Laser focusing of cold atoms: analytical solution of the problem

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The motion of paraxial atomic beams in a laser radiation field is studied within the framework of a parabolic equation. Exact parabolic equation solutions are found for a variety of potentials featuring a nonuniformity in the propagation direction. Special attention is paid to the propagation of cold atomic beams in the gradient field of the laser radiation mode. Explicit analytical expressions are found for the position of the focal points, focal spot radius, and spatial intensity distribution.