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

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The modulational instability and discrete matter wave solitons in dipolar BEC, 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 a marked contrast with the usual DNLS 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 the stability diagrams and bifurcations are investigated in closed form. For the case of a bulk medium, properties of fundamental on-site and inter-site localized modes are analyzed. On-site and inter-site surface localized modes are studied finding that they do not exist when nonlocal interactions predominate with respect to local ones.

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