# 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)):

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

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

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

which has simple poles at $\mu = -n-\frac{3}{2}$, $n = 1, 2, \ldots$, 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

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

or, carrying out the differentiation,

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

in agreement with Brysk's expression.

## References

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