Zero-degree Auger projectile electron spectroscopy of 1.5 MeV Li^+ on H_2 collisions

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ABSTRACT

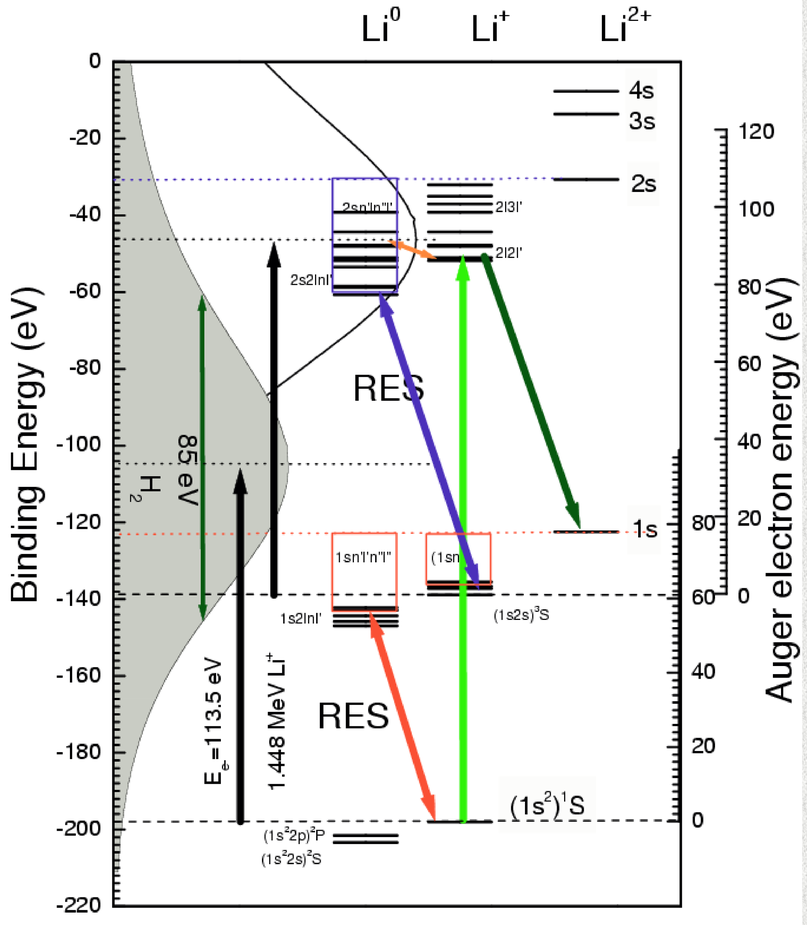
High-resolution zero-degree electron spectra were recently measured for He-like $^7Li^+$ ($1s^2$, $1s2s\ ^3S$) mixed state beams in collisions with H_2, at 1.5 MeV, the lowest energy possible on the 7 MV EN tandem Van de Graaff accelerator of the J. R. Macdonald Laboratory at Kansas State University. The primary goal was to extend our recent 1s2lnl' doubly-excited [1] and $2s2p^2\ ^2D$ triply-excited [2] state investigations to include lithium, for which mainly synchrotron investigations exist. For this collision system, the ground state can give rise to doubly-excited states 2l2l' by direct double excitation or 1snpn'l' by RTE, while the $1s2s\ ^3S$ metastable state can give rise to doubly-excited 2snp states by direct single excitation, $(1s2s\ ^3S)$nl states by capture and to triply-excited 2snln'l' states by RTE. We are still in the process of identifying the possible excitation mechanisms. At this collision energy, the electron scattering model, which has been very successful in treating RTE as Resonant Electron Scattering (RES) [1], may be breaking down.

References

[1] T.J.M. Zouros, E.P. Benis and T.W. Gorczyca Phys. Rev. A Rapid Communications, in print (2003).

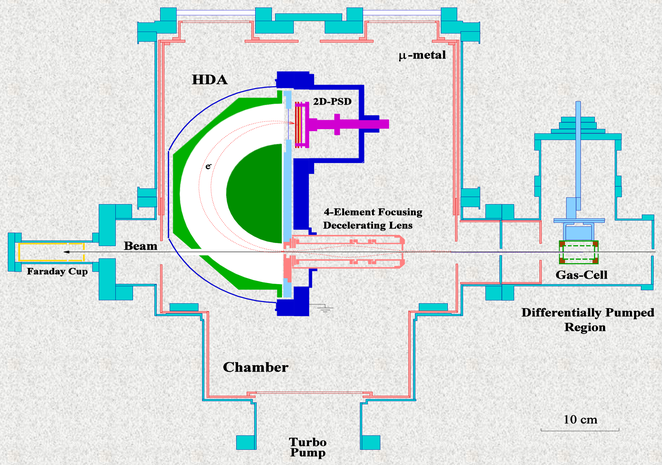
[2] E.P. Benis, T.J.M. Zouros, T.W. Gorczyca, M. Zamkov, and P. Richard, submitted to PRL (2003).

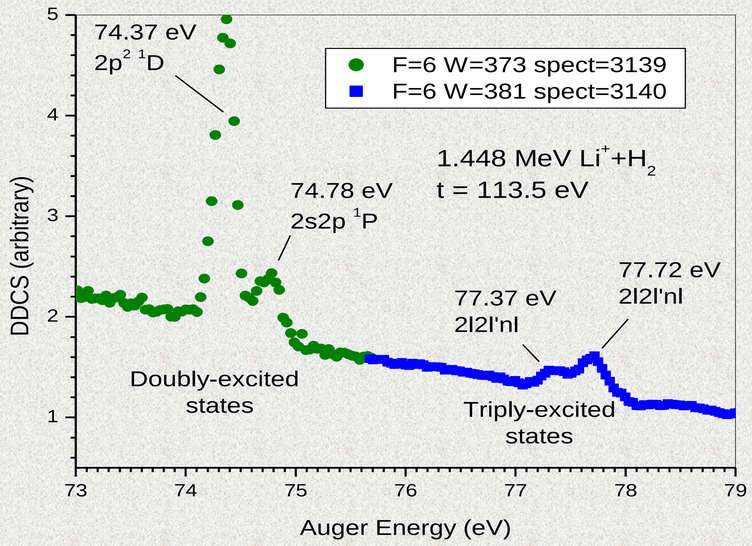
Lithium Energy Level Diagram and Transitions



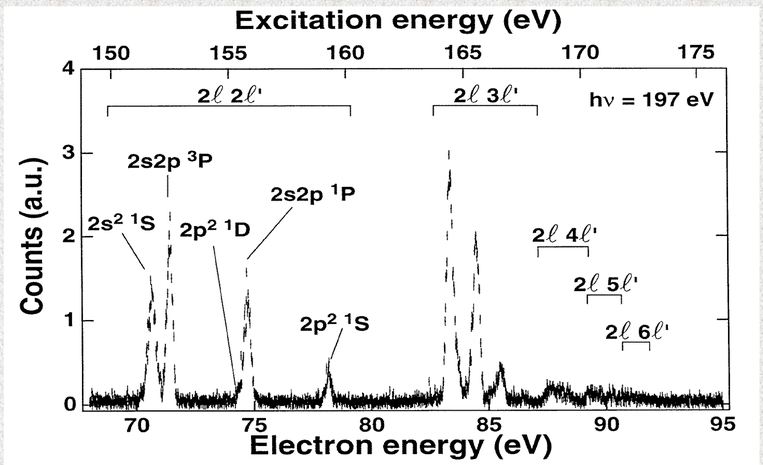
The finite width of the H_2 Compton profile is shown overlapping various energy levels of Li. Arrows indicate various transitions

The University of Crete zero-degree Hemispherical Spectrograph at the J.R. Macdonald Laboratory





Zero-degree electron rest frame spectrum taken at 1.448 MeV $Li^+ + H_2$ collisions using a deceleration factor of F=6. The Cusp energy is t=113.5 eV. Thus, the ratio η of H_2 target electron velocity v to projectile velocity V_p is η=0.37.



From Diehl et al, JPB **30** (1997) L595

Figure 2. Li^+ Auger spectrum recorded at an incident photon energy of 197 eV. The spectrum shows all expected $Li^+\ 2l'2l'' \rightarrow Li^{2+}\ (1s) + e^-$ lines and others arising from $Li^+\ nln'l'(n > 2) \rightarrow Li^{2+}(1s) + e^-$ decays.

Lithium Auger transition energies

Initial state	Intermediate State / BE (eV)	Final state/ BE (eV)	Auger energy (eV)
$1s2s\ ^3S$	$1s2s^2\ ^2S$/-146.93	$1s^2$/-198.04	51.11
$1s2s\ ^3S$	$1s2s2p\ ^4P$/-145.86	$1s^2$/-198.04	52.18
$1s2s\ ^3S$	$1s2s2p\ ^2P_$/-144.38	$1s^2$/-198.04	53.66
$1s2s\ ^3S$	$1s2s2p\ ^2P_+$/-142.89	$1s^2$/-198.04	55.15
$1s^2$	$1s2p^2\ ^2D$/-142.23	$1s^2$/-198.04	55.81
	$2s^2$ /-51.77	1s/-122.42	70.65
$1s2s\ ^3S$	$2s2p\ ^3P$/-51.02	1s/-122.42	71.4
	$2p^2\ ^1D$/-48.1	**1s/-122.42**	**74.32**
$1s2s\ ^3S$	**$2s2p\ ^1P$/-47.72**	**1s/-122.42**	**74.7**
$1s2s\ ^3S$	$2s2p^2\ ^2D$/-60.67	$1s2p\ ^1P$/-135.54	74.87
$1s2s\ ^3S$	$2s2p^2\ ^2D$/-60.67	$1s2p\ ^3P$/-136.63	75.96
$1s2s\ ^3S$	$2s2p^2\ ^2D$/-60.67	$1s2s\ ^1S$/-137.2	76.53
$1s2s\ ^3S$	$2s2p^2\ ^2S$/-58.8	$1s2p\ ^1P$/-135.54	76.74
$1s2s\ ^3S$	**$2s2p^2\ ^2P$/-58.43**	**$1s2p\ ^1P$/-135.54**	**77.11**
$1s2s\ ^3S$	**$2s2p^2\ ^2S$/-58.8**	**$1s2p\ ^3P$/-136.63**	**77.83**
	$2p^2\ ^1S$/-44.27	1s/-122.42	78.15
$1s2s\ ^3S$	$2s2p^2\ ^2P$/-58.43	$1s2p\ ^3P$/-136.63	78.20
$1s2s\ ^3S$	$2s2p^2\ ^2D$/-60.67	$1s2s\ ^3S$/-138.89	78.22
$1s2s\ ^3S$	$2s2p^2\ ^2S$/-58.8	$1s2s\ ^1S$/-137.2	78.40
$1s2s\ ^3S$	$2s2p^2\ ^2P$/-58.43	$1s2s\ ^1S$/-137.2	78.77
$1s2s\ ^3S$	$2s2p^2\ ^2P$/-58.43	$1s2s\ ^3S$/-138.89	80.46
$1s2s\ ^3S$	$2s2p^2\ ^2S$/-58.8	$1s2s\ ^3S$/-138.89	80.9
$1s2s\ ^3S$	$2s^22p\ ^2P$/-53.43	$1s2p\ ^1P$/-135.54	82.11
$1s2s\ ^3S$	$2s^22p\ ^2P$/-53.43	$1s2p\ ^3P$/-136.63	83.20
	2l3l'/-39.14	1s/-122.42	83.28
$1s2s\ ^3S$	$2s^22p\ ^2P$/-53.43	$1s2s\ ^1S$/-137.2	83.77
$1s2s\ ^3S$	$2s^22p\ ^2P$/-53.43	$1s2s\ ^3S$/-138.89	85.46