Second-order polarization-mode dispersion in photonic crystal fibers

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While the polarization decorrelation length is the scale on which the ensemble average 
\[ \langle S(t) \rangle \]
reaches its asymptotic value of 0, the diffusion length \( d_t \) is defined as the distance it takes for the variance to reach its asymptotic value of 1/3. This asymptotic value is 1/3 since the Stokes vectors are asymptotically uniformly distributed on the Poincaré sphere. We define the diffusion length \( d_t \) to be the maximum of the values \( d_1, d_2, \) and \( d_3 \). In Fig. 2, we show the results for different values of \( \tau / \alpha \).

These results show that as the ratio \( \tau / \alpha \) converges to the isotropic value 1, the local diffusion length becomes proportional to the fiber decorrelation length \( d_{C}\). However, the diffusion length has the same convex dependence on \( d_{C} \) as for all values of \( \tau / \alpha \), except for the isotropic case \( \tau / \alpha = 1 \), which is a singular limit. Thus, a small ellipticity has no significant effect on system behavior as compared to the case of only linear birefringence. However, the variation in the diffusion lengths for small \( \tau / \alpha \) and \( \alpha / d_{C} \) becomes larger indicating that the interaction between nonlinearity and PMD is changed as the strength of the ellipticity is increased.

In conclusion, we have described the dependence of both the polarization decorrelation length and the diffusion length on the amount of ellipticity present in an optical fiber. These results demonstrate in particular that the expression for the DGD in terms of the fiber correlation length does not depend on the strength of ellipticity. However, the diffusion is in general anisotropic on the Poincaré sphere, which affects nonlinear interactions. A small ellipticity does not significantly affect results that are predicted by a model that assumes that fibers are linearly birefringent.

References
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Conclusion

We have successfully measured first- and second-order PMD on two successive pulls of triangular structured PCF. The two PCFs were pulled under different conditions, which affected both the birefringence and the mode-coupling length. The experiment showed that the PMD of these fibers behaved in the same way as in standard fibers and could be treated using conventional methods. The reported PMD was comparable to the PMD reported in the mid-1990s for standard fibers.

References

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