Comment on "Formation of Repetitively Nanosecond Spatial Solitons in a Saturable Absorber *Q*-Switched Laser"

In their recent Letter [1], Chen and Lan claim that they observed spatial and phase solitons in an intracavity saturable absorber *Q*-switched laser. By changing the cavity length of a Nd:YVO4 laser, they could adjust the diameter of the beam on the saturable absorber and control the number of light spots on the transverse intensity distribution of the laser output. These spots are called amplitude solitons or localized structures in a self-pulsing laser by the authors. However, the transverse patterns they show to support this observation do not fit at all with what is currently recognized as a spatially localized structure. On the opposite, they clearly belong to the category of transverse patterns arising from mode competition in lasers. A localized structure must exhibit several properties to be assessed as cavity solitons [2–5]. These characteristics are the following ones: (i) the structures must have a specific shape, depending on the nonlinearity in the medium, and not on the boundary conditions (edges, cavity properties), (ii) they must be writable and erasable individually, and (iii) may be "written" at random positions in the medium. These localized structures are intrinsically different from transverse patterns in nonlinear systems (see, for example, [6,7]), which also occur because of the nonlinearity of the medium in which they develop but (i′) their shape depends on the boundary conditions, which change with the cavity length, (ii′) they appear globally instead of having an individual existence, and (iii′) they have specific positions with respect to boundaries. In fact, the shape of most of the patterns in Ref. [1] indicates clearly an asymmetry of the transverse boundary conditions preventing a circular shape and generating an overall elliptical one. A check of property (i) is that the size of the "spatial soliton" does not change as the boundary conditions are changed. It is an intrinsic property of the soliton, and it is not affected by a small change in the cavity length as it happens in Ref. [1]. Property (ii) is usually verified by adding one to several solitons in the vicinity of an isolated one, and one demonstrates writing and erasing of several solitons, independently of the existence of the other ones (for example, see [8]). Patterns as presented by Chen and Lan clearly belong to the second class because they lack properties (i), (ii), and (iii) while they obey criteria (i′), (ii′), and (iii′). Therefore, they do not fulfill the criteria for cavity solitons, and there is no other indication in Ref. [1] assessing them as spatial solitons. They possess instead all the properties of patterns. Furthermore, they are similar to other patterns already observed in lasers. Experiments realized on CO_2 lasers with and without an intracavity saturable absorber have demonstrated that the laser emission is produced in spatial patterns following rules that have been cleared out [7,9]. The parameters of the laser cavity essentially determine the properties of the family of patterns (in terms of interspot distance, symmetry, etc.). The active medium, more precisely the light-matter interaction, determines which member or superposition of members of the family is selected.

The authors also made a distinction between phase and amplitude solitons in the observed patterns. We do not find any indication in the results presented in Ref. [1] to assimilate such patterns to phase solitons. The "dark lines" are a common feature of the multitransverse modal operation of lasers, and they represent nodes of standing waves in the transverse direction. In conclusion, we find that all supposedly new findings of [1] are not supported by the evidence. A comparison with theoretical results, obtained since the 1980s, would give a complete and much better explanation of the experimental results of [1].

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