Nonlinear localized modes in dipolar Bose-Einstein condensates in optical lattices

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Modulational instability and discrete matter wave solitons in dipolar BECs, loaded into a deep optical lattice, are investigated analytically and numerically. The process of modulational instability of nonlinear plane matter waves in a dipolar nonlinear lattice is studied and the regions of instability are established. The existence and stability of bulk discrete solitons are analyzed analytically and confirmed by numerical simulations. In marked contrast with the usual discrete nonlinear Schrödinger behavior (no dipolar interactions), we found a region where the two fundamental modes are simultaneously unstable, allowing enhanced mobility across the lattice for large norm values. To study the existence and properties of surface discrete solitons, an analysis of the dimer configuration is performed. The properties of symmetric and antisymmetric modes including stability diagrams and bifurcations are investigated in closed form. For the case of a bulk medium, properties of fundamental o