$$P_{pc}(t) = \gamma_{se} P_A t - \frac{1}{2}\gamma_{se} P_A(\gamma_{se} + \Gamma_{pc} + d_{pc})t^2 \tag{1a}$$

$$P_{tc}(t) = \frac{1}{2}\gamma_{se} P_A d_{tc} t^2 \tag{1b}$$

$$X_1 = \frac{\langle P_A \rangle}{P_{pc}^{\infty}} \left(\frac{\Gamma_s - \langle \Gamma \rangle + \delta\Gamma}{\Gamma_s + \delta\Gamma - \delta\Gamma'} \right) - 1 \tag{2}$$

$(\Gamma_s - \langle \Gamma \rangle)$

The coefficients of pressure broadening for ^{3}He, ^{4}He and N_2 are listed in Table **??**.

The energy levels of ^{87}Rb are shown in Fig. **??**. where Γ_A is the pressure dependent FWHM, $\Gamma_A \approx 0.04 nm/amg \cdot [^3He]$.

EXP	Cell	Lasers	I_0 W/cm^2	$\mathrm{T}_{\mathrm{pc}}^{\mathrm{set}}$ °C	P_{He}^{∞}	Γ_{s}^{-1} hrs	$\langle\Gamma\rangle^{-1}$ hrs	$\langle P^{\mathrm{A}}\rangle$	$P_{\mathrm{line}}^{\mathrm{A}}$	D_{fr}	D_{pb}	$[\mathrm{Rb}]_{\mathrm{fr}}$ $10^{14}/\mathrm{cm}^3$	$\Delta\mathrm{T}_{\mathrm{Rb}}$ °C	$\Delta\mathrm{T}_{\mathrm{He}}$ °C	X
saGDH	Proteus	3B	3.8	180	0.46	27	74	-	-	0	0	-	-	-	-
	Priapus	3B	3.8	180	0.44	21	56	-	-	0	0	-	-	-	-
	Penelope	3B	3.8	180	0.39	18	46	-	-	0	0	-	-	-	-
	Powell	3B	3.8	180	0.38	13	25	-	-	0	0	-	-	-	-
	Prasch	3B	3.8	180	0.33	13	33	-	-	0	0	-	-	-	-
GEN	Al	2.5B	3.2	235	0.53(03)	7.86(05)	27.42(1.37)	-	-	-	4.53(25)	-	-	-	-
		5B	6.1	235	0.54(03)	6.73(18)	27.42(1.37)	-	-	-	4.53(25)	-	-	-	-
	Barbara	2.5B	1.6	235	0.37(02)	5.5(08)	42.95(2.15)	-	-	-	4.80(25)	-	-	-	-
		5B	3.1	235	0.57(03)	4.76(63)	42.95(2.15)	-	-	-	4.80(25)	-	-	-	-
	Gloria	3B	1.7	235	0.60(03)	6.13(04)	38.29(1.91)	-	-	-	7.20(40)	-	-	-	-
	Anna	1B	0.6	235	0.33(02)	5.60(34)	11.38(57)	-	-	-	9.64(57)	-	-	-	-
		1.5B	1.0	235	0.39(02)	5.37(08)	11.38(57)	-	-	-	9.64(57)	-	-	-	-
	Dexter	1.5B	1.5	235	0.47(02)	7.58(17)	18.45(92)	-	-	-	-	-	-	-	-
		5B	6.1	235	0.49(02)	6.63(12)	18.45(92)	-	-	-	-	-	-	-	-
	Edna	3B	2.4	235	0.56(03)	5.71(02)	27.42(1.37)	-	-	-	3.63(20)	-	-	-	-
	Dolly	3B	1.0	235	0.43(02)	6.16(03)	35.24(1.76)	-	-	-	20(1.3)	-	-	-	-
		1N1B	1.4	235	0.62(03)	5.79(07)	35.24(1.76)	-	-	-	20(1.3)	-	-	17(10)	-
	Simone	2N1B	3.8	215	0.31(01)	14.08(06)	22.87(1.14)	0.947(020)	0.91(05)	10.66(54)	8.89(45)	0.20(02)	-7(3)	-	-0.04(12)⋆
		2N1B	3.8	240	0.48(02)	6.89(20)	22.87(1.14)	-	-	-	9.76(49)	-	-	-	-
		2N1B	3.8	255	0.58(02)	6.45(10)	22.98(1.14)	0.929(023)	0.92(05)	12.48(83)	10.3(52)	0.90(09)	-4(5)	-	0.11(06)⋆
	Sosa	2N1B	1.9	160	0.57(02)	16.69(09)	73.68(3.68)	0.966(020)	1.00(03)	0	0	1.97(13)	4(1)	30(7)	0.24(06)†
		2N1B	1.9	170	0.61(03)	11.67(04)	73.68(3.68)	0.964(020)	0.98(03)	0	0	3.00(33)	3(3)	38(14)	0.27(06)⋆
		2N1B	1.9	180	0.55(02)	8.79(09)	73.68(3.68)	0.954(022)	0.97(03)	0	0	4.30(27)	1(2)	47(7)	0.43(06)†
		2N1B	1.9	190	0.40(02)	6.39(22)	73.68(3.68)	0.854(075)	0.82(03)	0	0	5.69(63)	-2(3)	48(20)	0.58(12)⋆
		2N1B	1.9	200	0.26(01)	5.04(17)	73.68(3.68)	-	-	0	0	-	-	43(18)	-
Transversity	Boris	3B	1.8	235	0.42(02)	6.25(04)	23.74(1.19)	0.871(050)	0.79(07)	1.96(18)	2.45(23)	2.19(34)	-8(7)	-	0.26(10)⋆
	Samantha	3B	1.8	235	0.50(02)	6.30(13)	36.51(1.83)	-	-	-	4.34(23)	-	-	-	-
		3N	2.6	235	0.68(03)	4.62(03)	22.13(1.11)	0.956(020)	0.99(03)	4.37(10)	4.34(23)	1.80(10)	7(2)	21(10)	0.12(05)⋆
	Alex	2N1B	2.6	235	0.59(03)	4.81(02)	32.96(1.65)	0.942(042)	0.99(03)	1.37(08)	1.19(07)	4.08(36)	0(4)	42(10)	0.34(06)†
	Moss	1N1B	1.8	235	0.62(03)	5.35(04)	33.00(1.65)	-	0.95(09)	-	2.40(13)	-	-	29(8)	-
	Tigger	1N1B	1.8	235	0.51(02)	4.89(05)	12.62(63)	-	0.95(09)	-	-	-	-	23(9)	-
	Astral	2N1B	2.6	235	0.69(03)	6.57(12)	48.90(2.45)	0.954(020)	0.99(03)	7.09(55)	6.21(56)	0.97(09)	3(5)	25(4)	0.17(05)†
	Stephanie	3N	2.6	235	0.63(03)	4.55(09)	48.35(2.42)	0.929(114)	0.99(03)	1.39(11)	1.50(10)	5.08(58)	7(5)	54(6)	0.31(08)⋆
	Brady	1N	0.9	235	0.62(03)	4.82(1.08)	33.50(1.68)	-	0.95(03)	-	2.36(24)	-	-	14(9)	-
		2N	1.8	235	0.68(03)	5.52(70)	33.50(1.68)	-	0.99(03)	-	2.36(24)	-	-	25(8)	-
		3N	2.6	235	0.70(03)	5.30(01)	33.50(1.68)	0.956(021)	0.99(03)	2.60(20)	2.36(24)	2.86(30)	6(5)	39(9)	0.14(05)†
	Maureen	3N	2.6	235	0.66(03)	5.42(12)	29.21(1.46)	-	0.97(09)	-	4.42(55)	-	-	32(12)	-
	Antoinette	3N	1.7	215	0.49(02)	6.63(37)	20.93(1.05)	0.958(020)	0.99(03)	2.85(13)	-	0.96(07)	0(3)	16(8)	0.28(08)†
		3N	1.7	235	0.61(03)	4.18(10)	20.93(1.05)	0.936(043)	0.99(03)	3.32(27)	-	1.83(20)	0(5)	20(10)	0.24(07)†
		3N	1.7	255	0.41(02)	2.66(11)	20.93(1.05)	0.776(099)	0.93(10)	3.57(23)	-	2.88(39)	-5(6)	33(9)	0.55(13)†

Table 1: Cell Performance for three sets of experiments: saGDH (top), GEN (middle), and Transversity & d_2^n (bottom). Within each experiment grouping, data is grouped by type of laser used (B = Broadband, N = Narrowband). I_0 is the nominal incident laser intensity at the center of the pumping chamber. T_{pc}^{set} is the oven set temperature. P_{pc}^{∞} is the equilibrium polarization in the pumping chamber and Γ_s is the slow time constant extracted from the five parameter fit to the polarization build up curve. Γ_c is the cell-averaged room temperature spin relaxation rate. $\langle P_A\rangle/P_A^l$ is the volume averaged to line averaged alkali polarizaiton ratio determined from the optical pumping simulation. P_A^l is the measured line averaged alkali polarization. $D_{fr}\&D_{pb}$ are the K to Rb density ratios determined from Faraday rotation and pressure broadening measurements. $[\mathrm{Rb}]_{fr}$ is the Rb number density measured from Faraday rotation. ΔT_{He} is the temperature of Rb inferred from the number density relative to the oven set temperature. ΔT_{He} is the temperature of ^{3}He inferred from temperature tests relative to the oven set temperature. X is the best combined value for the X-factor. ⋆ indicates X was measured using only spinup, alkali polarization, and Faraday rotation data. † indicates X was also measured using the early-time behavior of the spinup.

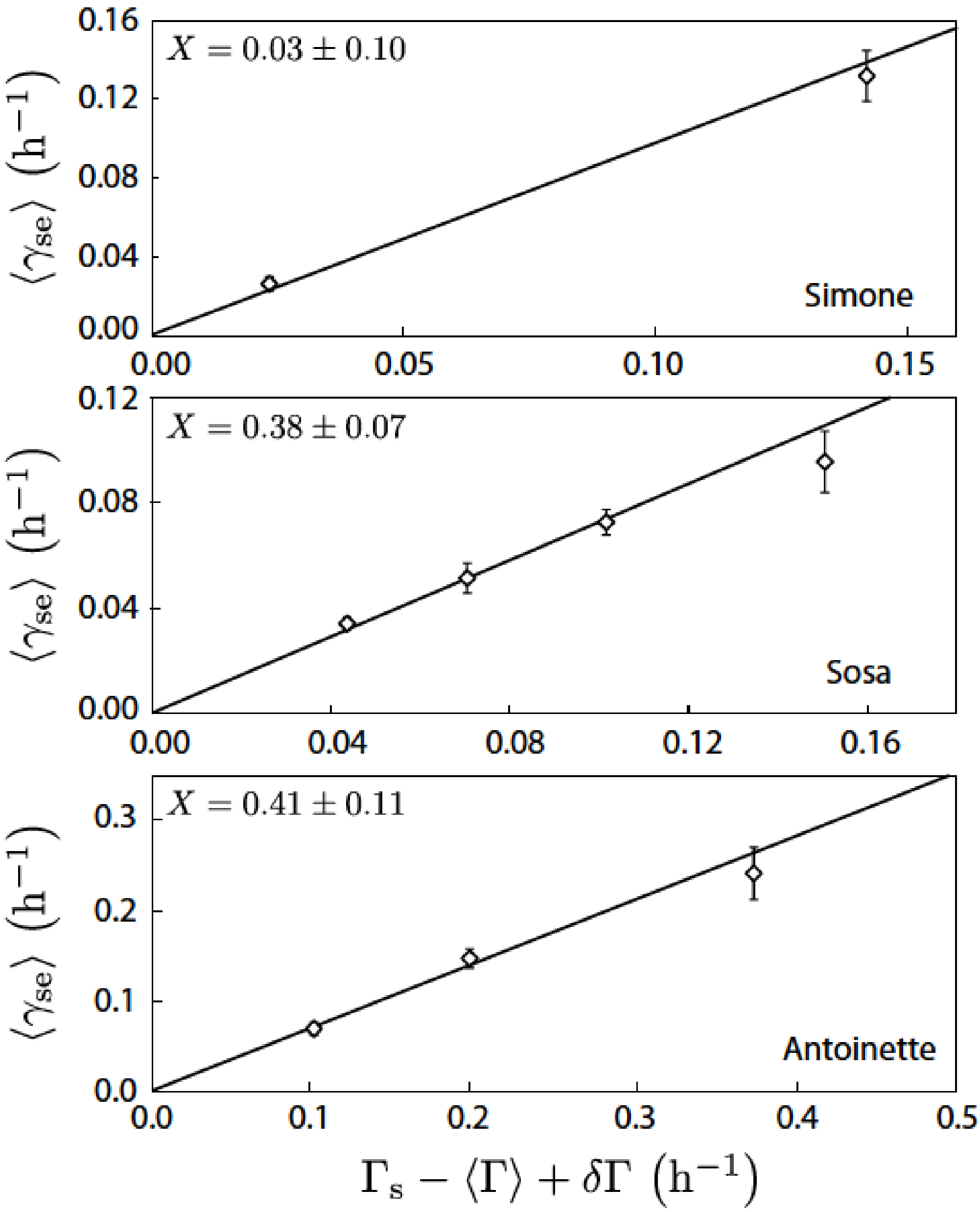

Figure 1: The cell-averaged spin-exchange rate $\langle \gamma_{se} \rangle$ is calculated using data from Faraday rotation and the spin-exchange constants k_{se}^{Rb} and k_{se}^{K}. The three linear fits shown here are constrained to go through zero. The errors quoted in values of X factor include the uncertainty in our determination of k_{se}^{K}.

Bibliography