Structured light at spatial/temporal interfaces

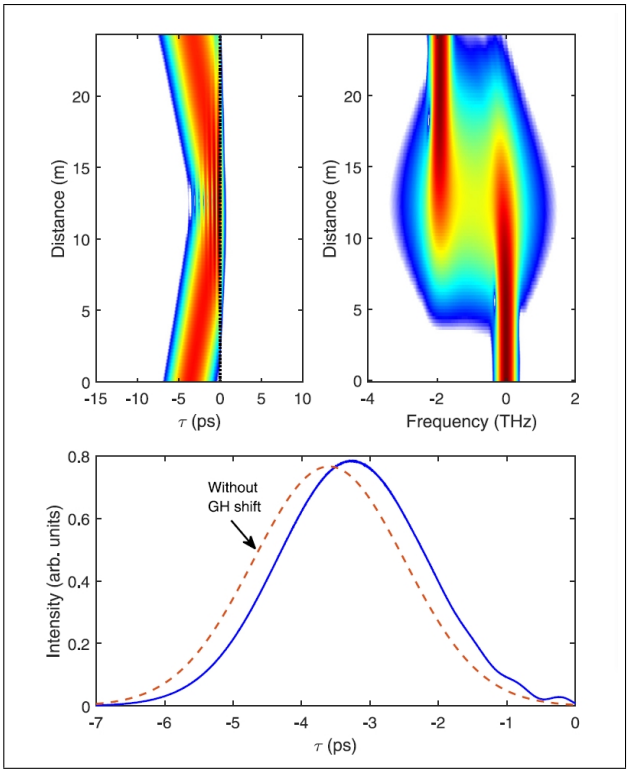

FIG. 1. Temporal and spectral evolution of a 6-ps-wide Gaussian pulse in a 200-m-long fiber undergoing total internal reflection at a moving temporal boundary in the reference frame of the boundary.

We have examined the reflection of light pulses from a temporal boundary, which amounts to a refractive index jump localized in time, moving in a linear or nonlinear optical medium. We have shown that in the linear regime, there exists a temporal counterpart to the celebrated Goos-Hanchen (GH) shift, which manifests itself as a time delay and occurs in the conditions of total internal reflection of the pulse from the boundary [1]. Such a temporal GH delay is orders of magnitude stronger than its spatial cousin and can cause either pulse retardation or advancement. We illustrate the effect in Fig.1. This work has been in collaboration with the group of Prof. Agrawal from the Institute of Optics, Rochester, USA. In the nonlinear regime, we have discovered giant intensity fluctuations, marked by the normalized intensity autocorrelation function of the order of 10^3 [2]. This work, carried out in collaboration with Prof. Cai and my graduate student at the time Prof. Liang, Shandong Normal University (SDNU), China, is featured in SDNU College News issue for 2021.

We have also collaborated with the groups of Prof. Friberg and Prof. Norrman from the Center for Photonics Sciences, University of Eastern Finland as well as our joint graduate student at the time, Prof. Chen (currently in Soochow University, China) on a series of papers, reviewed in [3], on structuring field correlations of random surface plasmon polaritons (SPP) which are surface waves supported by a spatial interface between a metal and dielectric.

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[1] S. A. Ponomarenko, J. Zhang, and G. P. Agrawal, "Goos-Hanchen shift at a temporal boundary," Phys. Rev. A, **106**, L061501 (2022).

[2] C. Liang , S. A. Ponomarenko, F. Wang, and Y. Cai, "Temporal Boundary Solitons and Extreme Superthermal Light Statistics," Phys. Rev. Lett., **127**, 053901 (2021).

[3] Y. Chen, A. Norrman, S. A. Ponomarenko, A. T. Friberg, "Optical coherence and electromagnetic surface waves [**Invited Review**]," Progress in Optics, **65**, 105 (2020).