

# Gas-phase Reactivity of OH Radicals Towards NH<sub>3</sub>: A Considerable Enhancement of the Rate Coefficients at Interstellar Temperatures

D. González<sup>1</sup>, S. Espinosa<sup>1</sup>, J. Albaladejo,<sup>1,2</sup> E. Jiménez<sup>1,2</sup>

<sup>1</sup> *Departamento de Química Física, Facultad de Ciencias y Tecnologías Químicas, Universidad de Castilla-La Mancha (UCLM), Avda. Camilo José Cela 1B, 13071 Ciudad Real, Spain.*

<sup>2</sup> *Instituto de Investigación en Química y Contaminación Atmosférica, UCLM, Camino de Moledores s/n, 13071 Ciudad Real, Spain.*

*Daniel.GPerezMadrid@uclm.es*

The OH radical is a crucial intermediate in combustion, atmospheric, and interstellar chemistry. Gas-phase rate coefficients,  $k(T)$ , for reactions involving this radical with inorganic nitrogen compounds at combustion and atmospheric temperatures have been determined since 1970's. Even though it is known that OH radicals are ubiquitous in the interstellar medium (ISM), there are scarce kinetic data for OH-reactions with IS species at interstellar temperatures (~10-100 K) [1]. In most cases, the OH-kinetics at these ultra-low temperatures were thought to be too slow to play an important role in the IS chemistry, but over the last decades, laboratory experiments have shown that these radical-molecule reactions are faster than previously thought, deviating from the typical Arrhenius behavior [1-3]. Particularly for nitrogen-bearing species, which could form amino acids in the ISM, the literature is very limited. Including  $k(10-100\text{ K})$  in astrochemical networks is fundamental to model the chemical evolution of the interstellar clouds as well as to shed some light about the products formed in such processes, which could be finally related to the formation of prebiotic molecules. A good example is the OH-reaction with ammonia (NH<sub>3</sub>), first detected in the Sagittarius B2 molecular cloud [4].  $k(T)$  has been determined over a large range of temperatures theoretically (5-4000 K) and experimentally (230-2360 K) showing a positive temperature dependence, i.e.,  $k(T)$  increases when temperature increases with a positive activation energy [5]. In this work, we report the first experimental determination of  $k(T)$  at  $T < 230\text{ K}$ , specifically in the (11.7-158.8) K temperature range. To carry out the kinetic experiments, the most powerful pulsed CRESU system worldwide was used to simulate the ultra-cold environment [6]. With this technique a uniform and supersonic jet is generated using a Laval nozzle. The OH radicals are generated in the cold jet by pulsed laser photolysis of H<sub>2</sub>O<sub>2</sub> and their temporal evolution is monitored by laser induced fluorescence. The results obtained have revealed an increase of  $k(T)$  with respect to  $k(230\text{ K})$  between 10 at 158.8 K and 380 at 21.7 K.

- [1] A. Potapov, A. Canosa, E. Jiménez, B. Rowe, *Angew. Chem. Int. Ed.* **2017**, 56, 8618-8640.
- [2] D. E. Heard, *Acc. Chem. Res.* **2018**, 51, 2620-2627.
- [3] A. J. Ocaña, S. Blázquez, A. Potapov, B. Ballesteros, A. Canosa, M. Antiñolo, L. Vereecken, J. Albaladejo, E. Jiménez, *Phys. Chem. Chem. Phys.* **2019**, 21, 6942-6957.
- [4] A. Cheung, D. Rank, C. Townes, D. Thorton, W. Welch, *Phys. Rev. Lett.* **1968**, 21, 1701-1705.
- [5] R. Atkinson, D. L. Baulch, R. A. Cox, J. N. Crowley, R. F. Hampson, R. G. Hynes, et al, *Atmos. Chem. Phys.* **2004**, 4, 1461-1738.
- [6] E. Jiménez, B. Ballesteros, A. Canosa, T. M. Townsend, F. J. Maigler, V. Napal, B. R. Rowe, J. Albaladejo, *Rew. Sci. Ins.* **2015**, 86, 045108.