

MICROHYDRATION OF $\text{Mg}^{2+}(\text{CH}_3\text{COO}^-)$ ION PAIRS FOLLOWED BY IR LASER SPECTROSCOPY: INSIGHTS INTO THE WATER-MEDIATED IONIC INTERACTIONS IN THE MAGNESIUM TRANSPORT CHANNEL

JEAN-XAVIER BARDAUD, ERIC GLOAGUEN, *Institut des Sciences Moléculaires d'Orsay, Université Paris-Saclay, CNRS, Orsay, France*; VALERIE BRENNER, MICHEL MONS, *CEA Saclay, LIDYL, Gif-sur-Yvette, France*; HIKARU TAKAYANAGI, KEISUKE HIRATA, SHUN-ICHI ISHIUCHI, MASA AKI FUJII, *Chemical Resources Laboratory, Tokyo Institute of Technology, Yokohama, Japan*.

Ionic interactions play a crucial role in ion transport and selectivity to maintain cellular ion homeostasis. For example, the Mg^{2+} channel is a membrane protein that regulates Mg^{2+} cation concentration on both sides of the cell membrane. Crystal structure of the Magnesium Transport E channel suggests a transport mechanism for Mg^{2+} ions involving the motion of hexa-hydrated Mg^{2+} cations recognized through water-mediated ionic interactions between the Mg^{2+} cation and the carboxylate groups of the channel interior.^a

In order to characterize these water-mediated ionic interactions, we investigated $\text{Mg}^{2+}(\text{CH}_3\text{COO}^-)(\text{H}_2\text{O})_n$ clusters. We probed their structures from $n = 4$ to 17 by measuring cryogenic gas phase infrared spectra, further interpreted by high level quantum chemistry DFT-D calculations of vibrational frequencies. This comparison allowed us to investigate size-selected microhydrated Mg^{2+} ion pairs.

In accordance with previous findings obtained on hydrated calcium^b and barium^c acetate clusters, hydration by 6 water molecules is insufficient to induce the ion separation. Nonetheless, partially-separated or separated ion pairs are formed from at least 10 water molecules, and more significantly with 14 water molecules. These results highlight the necessity of a second water-mediated ionic interaction for the transport of Mg^{2+} within the channel and possibly in cooperation with weaker secondary interactions, such as involving carbonyl groups, as suggested by the crystal structure.

^aTakeda, H.; Hattori, M.; Nishizawa, T.; Yamashita, K.; Shah, S.; Caffrey, M.; Maturana, A. D.; Ishitani, R.; Nureki, O. *Nat. Commun.* 2014, 5374.

^bDenton, J. K.; Kelleher, P. J.; Johnson, M. A.; Baer, M. D.; Kathmann, S. M.; Mundy, C. J.; Wellen, R. B. A.; Allen, H. C.; Choi, T. H.; Jordan, K. *D. Proc. Natl. Acad. Sci. U.S.A.* 2019, 116, 14874-14880.

^cDonon, J.; Bardaud, J.-X.; Brenner, V.; Ishiuchi, S.; Fujii, M.; Gloaguen, E. *Phys. Chem. Chem. Phys.* 2022, 24, 12121-12125.