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Proposal for laser cooling of rare-earth ions[1] OLIVIER DULIEU, YE HONG, JEAN-FRAN WYART, MAXENCE LEPERS, Laboratoire Aimé Cotton, CNRS, Université Paris-Sud, ENS Cachan, Université Paris-Saclay, Orsay, France
— The efficiency of laser cooling relies on the existence of an almost closed optical-transition cycle in the energy spectrum of the considered species. In this respect, rare-earth elements exhibit many transitions which are likely to induce noticeable leaks from the cooling cycle. In this work, to determine whether laser cooling of singly ionized erbium Er^+ is feasible, we have performed accurate electronic-structure calculations of energies and spontaneous-emission Einstein coefficients of Er^+, using a combination of ab initio and least-squares-fitting techniques. We identify five weak closed transitions suitable for laser cooling, the broadest of which is in the kilohertz range. For the strongest transitions, by simulating the cascade dynamics of spontaneous emission, we show that repumping is necessary, and we discuss possible repumping schemes.We expect our detailed study on Er^+ to give good insight into the laser cooling of neighboring ions such as Dy^+.

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