0}^{\infty} \frac{(2k+2)!}{(k+\frac{3}{2})k![(k+1)!]^2} \left(\frac{x}{4}\right)^k \tag{1}$$

The Mellin-Barnes integral representation of this ${}_2F_2$ hypergeometric function is

$$F = \frac{3\pi^{-1/2}}{2\pi i} \int_{-i\infty}^{i\infty} \frac{\Gamma(-\mu)\Gamma(\mu+\frac{3}{2})}{(\mu+\frac{3}{2})\Gamma(\mu+2)} x^\mu d\mu \tag{2}$$

which has simple poles at $\mu = -n - \frac{3}{2}$, $n = 1, 2, \dots$, and a double pole at $\mu = -\frac{3}{2}$. The series expansion in inverse powers of x then follows immediately by summing the residues at these poles. We obtain

$$F = 3\pi^{-1/2} \frac{d}{d\mu} \left(\frac{x^\mu \Gamma(-\mu)}{\Gamma(\mu+2)\Gamma(-\mu-\frac{1}{2})} \right)_{\mu=-3/2} - 3\pi^{-1/2} \sum_{n=1}^{\infty} \frac{(-1)^n \Gamma(n+\frac{3}{2})}{n! \Gamma(-n+\frac{1}{2}) n} x^{-n-3/2} \tag{3}$$

or, carrying out the differentiation,

$$F = \frac{3}{2} \pi^{-1/2} x^{-3/2} \left(\ln x + 4 \ln 2 - 2 + \gamma - 2\pi^{-1} \sum_{n=1}^{\infty} \frac{\Gamma(n+\frac{3}{2})\Gamma(n+\frac{1}{2})}{nn!} x^{-n} \right), \tag{4}$$

in agreement with Brysk's expression.

References

Brysk H 1975 *J. Phys. A: Math. Gen.* **8** 1260-4