Contribution ID: **74** Type: **not specified**

Excited Q-balls

Wednesday 28 June 2023 14:40 (20 minutes)

Complex scalars in U(1)-symmetric potentials can form stable Q-balls, non-topological solitons that correspond to spherical bound-state solutions. If the U(1) charge of the Q-ball is large enough, it can support a tower of unstable radial excitations with increasing energy. Previous analyses of these radial excitations were confined to fixed parameters, leading to excited states with different charges Q. In this work, we provide the first characterization of the radial excitations of solitons for fixed charge, providing the physical spectrum for such objects. We also show how to approximately describe these excited states analytically and predict their global properties such as radius, energy, and charge. This enables a complete characterization of the radial spectrum. We also comment on the decay channels of these excited states.

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Session Classification: Parallel

Track Classification: Formal/strings