Translational and internal states of hydrogen molecules produced from the vacuum ultraviolet photodissociation of amorphous solid methanol

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Within water rich interstellar ices, methanol is typically observed and is often the most abundant molecule after water. Because its abundance in some grain mantles varies between 0.05 and 0.50 relative to water, photolysis of methanol could be an appreciable source of the interstellar H_2 molecules.

		ΔH (kcal/mol)	E_a (kcal/mol)	
$CH_3OH + h\nu$	$\rightarrow CH_3O\cdot + H$	104	-	(1)
	$\rightarrow CH_2(\cdot)OH + H$	92	-	(2)
	$\rightarrow CH(:)OH + H_2$	71	-	(3)
	$\rightarrow CH_2(\cdot)O\cdot + H_2$	19	-	(4)
	$H + H \rightarrow H_2$	-104	0	(5)
	$H + CH_3OH \rightarrow CH_2(\cdot)OH + H_2$	-8	9	(6)
	$H + CH_3OH \rightarrow CH_3O\cdot + H_2$	1	14	(7)

We have investigated the mechanisms and dynamics of $H_2(v\text{=}0\text{-}5)$ production from the 157 nm (181 kcal/mol) photodissociation of amorphous solid methanol at 90 K with the resonance-enhanced multiphoton ionization technique. The hydrogen abstraction mechanism from methanol parent molecule by the photolytically produced hydrogen atom, reactions (6) and (7), yields translatioanlly and internally cold $H_2(v\text{=}0$ and 1) products. The molecular elimination processes, reactions (3) and (4), are the major sources of $H_2(v\text{=}2\text{-}5)$ products while the contribution of the hydrogen recombination mechanism, reaction (5), is minor.

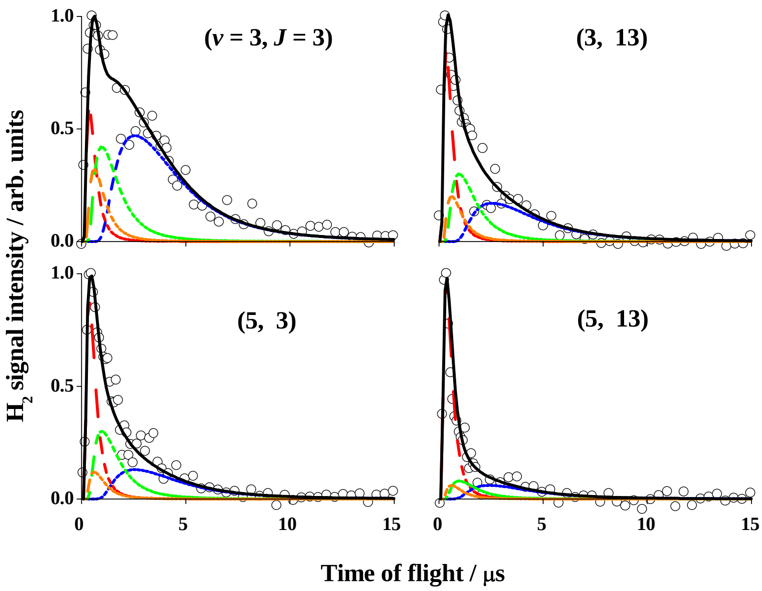

Figure 1: Time-of-flight spectra of $H_2(v\text{=}3, J\text{=}3, 13)$ and $H_2(v\text{=}5, J\text{=}3, 13)$. These spectra are composed of four Maxwell-Boltzmann distributions with T_{trans} = 5000, 1800, 700 and 100 K.