Ultracold mixtures of metastable triplet He and Rb: scattering lengths from *ab initio* calculations and thermalization measurements

S. Knoop[1], P.S. Żuchowski[2], D. Kędziera[3], Ł. Mentel[4], M. Puchalski[5], H.P. Mishra[1], A.S. Flores[1], and W. Vassen[1]

[1] *LaserLaB, Department of Physics and Astronomy, VU University, Amsterdam, The Netherlands*
[2] *Institute of Physics, Faculty of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Torun, Poland*
[3] *Department of Chemistry, Nicolaus Copernicus University, Torun, Poland*
[4] *Section of Theoretical Chemistry, VU University, Amsterdam, The Netherlands*
[5] *Faculty of Chemistry, Adam Mickiewicz University, Poznań, Poland*

Presenting Author: s.knoop@vu.nl

We have investigated the ultracold interspecies scattering properties of metastable triplet He and Rb. We have performed state-of-the-art *ab initio* calculations of the relevant interaction potential, from which the scattering lengths are obtained for all four isotope combination [1]. Experimentally, we have studied thermalization of an ultracold mixture in a quadrupole magnetic trap, containing 6×10^6 metastable triplet ^{4}He atoms in the $m_S = 1$ state and 3×10^8 ^{87}Rb atoms in the F=2, m_F=2 Zeeman substate, from which we obtain tight bounds on the scattering length [2], in excellent agreement with the *ab initio* calculation. Our combined theoretical and experimental work provides a necessary step towards quantum degenerate He*+Rb mixtures, which is interesting for few-body physics that require a large mass ratio. More general, our work shows the possibility of quantitative determination of scattering lengths for a system containing a heavy, many-electron atom using *ab initio* calculations.

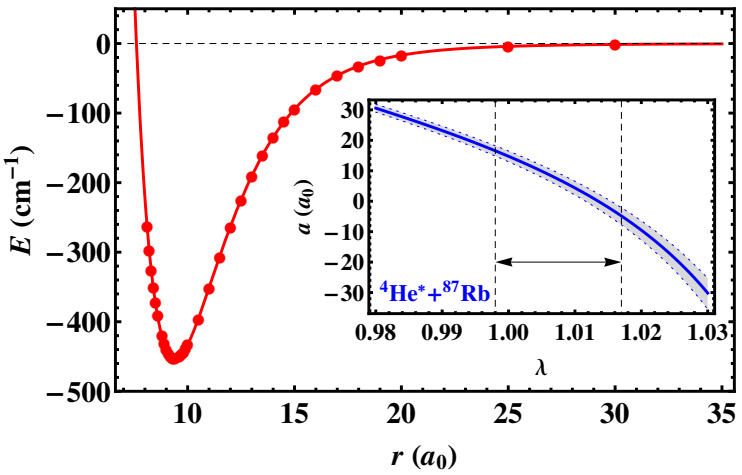

Figure 1: *Results of the ab initio calculation on the $^4\Sigma^+$ potential of He*Rb. The inset shows the quartet scattering length for $^4He^*+^{87}Rb$ as function of the scaling parameter of the potential well depth λ, where the shaded area (bounded by the blue dotted lines) represents the uncertainties in the long-range coefficients C_6 and C_8. The dashed vertical lines and the arrow represent the uncertainty in the ab initio potential.*

References

[1] S. Knoop, P.S. Żuchowski, D. Kędziera, Ł. Mentel, M. Puchalski, H.P. Mishra, A.S. Flores, W. Vassen, in preparation

[2] H.P. Mishra, A.S. Flores, W. Vassen, S. Knoop, in preparation