Absolute Charge Exchange Cross Sections for O^{5+}, O^{6+} and O^{7+} Collisions with CO and CO_2

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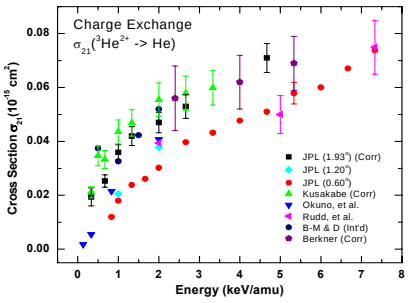
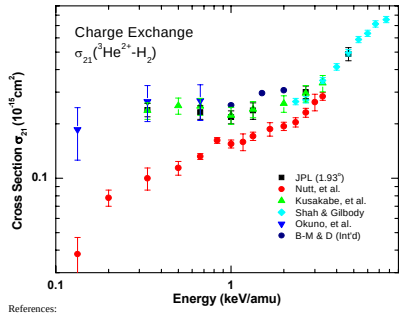
Motivated by ongoing EUV and X-ray studies of comets, we have continued our experimental investigations of absolute charge exchange cross sections for highly-charged ions present in the solar wind incident on cometary gases. These are the first measurements on the JPL charge exchange beam-line using a larger gas cell exit aperture. Data for O^{5+} and O^{7+} on CO_2 agree with earlier measurements [1], and are included in these new results for O^{5+}, O^{6+} and O^{7+} on CO and CO_2. The ion beam accelerating potential was 7 kV, which yields ion velocities consistent with the fast component of the solar wind. Agreement with earlier, smaller exit aperture measurements is also significant in demonstrating an independence from angular collection issues for these fast, heavy ions and targets. This was verified by studying collection angle-cross section effects for slow $^3He^{2+}$ ions on He and H_2.

Acceptance Angle Studies





References:

JPL: unpublished data; Angles indicate exit aperture (half) acceptance angle

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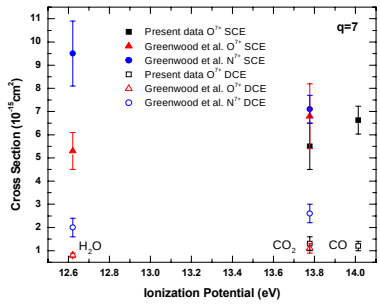
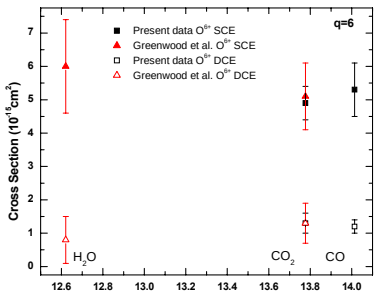
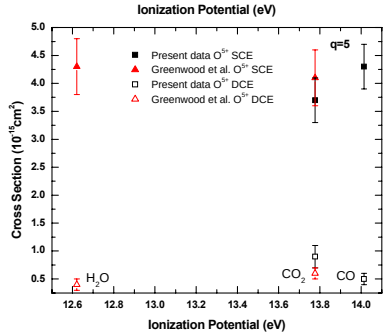
Gas Flow Through Cell

JPL Experimental Results for O^{5+}, O^{6+} and O^{7+}

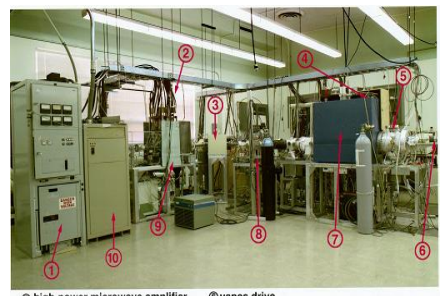
$O^{q+} + M \rightarrow (O^{(q-i)+})^* + M^{i+} \rightarrow O^{(q-j)+} + M^{k+} + (k\text{-}j)e^- + h\nu$

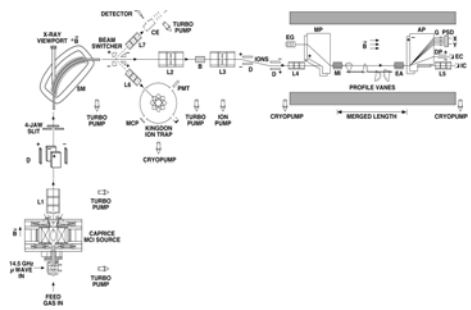




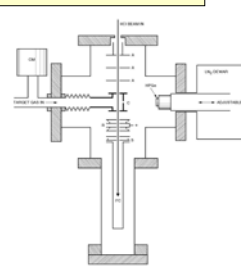


The JPL Highly-Charged Ion Facility

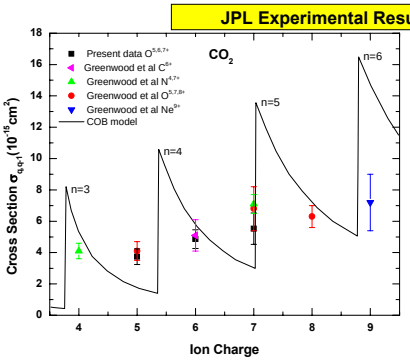




Photograph and Schematic of CE Gas Cell



JPL Experimental Results, σ (10^{-15}) cm^2 E_i = qx7 keV



Gas/Ion		C^{3+}	C^{5+}	N^{4+}	N^{7+}	O^{5+}	O^{6+}	O^{7+}	O^{8+}
H_2O	$\sigma_{q,q-1}$	1.5±0.1	6.0±1.4	2.9±0.2	9.5±1.4	4.3±0.5		5.3±0.8	6.3±0.7
	$\sigma_{q,q-2}$	0.8±0.1	0.8±0.7	0.7±0.1	2.0±0.4	0.4±0.1		0.8±0.1	1.5±0.5
	$\sigma_{q,q-3}$				<0.3	0.3±0.2		<0.3	<0.3
CO_2	$\sigma_{q,q-1}$	1.1±0.1	5.1±1.0	4.1±0.6	7.1±0.6	4.1±0.5		6.8±1.4	6.3±0.7
	$\sigma_{q,q-2}$	1.2±1.1	1.3±0.6	1.1±0.1	2.6±0.4	0.6±0.1		1.1±0.2	1.5±0.5
	$\sigma_{q,q-3}$				<0.3	0.6±0.1		0.3±0.1	<0.5
Present CO_2	$\sigma_{q,q-1}$					3.7±0.4	4.9±0.5	5.5±1.0	
	$\sigma_{q,q-2}$					0.9±0.2	1.3±0.3	1.3±0.3	
	$\sigma_{q,q-3}$						0.4±0.1	0.4±0.2	
Present CO	$\sigma_{q,q-1}$					4.3±0.4	5.3±0.8	6.6±0.6	
	$\sigma_{q,q-2}$					0.5±0.1	1.2±0.2	1.2±0.2	
	$\sigma_{q,q-3}$						0.2±0.1	0.1±0.1	

Comparisons of Theoretical Results[2] with JPL Experiments[1] for N^{7+}, σ (10^{-15}) cm^2

	H_2O	CO_2	CO
JPL[1] experiment E=3.3 keV/amu	9.5 ± 1.4	5.3 ± 0.8	- - -
CTMC (Classical Trajectory Monte Carlo) E=2keV/amu	9	8	8
LZ (Landau-Zener) E=2keV/amu	2.1	2.4	2.1
COB (Classical Over-the –Barrier) E=2 keV/amu	12	3.0	3.1

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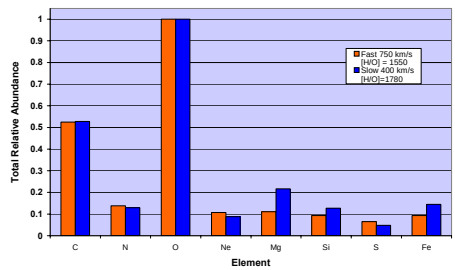

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