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Supplemental Material
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Table S1. Observed transitions from the $^3\Sigma_u^+$ ($\nu'' = 0, N''$) state of $^4He_2$ sharing a common upper np Rydberg state. The symbol Δ represents the difference between the observed line centers with the predictions of a nonlinear least-square fit of level energies to the experimental data.

	$1 \rightarrow np1_2$		$3 \rightarrow np1_2$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
99	34 290.021 53	−0.000 01	34 214.208 36	0.000 37
100	34 290.241 41	0.000 02	34 214.427 12	−0.000 72
101	34 290.455 30	0.000 01	34 214.641 23	−0.000 51
102	34 290.662 49	0.000 00	34 214.848 81	−0.000 13
103	34 290.863 74	0.000 00	34 215.050 24	0.000 05
104	34 291.059 38	0.000 00	34 215.245 73	−0.000 10
105	34 291.249 28	0.000 02	34 215.435 50	−0.000 21
106	34 291.433 64	0.000 11	34 215.619 34	−0.000 64
109	34 291.949 02	0.000 03	34 216.135 27	−0.000 17
110	34 292.107 16	−0.000 06	34 216.293 93	0.000 26
111	34 292.257 90	−0.000 02	34 216.444 42	0.000 05
112	34 292.399 93	−0.000 06	34 216.586 54	0.000 10
	$3 \rightarrow np3_4$		$5 \rightarrow np3_4$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
81	34 279.628 36	0.000 45	34 143.446 50	0.000 00
82	34 280.029 21	0.000 32	34 143.847 30	−0.000 18
83	34 280.415 91	0.000 32	34 144.233 80	−0.000 38
84	34 280.788 55	0.000 18	34 144.606 90	−0.000 05
85	34 281.148 33	−0.000 05	34 144.967 20	0.000 24
86	34 281.495 92	0.000 04	34 145.314 30	−0.000 17
87	34 281.830 84	−0.000 10	34 145.649 60	0.000 07
88	34 282.154 19	−0.000 05	34 145.973 10	0.000 27
	$5 \rightarrow np5_6$		$7 \rightarrow np5_6$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
94	34 275.169 49	0.000 14	34 079.102 20	−0.000 70
95	34 275.427 33	−0.000 03	34 079.361 19	0.000 28
96	34 275.678 34	0.000 00	34 079.611 05	−0.000 84
97	34 275.921 23	0.000 08	34 079.854 41	−0.000 28
98	34 276.156 71	−0.000 01	34 080.090 30	0.000 03
99	34 276.385 36	0.000 01	34 080.318 87	−0.000 03
100	34 276.607 01	−0.000 15	34 080.540 94	0.000 23
101	34 276.822 30	−0.000 02	34 080.755 96	0.000 09
102	34 277.031 16	−0.000 01	34 080.964 75	0.000 03
103	34 277.233 94	−0.000 04	34 081.167 77	0.000 24
104	34 277.431 31	0.000 02	34 081.364 73	−0.000 11
105	34 277.622 36	−0.000 06	34 081.556 14	0.000 18
106	34 277.808 48	−0.000 13	34 081.742 41	0.000 25
107	34 277.989 26	−0.000 23	34 081.923 48	0.000 44
108	34 278.165 09	−0.000 43	34 082.099 59	0.000 52
109	34 278.336 71	−0.000 07	34 082.270 41	0.000 08
110	34 278.503 42	−0.000 01	34 082.437 00	0.000 03
111	34 278.665 60	−0.000 03	34 082.599 24	0.000 06
112	34 278.823 50	−0.000 01	34 082.757 07	0.000 01
113	34 278.977 54	−0.000 87	34 082.912 44	0.000 49
114	34 279.127 52	0.000 22	34 083.060 31	−0.000 54
115	34 279.273 05	0.000 33	34 083.205 55	−0.000 71
116	34 279.409 60	−0.007 08	34 083.351 60	0.001 37
117	34 279.552 24	0.000 63	34 083.484 28	−0.000 88
118	34 279.689 01	0.001 35	34 083.618 41	−0.002 80
119	34 279.820 79	0.001 71	34 083.749 05	−0.003 58
120	34 279.942 97	0.000 23	34 083.876 24	−0.000 05
121	34 280.066 04	−0.001 28	34 084.001 02	0.000 16
122	34 280.189 32	−0.000 49	34 084.123 99	0.000 64
123	34 280.308 19	−0.000 10	34 084.241 97	0.000 13
126	34 280.644 88	0.000 03	34 084.577 67	−0.000 73
127	34 280.754 04	0.000 21	34 084.685 94	−0.001 44
128	34 280.858 32	0.000 15	34 084.791 30	−0.000 42
130	34 281.060 87	0.001 25	34 084.990 94	−0.002 23

	$7 \rightarrow np7_8$		$9 \rightarrow np7_8$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
78	34 256.960 96	0.000 08	34 001.699 06	−0.000 13
79	34 257.411 18	0.000 01	34 002.149 48	−0.000 01
80	34 257.845 17	−0.000 08	34 002.583 72	0.000 15
81	34 258.262 94	−0.000 26	34 003.001 93	0.000 41
82	34 258.667 00	0.000 83	34 003.404 12	−0.000 37
83	34 259.054 86	0.000 41	34 003.792 64	−0.000 12
84	34 259.431 20	0.001 65	34 004.167 20	−0.000 67
86	34 260.142 15	−0.000 27	34 004.880 86	0.000 12
87	34 260.479 26	−0.000 43	34 005.218 09	0.000 08
89	34 261.120 17	−0.000 10	34 005.858 63	0.000 04
90	34 261.424 63	0.000 27	34 006.162 49	−0.000 18
	$9 \rightarrow np9_{10}$		$11 \rightarrow np11_{10}$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
101	34 247.794 65	−0.002 14	33 934.239 28	0.000 28
103	34 248.207 04	0.000 01	33 934.649 23	0.000 00
104	34 248.402 10	0.000 02	33 934.843 85	−0.000 43
105	34 248.587 08	−0.000 15	33 935.029 48	0.000 05
106	34 248.780 80	−0.013 95	33 935.238 83	0.001 88
108	34 249.136 06	0.001 86	33 935.575 76	−0.000 64
109	34 249.304 31	−0.000 02	33 935.746 53	0.000 00
110	34 249.470 92	0.000 49	33 935.912 46	−0.000 17
111	34 249.633 17	0.001 12	33 936.073 68	−0.000 58
114	34 250.091 30	0.001 70	33 936.531 57	−0.000 23
115	34 250.236 01	0.001 10	33 936.676 78	−0.000 33
116	34 250.377 70	0.002 35	33 936.817 49	−0.000 07
117	34 250.514 97	0.001 50	33 936.955 30	−0.000 38
118	34 250.649 75	0.001 26	33 937.090 31	−0.000 39
	$11 \rightarrow np11_{12}$		$13 \rightarrow np11_{12}$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
61	34 208.628 17	0.000 11	33 837.869 34	−0.000 03
62	34 210.359 74	−0.000 77	33 839.601 92	0.000 10
	$13 \rightarrow np13_{14}$		$15 \rightarrow np13_{14}$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
65	34 188.451 86	−0.000 10	33 761.784 39	0.000 02
66	34 189.201 78	−0.000 37	33 762.534 65	0.000 09
67	34 190.610 88	0.000 50	33 763.942 71	−0.000 09
68	34 191.275 74	0.000 70	33 764.607 39	−0.000 07
	$15 \rightarrow np15_{16}$		$17 \rightarrow np15_{16}$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
56	34 152.062 90	0.000 28	33 670.956 39	−0.000 05
57	34 153.224 16	0.000 66	33 672.117 07	−0.000 25
58	34 154.322 74	−0.000 89	33 673.217 66	0.000 20
	$17 \rightarrow np17_{18}$		$19 \rightarrow np17_{18}$	
n	$\tilde{\nu}_{\rm obs}$	Δ	$\tilde{\nu}_{\rm obs}$	Δ
41	34 091.108 06	−0.000 38	33 557.216 64	0.000 43
42	34 094.051 40	−0.000 43	33 560.160 36	0.000 76
43	34 096.763 66	−0.000 29	33 562.871 89	0.000 17
45	34 101.525 00	0.000 87	33 567.631 48	−0.000 43