Scientific importance of the discrete electronic structure of f- and d-electron systems

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We will point out the scientific importance of the increasing evidence for the existence of the discrete energetical states in compounds containing atoms with incomplete 4f, 5f and 3d shells. As the existence of such states has been rather accepted in conventional rare-earth compounds, both ionic and intermetallic, there is growing evidence for their existence also in heavy-fermion compounds and 3d oxides. As far as the heavy-fermion compounds are concerned we will concentrate on analysis of the low-energy electronic structure, below 1 meV, of such hall-mark heavy-fermion compounds like YbRh$_2$Si$_2$ and UPd$_2$Al$_3$ establishing the valency, the charge distribution and the width of the discrete states. For the 3d compounds we recall the experimental evidence for the discrete electronic structure of FeBr$_2$ and LaCoO$_3$ with analysis of their macroscopic properties. Finally we would like to point out that the present ab initio calculations offer the description of the electronic structure of 3d compounds in the eV energy scale only, i.e. with 1000 times less accuracy than our theoretical atomistic-based approach.