The strange world of self-induced transparency and light bullets

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The remarkable phenomena of self-induced transparency and solitons will be studied in a new project supported by a grant of £397K from EPSRC. This joint theoretical and experimental project, involving scientists from the Advanced Technology Institute at the University of Surrey along with colleagues in the UK, France, and the USA, will study fundamental quantum coherent phenomena which may one day have applications in optical information processing.

The passage of very bright, very short light pulses through an optical material shows many interesting and useful effects. Normally, the pulse would spread out in space and time as a result of diffraction and dispersion. However when the pulse is very bright, nonlinear effects can exactly cancel this spreading, and the light pulse propagates without any change in shape: a 'soliton' or 'light bullet'.

It is easier to form solitons when the light is confined to a small cavity, and 'cavity solitons' are now attracting interest as a way of storing and manipulating data for optical storage or optical computing. Another effect, seen when the pulse duration is very short, is self-induced transparency (SIT), in which the material which normally absorbs light becomes completely transparent to a bright, short-duration light pulse.

This research project is based on theoretical predictions by one of the co-investigators, Dr. Gabriella Slavcheva. Using a new theory of nonlinear coherent pulse dynamics based on Richard Feynman's model of atoms in an electromagnetic field, Dr. Slavcheva predicted the existence of cavity

solitons formed as a result of self-induced transparency.

With the help of collaborators from the École Normale Supérieure in Paris, and the University of Arizona, the scientists from the ATI will employ both theory and experiment to demonstrate the existence of this new type of soliton and to investigate the potential for applications in information technology and communications.

Source: University of Surrey