Double Solution and Self-Gravitation

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Einstein himself, while he was struggling with the concept of photon, considered the possibility to add a non-linearity at the level of Maxwell's equation in order to explain why, contrary to Maxwell waves, photons stay localized in space throughout time. de Broglie also advocated this idea in the context of the double solution program, when he proposed to replace wave-particle dualism by a wave monistic formulation of the theory in which the particle would be a self-focused wave (what is today commonly called a soliton).

Independently, since the 80's, Penrose, Diosi and others studied following suggestions of Moller and Rosenfeld in the 60's, the possibility that gravitation results into the emergence of a self-focusing non-linear correction to the Schroedinger equation (expressed through the so-called Newton-Schroedinger equation), which is strongly reminiscent of de Broglie's ideas.

We show that self-gravitation makes it possible to explain why massive, macroscopic objects behave as classical, localized, objects; however, it does not suffice to derive de Broglie's guidance equation at the microscopic level. These results are also shown to be valid in very general situations where the self-focusing non-linearity respects Galilei invariance (NLS equation, Newton-Schroedinger equation and so on).