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Perfect vortex beams expressed as Laguerre-Gauss modes

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Introducción

We prove that perfect vortex beams (PVB)[1] form basis and can be expressed in terms of Laguerre-Gauss(LG)[2] modes and vice versa.

Desarrollo

From [1,4,5] we have:

$$\sum_{l=-\infty}^{\infty}\int_0^{2\pi}\int_0^{\infty} PVB_l \cdot PVB_l^* \cdot rdrd\theta = 1 \tag{1}$$

From [2] we have the expression of the LG modes:

$$LG_{lp}(x) = \sqrt{\frac{2}{\pi}}\sqrt{\frac{p!}{(|l|+n)!}}\frac{\exp^{-\frac{ikr^2}{2q(z)}}}{W(z)}\left[\frac{\sqrt{2}r}{W(z)}\right]^{|l|} L_p^{|l|}\left[\frac{2r^2}{W(z)^2}\right]\exp^{i(l\theta+(2p+|l|+1)\zeta(z))} \tag{2}$$

From [3] we can obtain the coefficients of expansion C_{lp} and C_l :

$$C_{lp} = \int_0^{2\pi}\int_0^{\infty} PVB_l \cdot LG_{lp}^* \cdot rdrd\theta \qquad C_l = \int_0^{2\pi}\int_0^{\infty} PVB_l^* \cdot LG_{lp} \cdot rdrd\theta \tag{3}$$

With which we can write:

$$PVB_l = \sum_{p=0}^{\infty}\sum_{l=-\infty}^{\infty} C_{lp} \cdot LG_{lp} \qquad LG_{lp} = \sum_{l=-\infty}^{\infty}\int_0^{\infty} C_l \cdot PVB_l \cdot rdr \tag{4}$$

Referencias

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