# Scattering resonances in cold $ND_3$-$H_2$ and $ND_3$-HD collisions: towards external field control

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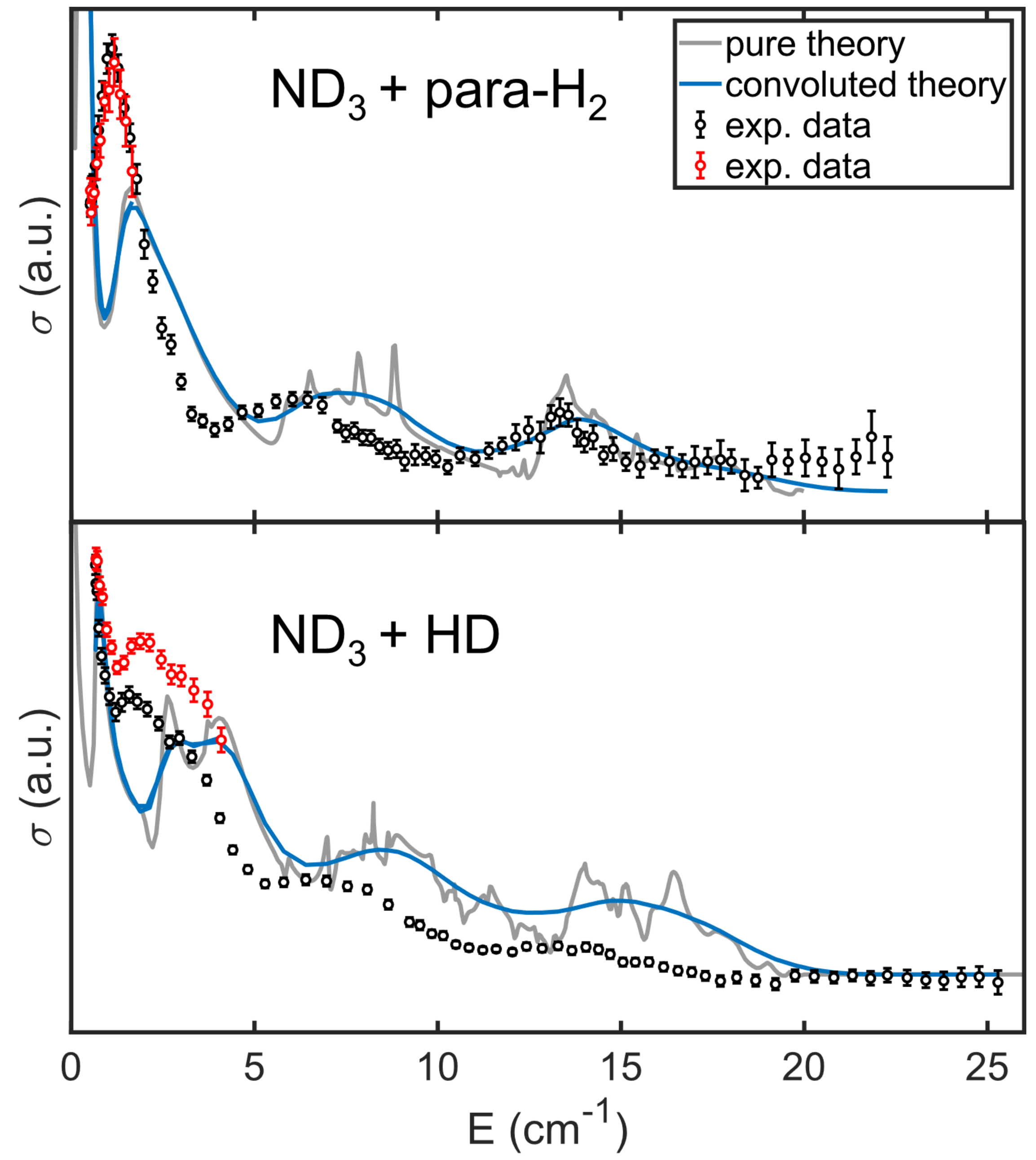
## Introduction

Recently it has become possible to image differential cross sections of collisions between NO and He, state-to-state selectively and at energies below 1 K. [1] In this cold regime, the wavelike quantum nature of matter starts to dominate the collision process, leading to rich resonance behaviour that is directly observable as sharp increases in the cross section.

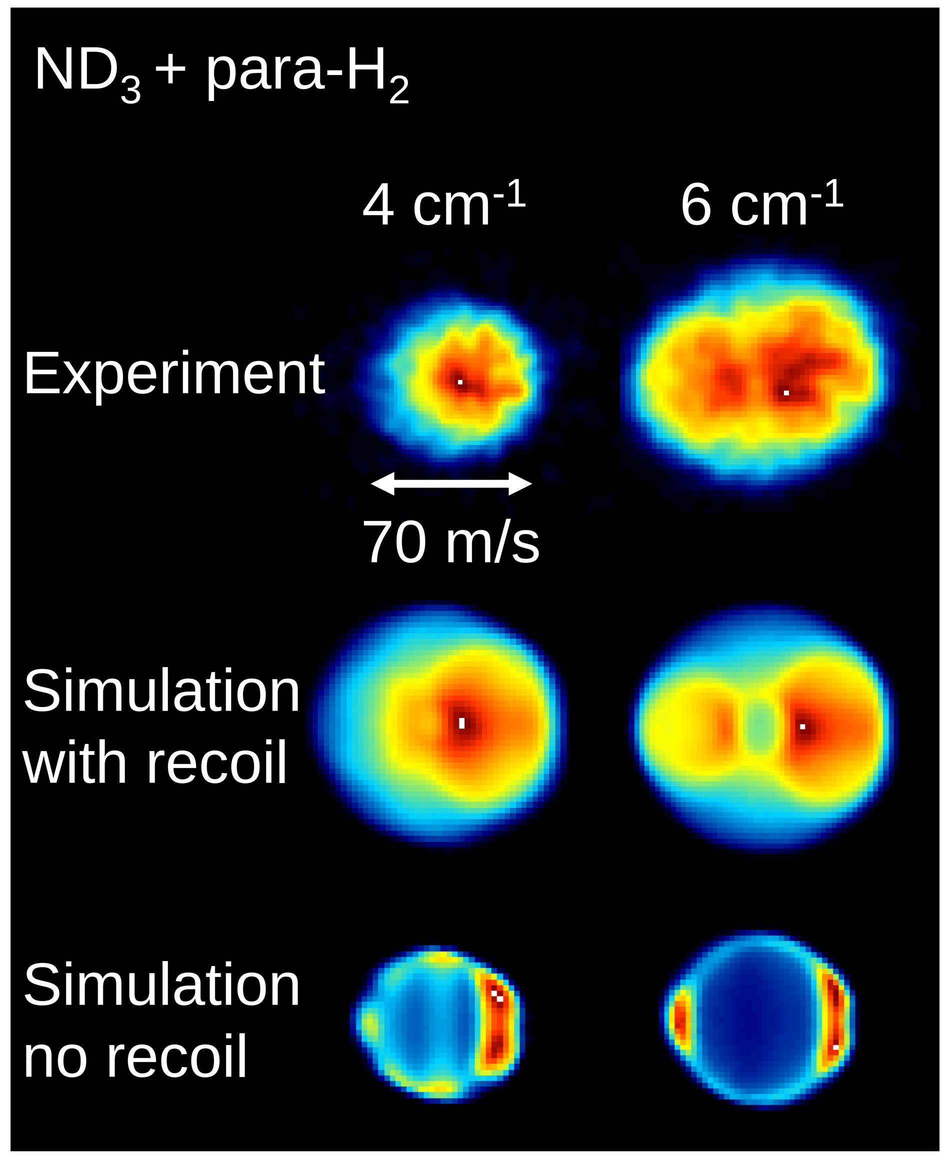
As a next step, we plan to add a level of control to these low-energy collisions by tuning scattering resonances using external electric fields. To this end, collisions involving ammonia are of great interest, as its large dipole moment makes it susceptible to electric fields.

## Results

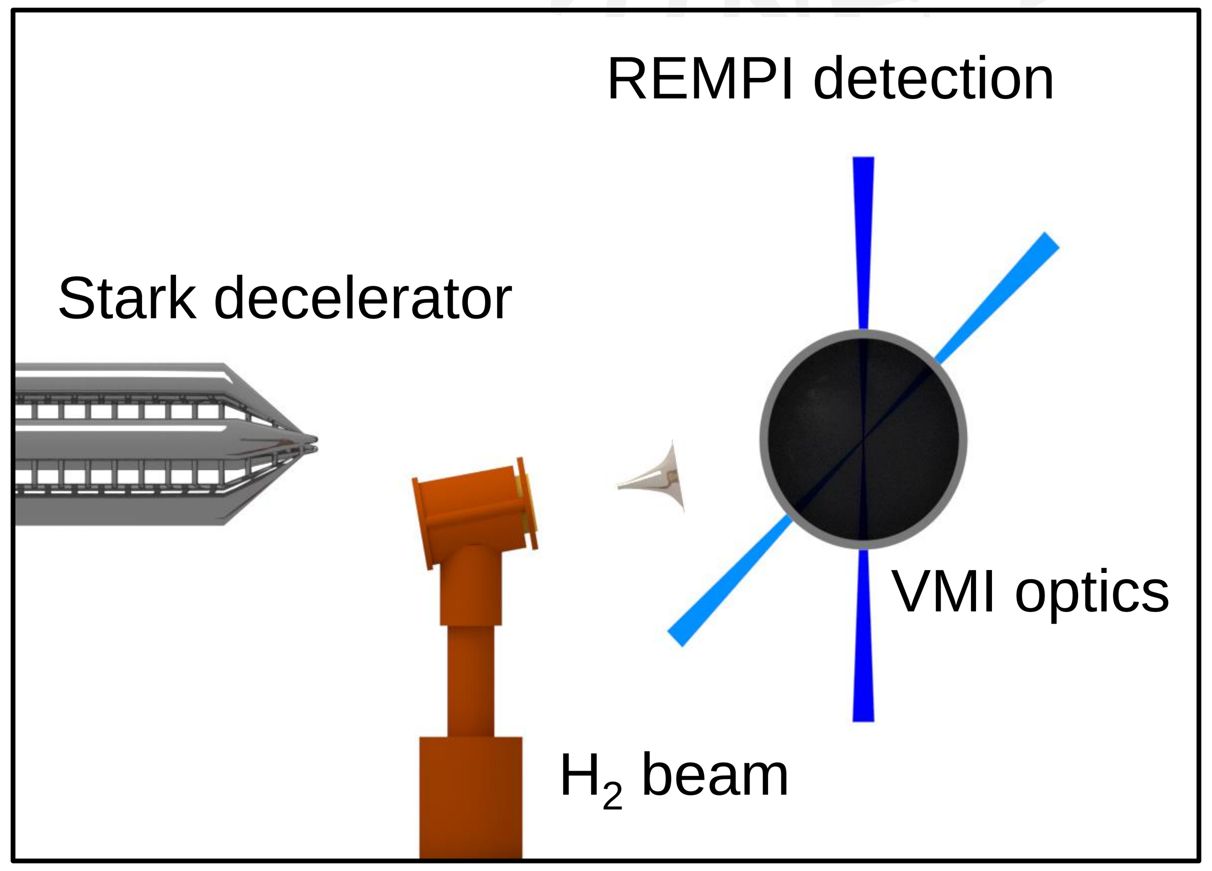
**Left:** We measured scattering resonances in the zero-field integral cross section of $ND_3$ colliding with para-$H_2$ and HD.




**Right**: $ND_3$ is currently detected above threshold, blurring images of the differential cross section. [2]




## Experimental setup




1. Stark decelerator selects velocity and quantum state of $ND_3$.
2. 5° collision angle with a beam of $H_2$ cooled down to 35 K.
3. 2+1 REMPI detection of $ND_3$ at 317 nm
4. Velocity Map Imaging (VMI) reveals the final distribution of scattered $ND_3$.

## Conclusion

We made an important fist step towards enabling external electric field control over scattering resonances by observing those resonances in the zero-field integral cross section of $ND_3$ colliding with $H_2$ and HD.

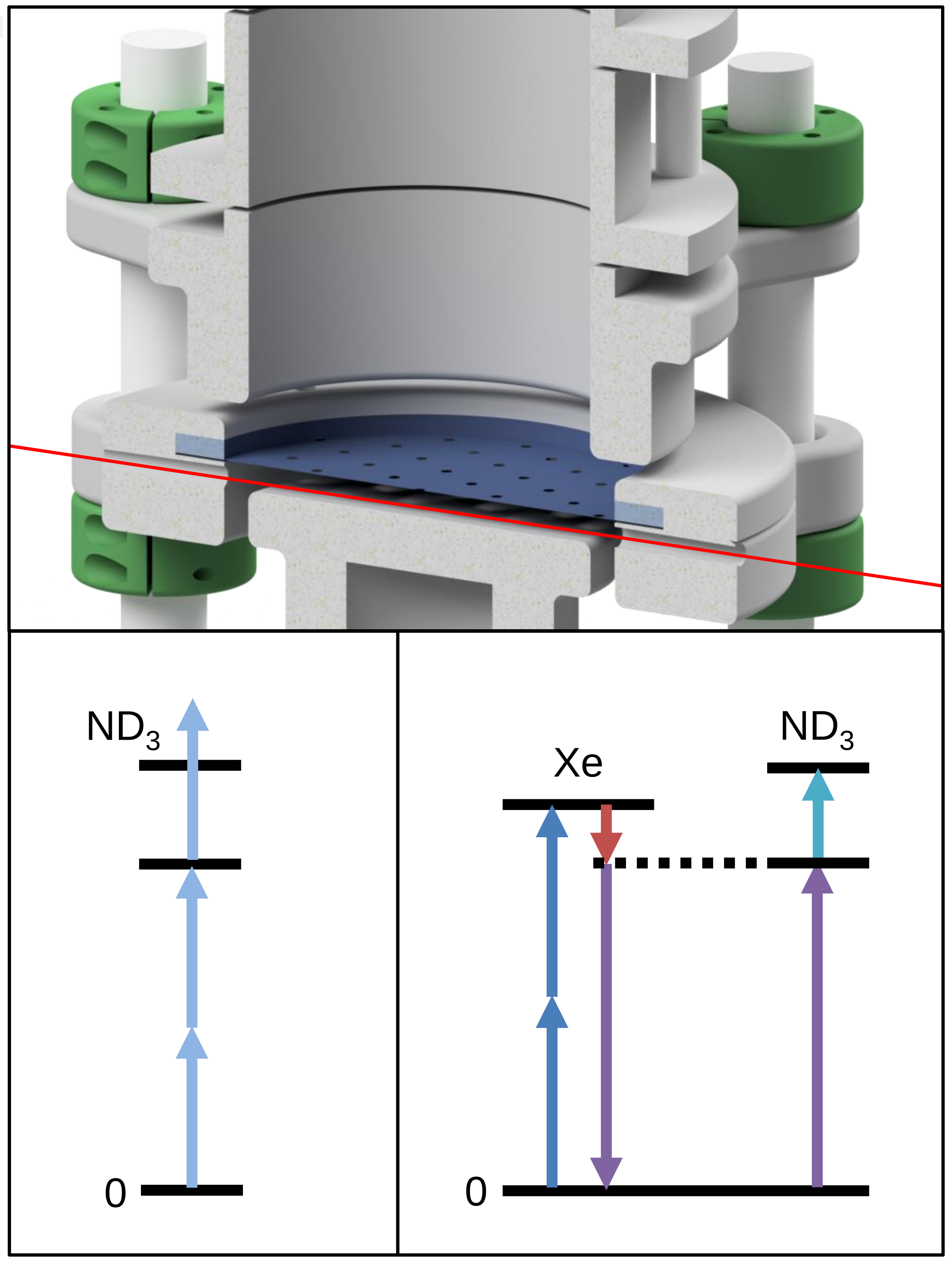
Next, we will work on realizing a recoil-free VUV+UV REMPI scheme to detect ammonia with high resolution, as well as build a VMI detector capable of generating fields up to 40 kV/cm.

## Future: electric fields and VUV

**Top**: high voltage VMI designed like [3].
Pulsing the extractor grid and repeller creates a strong, homogeneous field of up to 40 kV/cm during the collisions.

**Bottom left:** conventional 2+1 REMPI scheme.
Leaves a 20 m/s recoil to the ion.

**Bottom right:** proposed detection scheme.
VUV is generated by four wave mixing in Xe, making recoil free detection possible.




## References

[1] T. de Jongh, et al., *Science* 368.6491 (2020): 626-630.
[2] Z. Gao, et al., *Phys. Chem. Chem. Phys.* 21.26 (2019): 14033-14041.
[3] V. Plomp, et al., *Molecular Physics* (2020): e1814437.

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