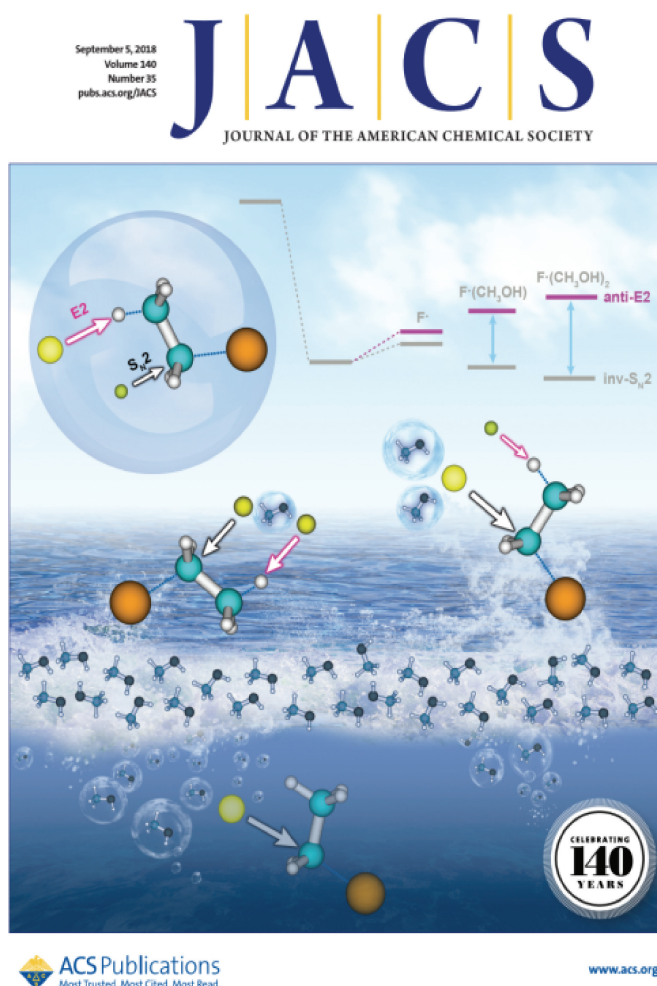


## Competing dynamics of elimination versus substitution driven by solvation

Under the support by the National Natural Science Foundation of China, Prof. Zhang JiaXu (张家旭), Prof. Yang Li, and Liu Xu at the School of Chemistry and Chemical Engineering, Harbin Institute of Technology in collaboration with Prof. William L. Hase at Texas Tech University have performed chemical dynamics simulations that revealed how a solvent molecule affects competing elimination and substitution dynamics, providing insight into mechanism evolution with increased solvation. The findings were published in *JACS* (2018, 140(35): 10995–11005), which was selected as the Front Cover and highlighted by *JACS* Spotlights titled “Simulations Define The Relationship Between Solvation And Selectivity”.

Base-induced elimination (E2) and bimolecular nucleophilic substitution ( $S_N2$ ) are two fundamental and ubiquitous reaction mechanisms in preparative organic synthesis, which may occur as unwanted side reactions of each other making their competition an intriguing question to be probed. Experiments found that the gas-phase trade-off between E2 and  $S_N2$  has been suggested to in general strongly favor elimination, but nucleophilic substitution prevails in the bulky solution. Understanding this phenomenon requires studying the detailed dynamical effects caused by solvent molecules.

Here, they reproduce the experimental findings employing direct dynamics trajectory simulations and show that the E2 mechanism dominates over  $S_N2$  for the solvent-free reaction. This is energetically quite unexpected considering the similar activation barriers for the two processes on the static PES and alternatively dynamical effects are found to be responsible. Introducing one solvating methanol molecule, dynamical behaviors show strikingly distinct features that largely enhance the  $S_N2$  importance and it is understood that a differential solute-solvent interaction at the central barrier stabilizes the transition state for substitution more strongly. Upon further solvation, this subtle discrepancy in stabilization becomes more pronounced, which is assumed to drastically suppress the E2 route and, in turn, favor  $S_N2$  events. The work opens the door to a detailed atomistic understanding of transformation reactions in distinctly different realms.



**Figure** Mechanistic evolution for competing E2/ $S_N2$  reactions controlled by solvation.