Multichannel quantum-defect theory for ultracold atom-ion collisions

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We develop an analytical model for ultracold atom-ion collisions using the multichannel quantum-defect formalism. The model is based on the analytical solutions of the r^-4 long-range potential and on the application of a frame transformation between asymptotic and molecular bases. This approach allows the description of the atom-ion interaction in the ultracold domain in terms of three parameters only: the singlet and triplet scattering lengths, assumed to be independent of the relative motion angular momentum, and the lead dispersion coefficient of the asymptotic potential. We also introduce corrections to the scattering lengths that improve the accuracy of our quantum-defect model for higher order partial waves, a particularly important result for an accurate description of shape and Feshbach resonances at finite temperature. The theory is applied to the system composed of a 40Ca+ ion and a Na atom, and compared to numerical coupled-channel calculations carried out using ab initio potentials. For this particular system, we investigate the spectrum of bound states, the rate of charge-transfer processes, and the collision rates in the presence of magnetic Feshbach resonances at zero and finite temperature.

- AQUTE [3]
- Result [4]

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