

Table S1: Observed lines from $X^1\Sigma^+$ of H^{81}Br^a to 0^+ states

J	$P(J)$	$R(J)$	$T(J)$	J	$P(J)$	$R(J)$	$T(J)$
		$j^3\Sigma^- - X(0-0)$				$j^3\Sigma^- - X(1-0)$	
0		82199.5	82268.1	0		84467.7	
1	82168.6	82210.6		1		84479.1	
2	82149.3	82217.7		2	84418.0	84486.4	
3	82126.7	82221.9		3	84395.0	84491.9	
4	82100.7			4	84369.7	84492.9	
		$E^1\Sigma^+ - X(2-0)$				$[6p\pi]^3\Sigma^- - X(0-0)$	
0		82289.0	82356.3	0		84822.3	
1	82259.4	82299.8	82392.8	1	84790.8	84837.3	
2	82238.9	82307.4	82425.3	2	84772.9	84851.0	
3			82453.3	3	84754.7	84864.3	
		$m^3\Pi - X(0-0)$				$r^3\Pi - X(0-0)$	
0		83469.3		4	84734.9	84876.4	
1	83437.0	83484.3		5	84714.7	84888.6	
2	83419.2*	83498.2					
3		83512.1		0		85917.1	
4		83524.2		1	missing	85931.2	
		$H^1\Sigma^+ - X(2-0)$		2	85867.6	85945.2	
0		84050.2		3		85958.5*	
1	84024.2	84052.8		4		85970.5	
2	84001.0	84048.2					
3	83970.0	84036.1		0		$[5d\pi]^1\Sigma^+ - X(0-0)$	
4	83931.3			1		86523.1	
		$E^1\Sigma^+ - X(3-0)$		2		86533.5	
0		84262.4		3		86540.2	
1	84234.6	84267.9		4		86543.2	
2	84211.1	84271.3				86545.1	
3	84183.9	84273.6					

(a) Energies are given in cm^{-1} (vacuum corrected).

(b) Asterisks (*) indicate blended lines. Italics indicate very weak lines

Table S1: continued

J	$P(J)$	$R(J)$	$T(J)$	J	$P(J)$	$R(J)$	$T(J)$
		$j \ ^3\Sigma^- - X(2 - 0)$				Band XXXII	
0		86876.0		0		89962.4	
1	86845.8	86887.7		1	89931.7	89971.8	
2	86826.5	86897.3		2	89912.5	89978.7	
3	86804.3	86904.9		3	89887.9		
4	86780.4						
		$[6p\pi] \ ^3\Sigma^- - X(1 - 0)$				$[7p\sigma] \ ^3\Pi - X(0 - 0)$	
0		87325.0	87404.1	0		90430.9	90500.5
1	87292.9	87339.3	87449.2	1	90400.5	90443.1	90538.6
2	87274.9	87353.0		2	90381.8	90450.5	
3	87256.8	87366.3		3		90454.1	
4	87236.9						
		$[5d\sigma] \ ^3\Pi - X(0 - 0)$					
0			88083.4				
1			88127.5				
2			88172.8				
3			88216.9				

Table S2: Observed lines from $X^1\Sigma^+$ of H^{81}Br a,b to $\Omega > 0$ states

J	$P(J)$	$Q(J)$	$R(J)$	$S(J)$	$T(J)$
$k^3\Pi_1 - X(1-0)$					
0			82761.0		
1		82744.2*	82776.0		
2	82711.0	*	82789.9		
3	82692.1	82739.9	82803.2		
4		82736.4	82815.4		
$L^1\Phi_3 - X(0-0)$					
0					82957.9
1				82941.0	83007.9
2			82907.8	82974.6	
3		82857.9	82924.6		
4				83040.8	
$K^1\Pi_1 - X(0-0)$					
0			83252.0		83322.8
1		83234.7	83263.2	83305.9	83363.7
2	83201.6	83229.4	83272.4	83329.9	83403.1
3	83180.3	83222.3	83279.8		
$r^3\Pi_2 - X(0-0)$					
0					83370.4
1			83303.4		83419.0*
2		83270.1 ^c	83320.0		83466.5
3			83335.4		
4			83349.7		
$r^3\Pi_1 - X(0-0)$					
0			83309.7		83391.8
1		83292.6	83325.8		83439.5
2	83259.5		83341.4		

(a) Energies are given in cm^{-1} (vacuum corrected).

(b) Asterisks (*) indicate blended lines.

(c) Q branch blended.

Table S2: continued

J	$O(J)$	$P(J)$	$Q(J)$	$R(J)$	$S(J)$	$T(J)$
$m^3\Pi_1 - X(1 - 0)$						
0				83586.1		83664.6
1			*	83599.7		83709.7
2		83536.2	83568.1	83615.0		83754.2
3		83518.2				83797.5
$M^1\Pi_1 - X(0 - 0)$						
0				83865.2		83946.7
1			83847.5	83880.8	83929.9	83995.7
2		83814.3		83896.4	83961.3	84042.9
3		83797.4		83911.6		
4				83926.1		
$L^1\Phi_3 - X(1 - 0)$						
0						85341.4
1					85324.5	85389.3
2				85291.3	85355.4	85436.0
3			85241.1	85306.0	85386.0	
4				85320.0		
$[6d\sigma] ^3\Pi_1 - X(0 - 0)$						
Band XVI						
0				85548.3		85626.0
1				85563.0		85671.1
2			85529.9	85576.0		
3			85526.1	85587.1		
4			85519.4			
$K^1\Pi_1 - X(1 - 0)$						
0				85636.6		85710.3
1			85619.4	85649.0		85752.4
2		85586.8	85616.3	85660.0		85791.5
3		85566.4		85668.3		
4		85543.1		85675.7		

Table S2: continued

J	$O(J)$	$P(J)$	$Q(J)$	$R(J)$	$S(J)$	$T(J)$
$R^1\Pi_1 - X(0 - 0)$						
0				85960.1*		86039.9
1				85974.0		86085.9
2		85910.1	85941.6	85988.7		86132.7
3	85859.6			86002.3		86178.2
4	85825.8					86226.2
5						86273.5
$M^1\Pi_1 - X(1 - 0)$						
0				86245.2		86324.1*
1			86228.2	86260.2		86370.2
2		86195.2	86226.7	86273.5	86336.8	
$^3\Phi_3 - X(0 - 0)$						
Band XXI						
0						86427.3
1					86410.2	86480.2
2				86376.9	86447.0	86533.5
3			86325.2*	86396.1	86483.7	
4			86329.3	86416.8	86521.1	
[5d δ] $^3\Pi_1 - X(0 - 0)$						
0				86602.4		86686.0
1			86584.7 ^c	86619.6		86735.5
2		86552.4		86636.3		
3		86536.1		86652.6		
4		86520.1		86668.0		
5				86682.1		
6				86693.7		
Band XXV						
0				86993.9		87078.1
1			86976.5 ^c	87010.6		87128.7
2				87027.3		

Table S2: continued

J	$P(J)$	$Q(J)$	$R(J)$	$S(J)$	$T(J)$
Band XXVII					
0			87948.1		88024.6
1		87930.2	87962.8		88069.1
2	87898.2	87927.2	87975.5		88115.7
3		87924.3			
4		87919.5			
[5d δ] $^1\Phi_3 - X(0-0)$					
0					89022.2
1				89006.1	89077.1
2			88972.5	89043.4	89131.6
3			88994.1		
$^3\Delta_3 - X(0-0)$					
Band XXX					
0					89334.7
1				89318.1	89392.6
2			89285.4	89358.6	
3			89307.2		
Band XXXI					
0			89563.7		
1		89547.4	89577.3		
2	89513.0	89545.1			
3	89493.8	89541.7			
4		89538.0			
[7p σ] $^1\Pi_1 - X(0-0)$					
0			90108.8		90192.0
1		90090.8*	90126.2		90239.6
2	90057.9	*			90286.6
3	90041.7	*			90330.6
4		90089.8			
5		90086.1			
6		90080.8			