Determination of the sticking coefficient and scattering dynamics of water on ice using molecular beam techniques

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Introduction:

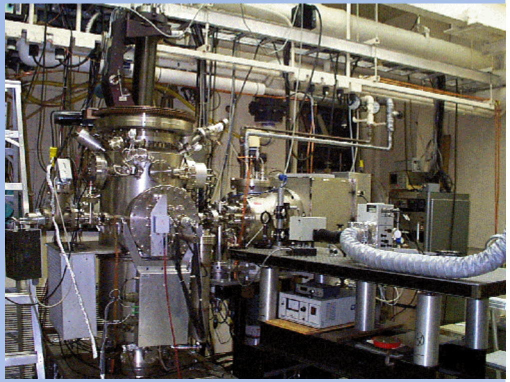
❖ The sticking of gas-phase molecules onto surfaces is the initial step in many important processes like the first step in reactions proceeding through a Langmuir-Hinshelwood mechanism is the adsorption of the reactants to the surface.

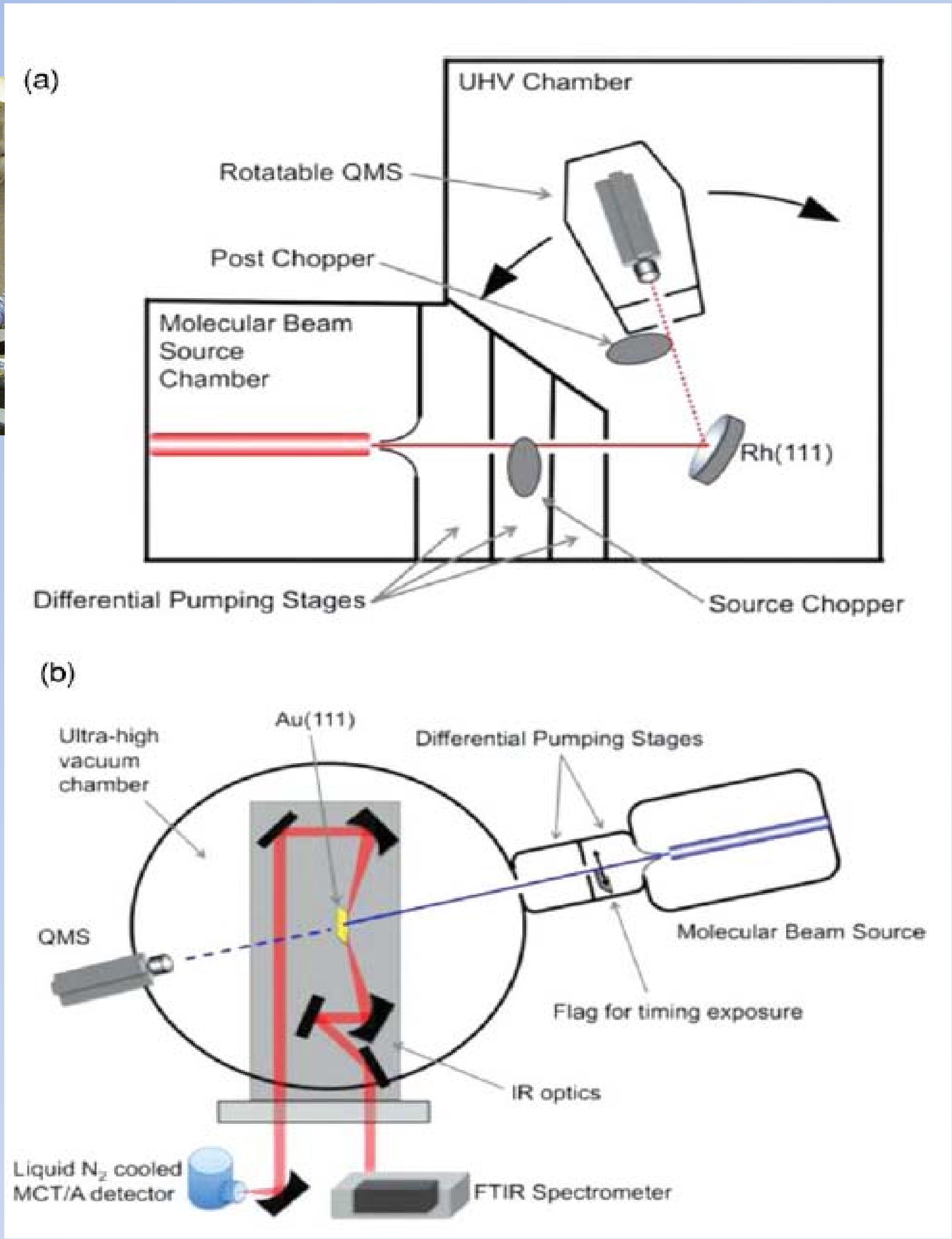
❖ Atmospheric phenomenon, the sticking of water on ice is important for understanding the behaviour and development of icy bodies in space.

❖ Previous studies showed that H_2O sticking coefficient on H_2O ice to be 0.99 ± 0.03 for incident angles $\Theta_I = 0° – 70°$ and incident beam energies $E_I = 0.04–1.7$ eV.

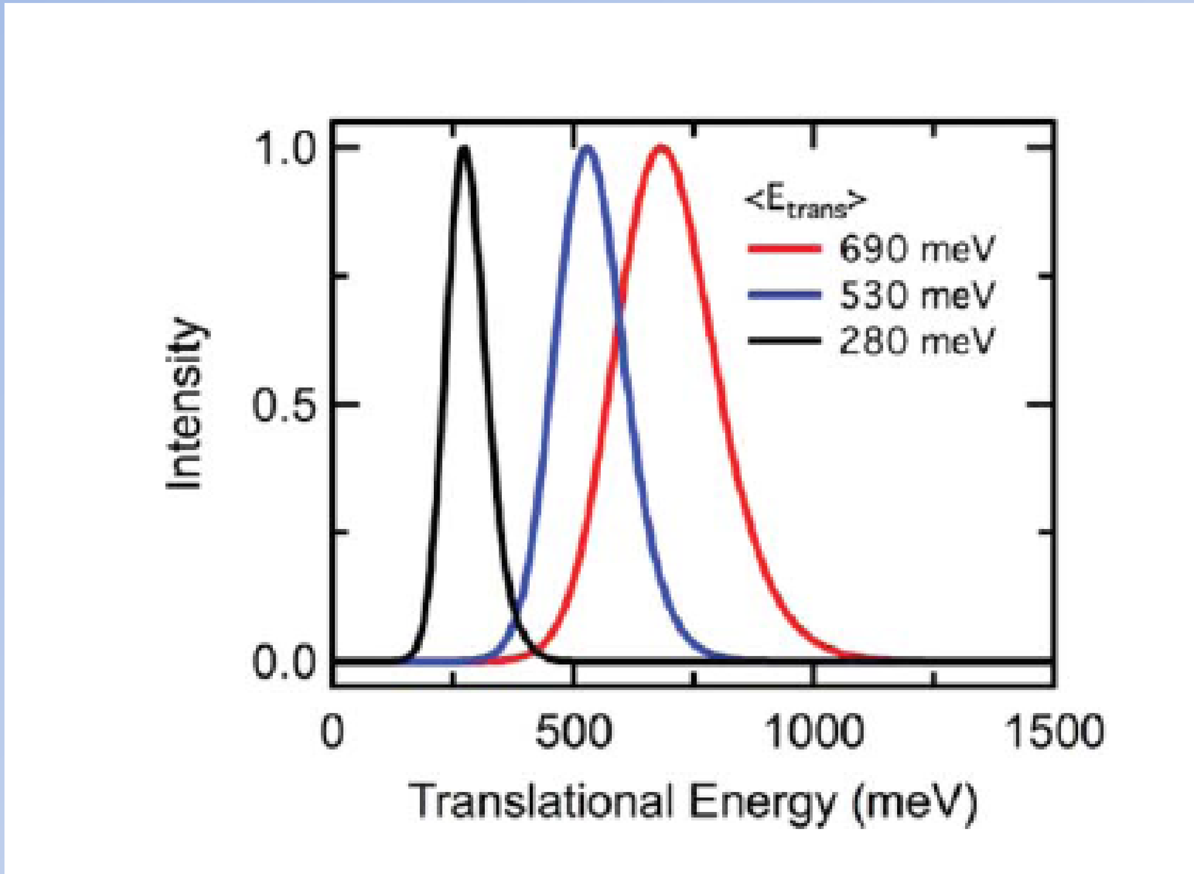
❖ **In this paper, the sticking coefficients (S) of D_2O and H_2O on crystalline ice (CI) were determined using molecular beam techniques.**

Experimental section:

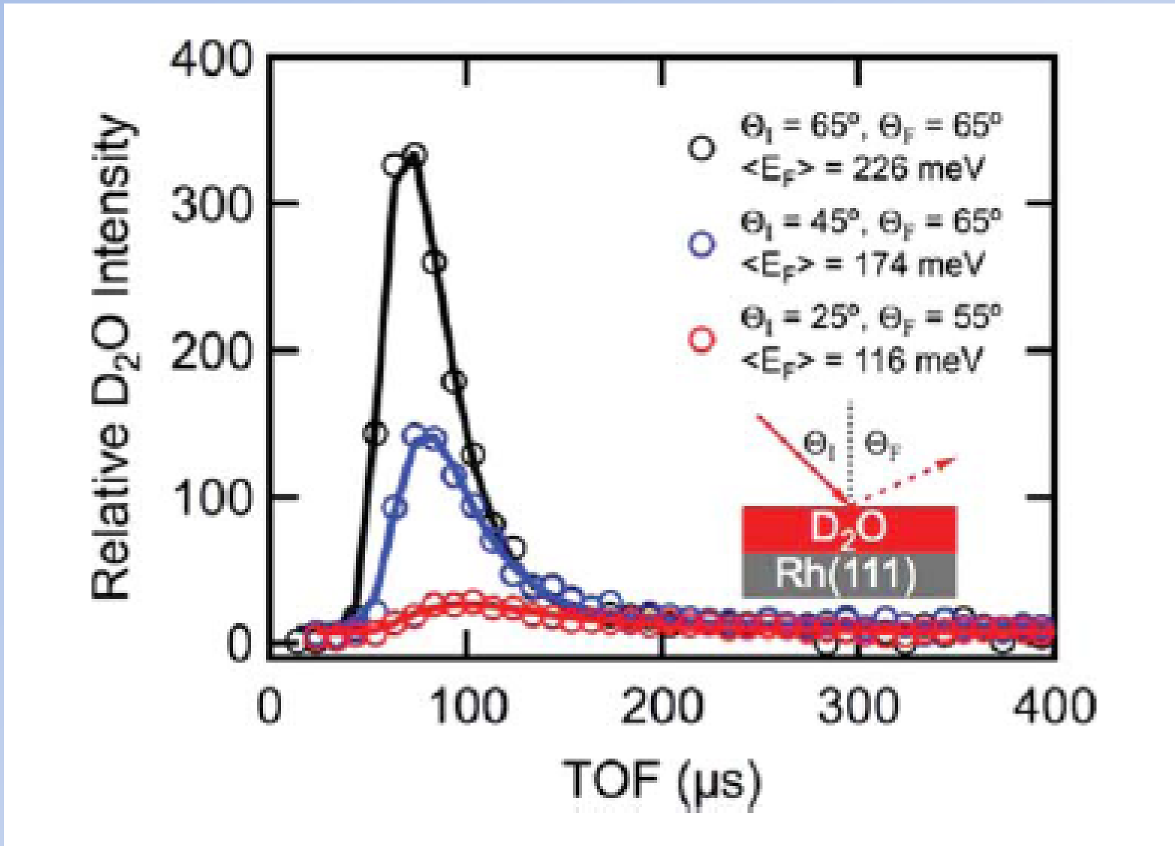




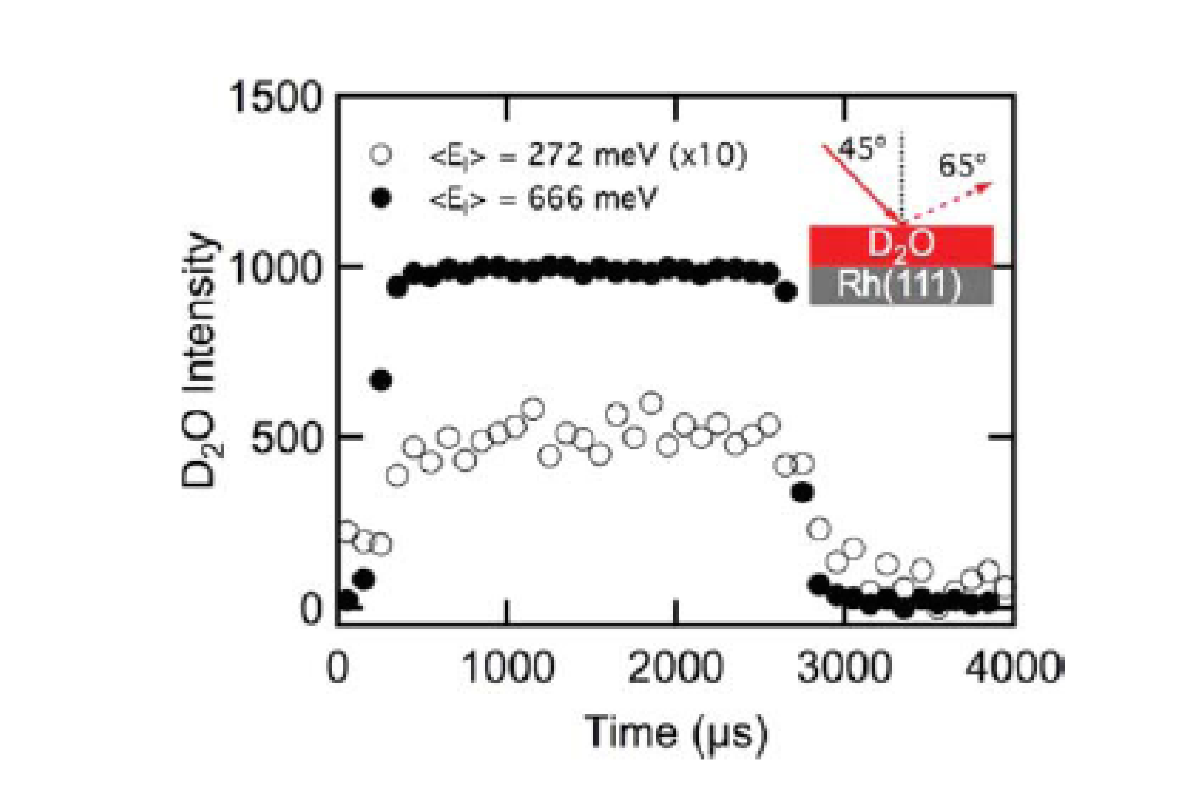
Results:



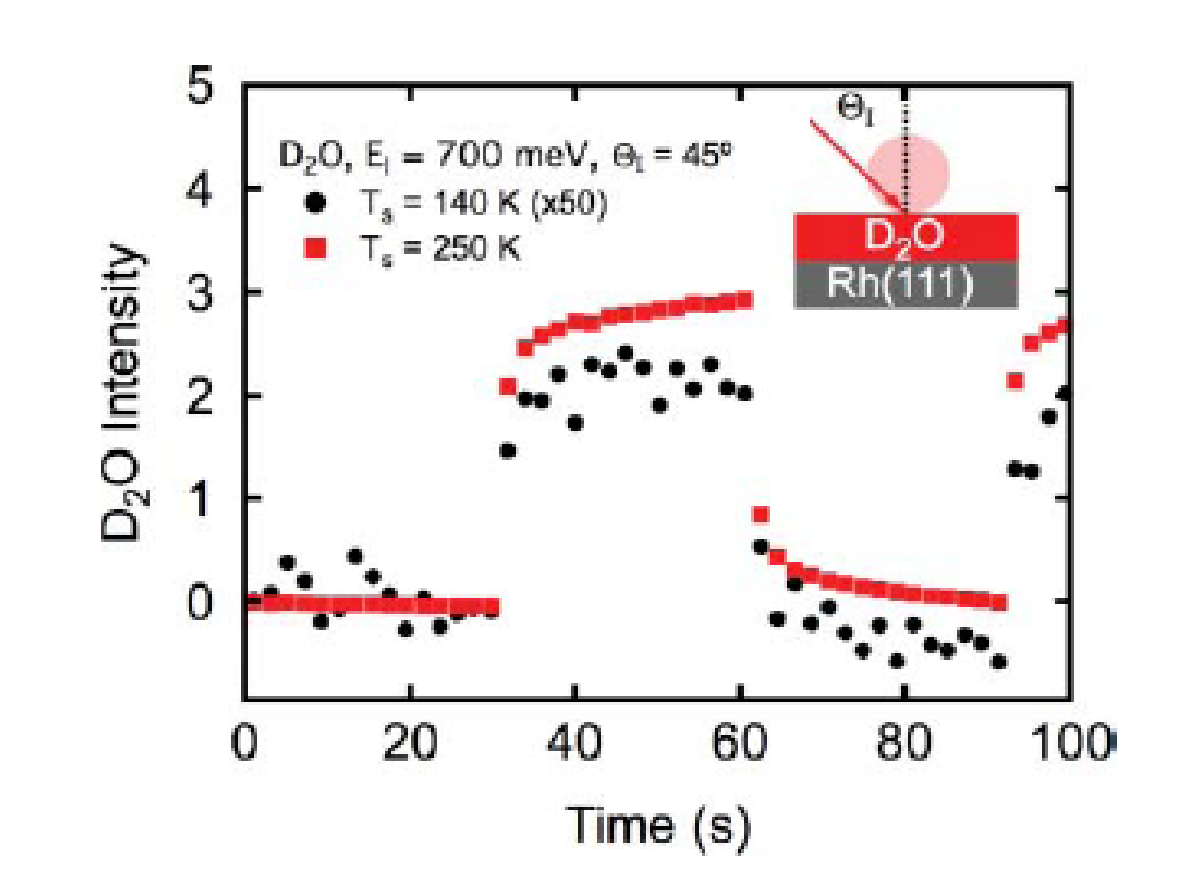
Incident energy distributions for three different D_2O beams



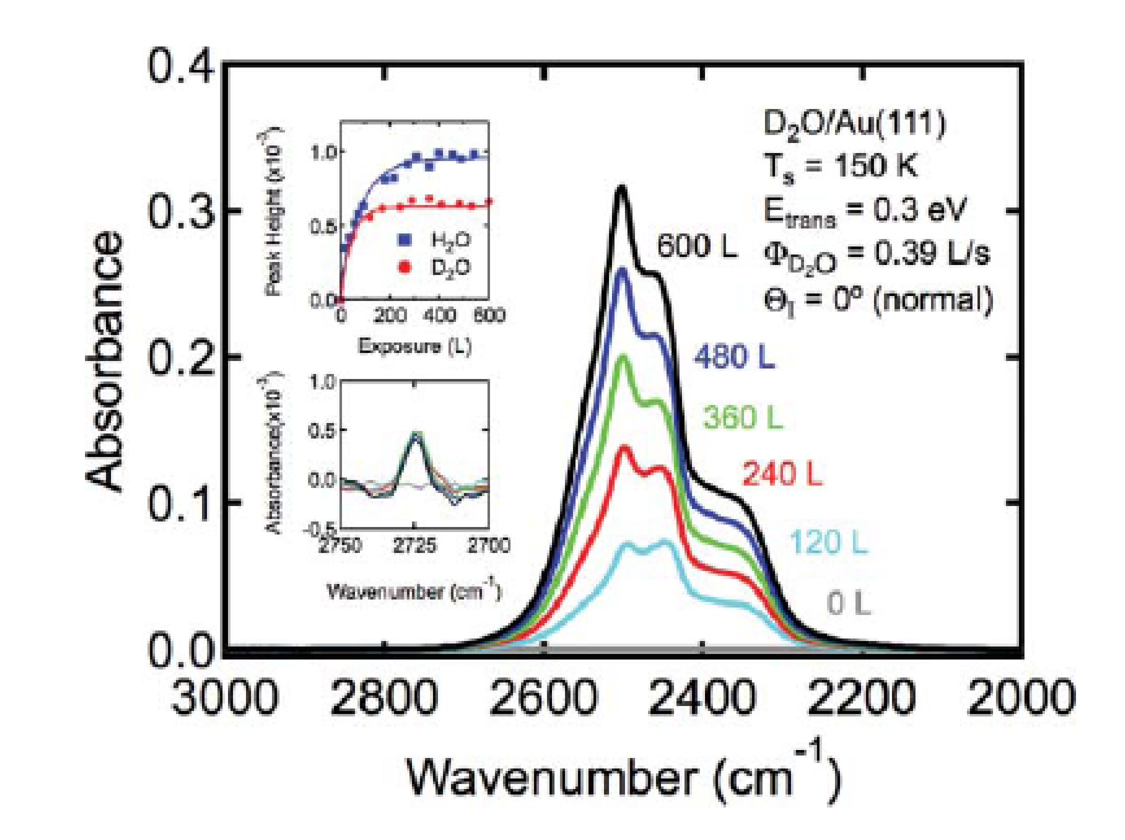
TOF spectra of scattered D_2O. The spectra were taken at three different Θ_I, $E_I = 690$ meV, and $T_S = 140$ K.



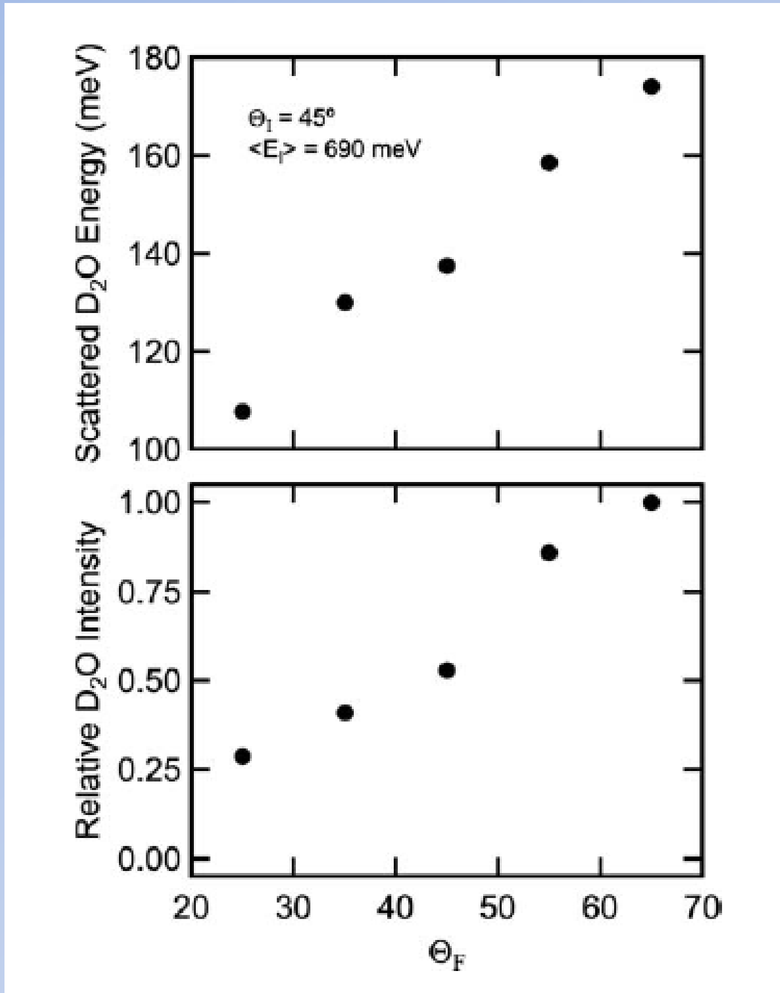
Examples of square-wave spectra. The intensity of scattered D_2O was measured for two different E_I with T_S = 140 K, Θ_I = 45°, and Θ_F = 65°.



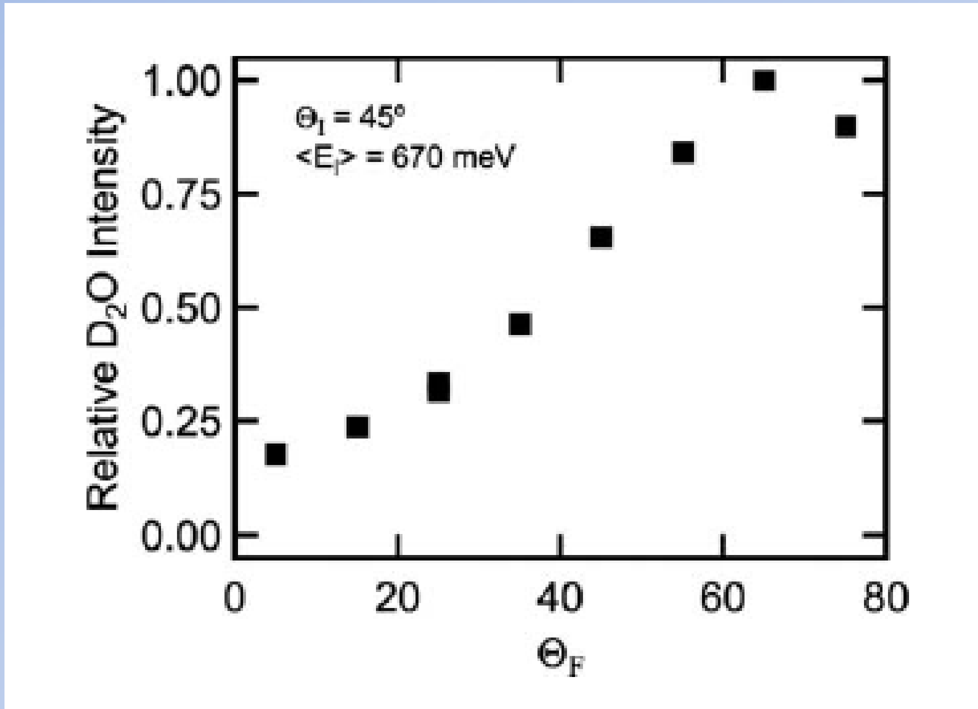
Determination of absolute scattering fraction. An example of the results for the slow-modulation experiments. The D_2O scattered from a warm surface (red squares) was compared to the scattering from a cold surface (black circles). The results for T_S = 140 K have been multiplied by 50 for clarity.



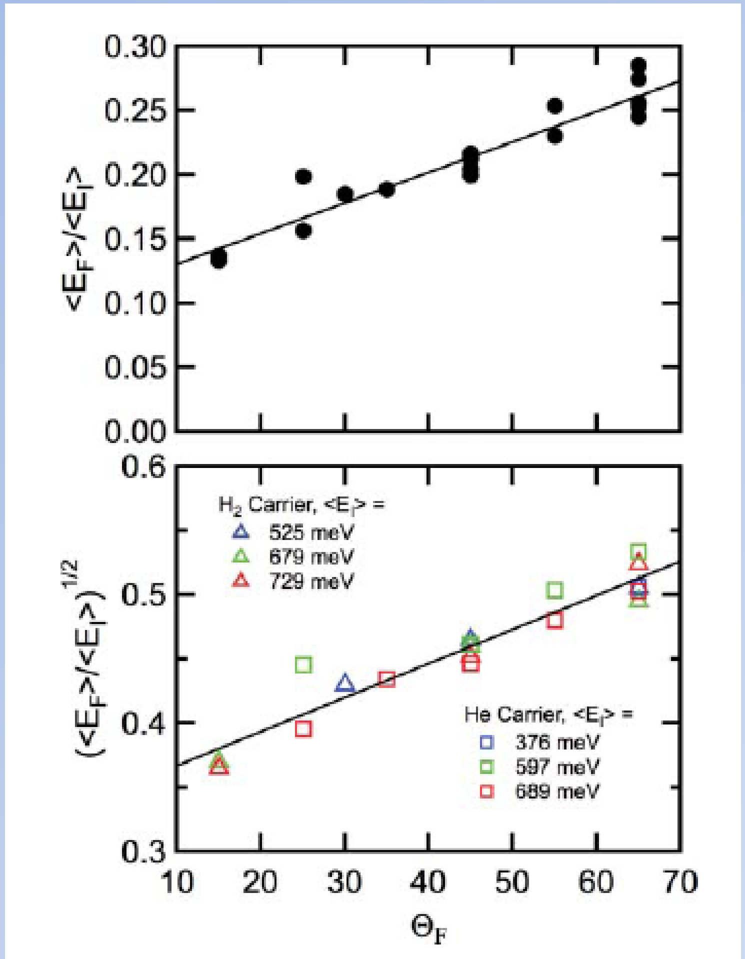
IRRAS spectra of D_2O on Au(111) at various exposures. The lower inset plot is the dangling O–D region of the spectrum for each trace in the main panel. The upper inset plots the dangling O–D or O–H peak height vs exposure for D_2O and H_2O and shows the peak saturating for both isotopologues by 150 L exposure.



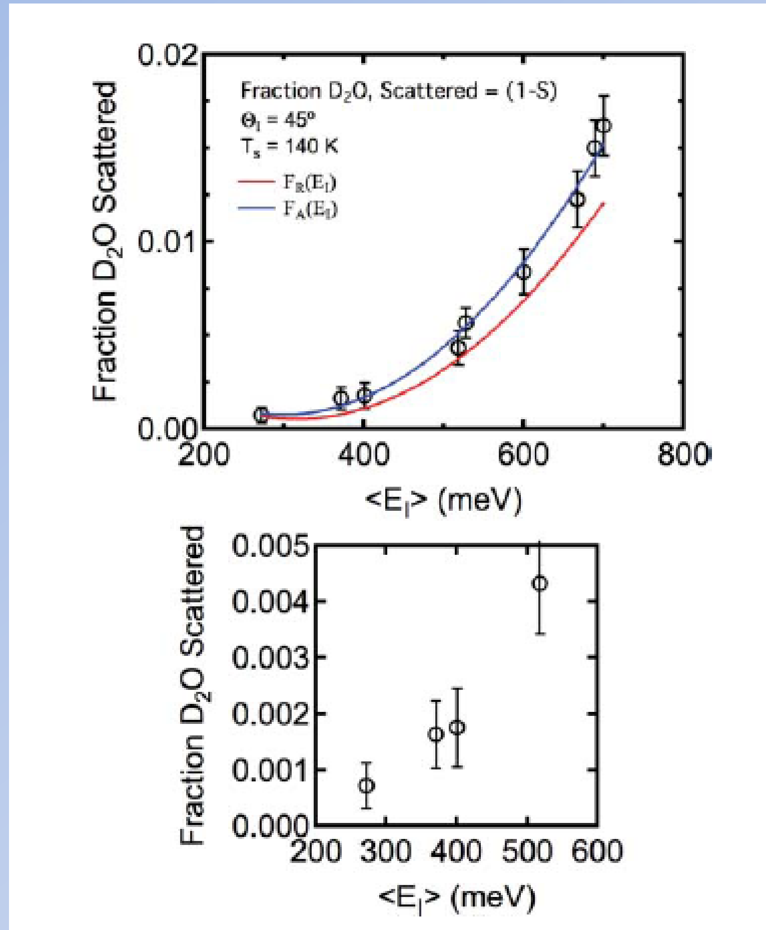
Angular dependence of the energy and intensity of D_2O scattered from a crystalline ice surface at T_S = 140 K.



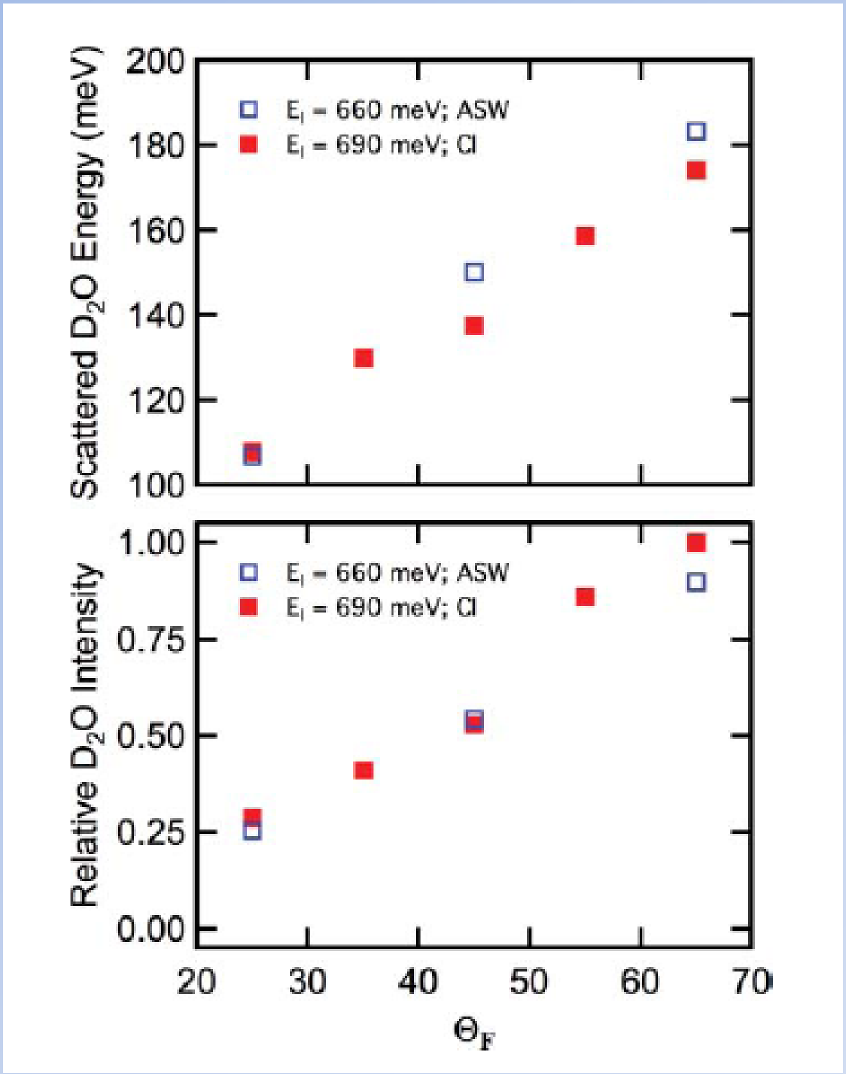
Angular dependence of the intensity of D_2O scattered from a crystalline ice surface at T_S = 140 K. Data are calculated from square-wave chopping measurements similar to those shown in Fig. 4



Fractional energy loss of D_2O scattered from the crystalline ice surface as a function of F (top). The bottom panel shows the data plotted as the square root of the energy ratio for D_2O seeded in both H_2 and He and three different incident energies. All data were collected for $\Theta_I = 45°$ and $T_S = 140$ K.



Fraction of D_2O scattered from crystalline ice at T_S = 140 K and Θ_I = 45◦. The fraction of D_2O scattered from the ice surface (1−S) is shown for incident energies from 200 to 800 meV. The lower panel highlights the high sticking portion below 600 meV. Even at the lowest incident energies, scattering was observed, indicating that 1−S does not reach zero under any of the conditions examined herein



D_2O scattering from ASW and CI. The angular dependence of the energy and intensity of D_2O scattered from ASW at 110 K and CI at 140 K and $\Theta_I = 45^\circ$ are shown. The two datasets are indistinguishable within the experimental limits

Summary:

The sticking of D_2O onto D_2O ice at incident energies between 0.3 and 0.7 eV has been examined in detail.

Sticking coefficient found to be less than 1, it never reaches 1 at higher energy.

Thanks!!!!!