Periodic transverse patterns of light propagating in linear media experience the self-imaging or Talbot effect [1], i.e., the intensity and phase distribution of the optical field are periodic along the longitudinal propagation coordinate as well. The longitudinal period that separate two successive self-image planes is known as the Talbot distance $Z_T$ and only depends on the transverse period of the pattern $p$ and on the light wavelength $\lambda$.

In between two planes separated by a distance $Z_T$, diffraction strongly modifies the appearance and the multiplicity of the pattern. However, at distances corresponding to particular fractions of $Z_T$, the transverse pattern can be described in terms of simple transformations of the input one (fractional Talbot effect).

Here we show that the fractional Talbot effect can be exploited in combination with the excitation of arrays of quadratic spatial solitons [2] to obtain various types of all-optical switches.

In our experiments we used a Lithium Triborate (LBO) crystal as a degenerate optical parametric amplifier by pumping it with several hundreds of intense, focused beams disposed on a rectangular lattice. The matrix of beams is produced by passing through a microlens array a 4-mm-wide, GW-level pulse-beam from our ps, frequency doubled Nd:glass laser system (TWINKLE, Light Conversion). The lattice period is adjusted by means of a telescope so that the LBO crystal length matches exactly $Z_T/2$. Therefore, the pump pattern at the output face of the crystal is a transversally shifted copy of the input one, even in the case of input peak intensity just below the threshold for the formation of solitons from quantum noise amplification. When the pump beam is launched together with a suitable phase-matched, subharmonic seed, spatial solitons get formed in the first few mm of propagation along the axis of the input pattern. Since solitons propagate in straight direction, the resulting pattern is invariant with propagation and thus appears shifted by a 1/2 period at the output, with respect to the unseeded configuration (compare Fig. 1.a with 1.b). An all-optical switch is therefore realized. The switch can be operated with a high on/off contrast over a wide range of pump and seed input peak intensities.

Numerical simulation of the system show that the scheme of the switch is general and, for instance, it can be used to develop a pattern-multiplicity switch. In fact, by chosing a crystal $Z_T/4$ long, the unseeded output profile of the pump is similar to that depicted in Fig. 1.c. By seeding the process, a pump pattern (Fig. 1.d) similar to that of the input is recovered at the output thanks to the soliton array formation, thus realizing a switch between two patterns of different transverse period.

The Talbot effect and the excitation of soliton arrays

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*35–Word Abstract*
We show that various types of all–optical switches can be obtained by exploiting both the fractional Talbot effect and the excitation of large arrays of parametric spatial solitons. Experimental and numerical data are presented.