Supplemental material of the published article "Polarization Spectroscopy Applied to Electromagnetically Induced Transparency in Hot Rydberg Atoms Using a Laguerre–Gaussian Beam" by Naomy Duarte Gomes, Bárbara da Fonseca Magnani, Jorge Douglas Massayuki Kondo e Luis Gustavo Marcassa at. *Atoms* **2022**, *10*, 58. https://doi.org/10.3390/atoms10020058

Fig. 2 - data

Detuning	G_1det	Detuning	G_2det
-20.895	0.96697	-20.6712	0.51014
-20.307	0.97413	-20.097	0.4959
-19.719	0.96435	-19.5228	0.49003
-19.131	0.96309	-18.9486	0.49426
-18.543	0.96102	-18.3744	0.48397
-17.955	0.97287	-17.8002	0.50223
-17.367	0.97363	-17.226	0.4837
-16.779	0.96536	-16.6518	0.49228
-16.191	0.96622	-16.0776	0.5008
-15.603	0.96778	-15.5034	0.50244
-15.015	0.96128	-14.9292	0.51498
-14.427	0.96198	-14.355	0.51416
-13.839	0.96541	-13.7808	0.48969
-13.251	0.97867	-13.2066	0.50925
-12.663	0.97227	-12.6324	0.50285
-12.075	0.96223	-12.0582	0.50033
-11.487	0.98956	-11.484	0.5162
-10.899	0.98689	-10.9098	0.51982
-10.311	0.9702	-10.3356	0.5235
-9.723	0.97353	-9.7614	0.54012
-9.135	0.96753	-9.1872	0.54394
-8.547	0.96037	-8.613	0.55253
-7.959	0.98245	-8.0388	0.57209
-7.371	0.98185	-7.4646	0.55982
-6.783	0.97096	-6.8904	0.59342
-6.195	0.96864	-6.3162	0.58987
-5.607	0.94166	-5.742	0.57495
-5.019	0.92008	-5.1678	0.48615
-4.431	0.8742	-4.5936	0.43402
-3.843	0.81218	-4.0194	0.34256
-3.255	0.66949	-3.4452	0.21042
-2.667	0.51571	-2.871	0.14342
-2.079	0.41335	-2.2968	0
-1.491	0.24772	-1.7226	0.0367
-0.903	0.11098	-1.1484	0.17941
-0.315	0.05541	-0.5742	0.28504

Detuning	G_1det	Detuning	G_2det
0.861	0.03086	0.5742	0.70035
1.449	0.15666	1.1484	0.83044
2.037	0.32113	1.7226	0.92449
2.625	0.49024	2.2968	0.97478
3.213	0.66949	2.871	1
3.801	0.82968	3.4452	0.95645
4.389	0.91958	4.0194	0.89519
4.977	0.96586	4.5936	0.83958
5.565	0.99148	5.1678	0.76734
6.153	0.9938	5.742	0.75037
6.741	0.99445	6.3162	0.7199
7.329	0.99904	6.8904	0.68188
7.917	0.99511	7.4646	0.65455
8.505	1	8.0388	0.63124
9.093	0.99556	8.613	0.62395
9.681	0.98886	9.1872	0.61223
10.269	0.99309	9.7614	0.60248
10.857	0.97877	10.3356	0.60834
11.445	0.98144	10.9098	0.57992
12.033	0.97998	11.484	0.57188
12.621	0.97842	12.0582	0.56227
13.209	0.98422	12.6324	0.54176
13.797	0.99113	13.2066	0.54237
14.385	0.97161	13.7808	0.54803
14.973	0.97721	14.355	0.55028
15.561	0.9701	14.9292	0.53665
16.149	0.97575	15.5034	0.53917
16.737	0.97908	16.0776	0.54415
17.325	0.97197	16.6518	0.53113
17.913	0.98467	17.226	0.54217
18.501	0.96551	17.8002	0.54817
19.089	0.97045	18.3744	0.55594
19.677	0.95891	18.9486	0.55573
20.265	0.96244	19.5228	0.56384
20.853	0.97065	20.097	0.53719
		20.6712	0.5421

Fig 3 - data

Detuning	G_exp	Detuning	G_th	Detuning	LG_exp	Detuning	LG_th
-10.07	0.50152	-10	0.49229	-10.99	0.51397	-10	0.51535
-9.54	0.50534	-9.9	0.4916	-10.41	0.52195	-9.9	0.51465
-9.01	0.5226	-9.8	0.49088	-9.83	0.51575	-9.8	0.51393
-8.48	0.52657	-9.7	0.49013	-9.25	0.52195	-9.7	0.5132
-7.95	0.53548	-9.6	0.48936	-8.67	0.54952	-9.6	0.51244
-7.42	0.55578	-9.5	0.48856	-8.09	0.53093	-9.5	0.51167
-6.89	0.54305	-9.4	0.48774	-7.51	0.51439	-9.4	0.51089
-6.36	0.57793	-9.3	0.48688	-6.93	0.53378	-9.3	0.51008
-5.83	0.57425	-9.2	0.48599	-6.35	0.54097	-9.2	0.50924
-5.3	0.55876	-9.1	0.48507	-5.77	0.51325	-9.1	0.50839
-4.77	0.46657	-9	0.48411	-5.19	0.50392	-9	0.50751
-4.24	0.41245	-8.9	0.48312	-4.61	0.4224	-8.9	0.50661
-3.71	0.31751	-8.8	0.48208	-4.03	0.37117	-8.8	0.50568
-3.18	0.18033	-8.7	0.48101	-3.45	0.22168	-8.7	0.50473
-2.65	0.11079	-8.6	0.47988	-2.87	0.10168	-8.6	0.50374
-2.12	0.00559	-8.5	0.47872	-2.29	0.01083	-8.5	0.50272
-1.59	0	-8.4	0.4775	-1.71	0	-8.4	0.50167
-1.06	0.14814	-8.3	0.47623	-1.13	0.09484	-8.3	0.50059
-0.53	0.2578	-8.2	0.47491	-0.55	0.29122	-8.2	0.49947
0	0.53371	-8.1	0.47353	0.03	0.57517	-8.1	0.49831
0.53	0.68893	-8	0.47208	0.61	0.82592	-8	0.49712
1.06	0.82398	-7.9	0.47058	1.19	0.99964	-7.9	0.49588
1.59	0.92161	-7.8	0.469	1.77	1	-7.8	0.49459
2.12	0.97382	-7.7	0.46734	2.35	0.94984	-7.7	0.49326
2.65	1	-7.6	0.46561	2.93	0.91549	-7.6	0.49187
3.18	0.95479	-7.5	0.4638	3.51	0.80626	-7.5	0.49043
3.71	0.89119	-7.4	0.4619	4.09	0.72161	-7.4	0.48894
4.24	0.83346	-7.3	0.4599	4.67	0.6961	-7.3	0.48738
4.77	0.75847	-7.2	0.4578	5.25	0.67864	-7.2	0.48576
5.3	0.74086	-7.1	0.45559	5.83	0.64743	-7.1	0.48408
5.83	0.70923	-7	0.45328	6.41	0.60745	-7	0.48231
6.36	0.66976	-6.9	0.45083	6.99	0.5927	-6.9	0.48048
6.89	0.64139	-6.8	0.44826	7.57	0.57931	-6.8	0.47856
7.42	0.61719	-6.7	0.44556	8.15	0.57461	-6.7	0.47655
7.95	0.60962	-6.6	0.4427	8.73	0.56271	-6.6	0.47445
8.48	0.59745	-6.5	0.43968	9.31	0.54888	-6.5	0.47225
9.01	0.58734	-6.4	0.4365	9.89	0.54111	-6.4	0.46994
9.54	0.59342	-6.3	0.43314	10.47	0.53598	-6.3	0.46752
10.07	0.56392	-6.2	0.42958			-6.2	0.46499
10.6	0.55557	-6.1	0.42581			-6.1	0.46232
		-6	0.42183			-6	0.45951
		-5.9	0.41761			-5.9	0.45656
		-5.8	0.41313			-5.8	0.45345
		-5.7	0.40838			-5.7	0.45017
		-5.6	0.40334			-5.6	0.44671
		-5.5	0.39799			-5.5	0.44305
		-5.4	0.39231			-5.4	0.43919
		-5.3	0.38627			-5.3	0.43511
		-5.2	0.37985			-5.2	0.43079
		-5.1	0.37302			-5.1	0.42621
		-5	0.36576			-5	0.42136
		-4.9	0.35804			-4.9	0.41622
		-4.8	0.34983			-4.8	0.41076
		-4.7	0.34109			-4.7	0.40496
		-4.6	0.33181			-4.6	0.3988
		-4.5	0.32195			-4.5	0.39225
		-4.4	0.31148			-4.4	0.38528
		-4.3	0.30038			-4.3	0.37787
		-4.2	0.28861			-4.2	0.36999
		-4.1	0.27618			-4.1	0.3616
		-4	0.26306			-4	0.35267
		-3.9	0.24925			-3.9	0.34317
		-3.8	0.23476			-3.8	0.33307

Detuning	G_exp	Detuning	G_th	Detuning	LG_exp	Detuning	LG_th
		-3.7	0.21961			-3.7	0.32233
		-3.6	0.20383			-3.6	0.31092
		-3.5	0.1875			-3.5	0.2988
		-3.4	0.17069			-3.4	0.28597
		-3.3	0.15352			-3.3	0.27239
		-3.2	0.13613			-3.2	0.25806
		-3.1	0.11869			-3.1	0.24297
		-3	0.10141			-3	0.22713
		-2.9	0.08454			-2.9	0.21057
		-2.8	0.06834			-2.8	0.19335
		-2.7	0.05313			-2.7	0.17554
		-2.6	0.03921			-2.6	0.15725
		-2.5	0.02691			-2.5	0.13863
		-2.4	0.01656			-2.4	0.11986
		-2.3	0.00844			-2.3	0.10118
		-2.2	0.00285			-2.2	0.08289
		-2.1	0			-2.1	0.06531
		-2	8.0399E-5			-2	0.04885
		-1.9	0.00321			-1.9	0.03395
		-1.8	0.00944			-1.8	0.02109
		-1.7	0.01879			-1.7	0.01079
		-1.6	0.03119			-1.6	0.00359
		-1.5	0.04653			-1.5	0
		-1.4	0.06467			-1.4	5.237E-4
		-1.3	0.08544			-1.3	0.00561
		-1.2	0.10863			-1.2	0.01563
		-1.1	0.13403			-1.1	0.03084
		-1	0.16141			-1	0.05142
		-0.9	0.19057			-0.9	0.07738
		-0.8	0.22129			-0.8	0.10866
		-0.7	0.25335			-0.7	0.145
		-0.6	0.28655			-0.6	0.18608
		-0.5	0.32072			-0.5	0.23142
		-0.4	0.35567			-0.4	0.28047
		-0.3	0.39122			-0.3	0.33258
		-0.2	0.42724			-0.2	0.38705
		-0.1	0.46354			-0.1	0.44312
		0	0.5			0	0.5
		0.1	0.53646			0.1	0.55688
		0.2	0.57276			0.2	0.61295
		0.3	0.60878			0.3	0.66742
		0.4	0.64433			0.4	0.71953
		0.5	0.67928			0.5	0.76858
		0.6	0.71345			0.6	0.81392
		0.7	0.74665			0.7	0.855
		0.8	0.77871			0.8	0.89134
		0.9	0.80943			0.9	0.92262
		1	0.83859			1	0.94858
		1.1	0.86597			1.1	0.96916
		1.2	0.89137			1.2	0.98437
		1.3	0.91456			1.3	0.99439
		1.4	0.93533			1.4	0.99948
		1.5	0.95347			1.5	1
		1.6	0.96881			1.6	0.99641
		1.7	0.98121			1.7	0.98921
		1.8	0.99056			1.8	0.97891
		1.9	0.99679			1.9	0.96605
		2	0.99992			2	0.95115
		2.1	1			2.1	0.93469
		2.2	0.99715			2.2	0.91711
		2.3	0.99156			2.3	0.89882
		2.4	0.98344			2.4	0.88014
		2.5	0.97309			2.5	0.86137

Detuning	G_exp	Detuning	G_th	Detuning	LG_exp	Detuning	LG_th
		2.6	0.96079			2.6	0.84275
		2.7	0.94687			2.7	0.82446
		2.8	0.93166			2.8	0.80665
		2.9	0.91546			2.9	0.78943
		3	0.89859			3	0.77287
		3.1	0.88131			3.1	0.75703
		3.2	0.86387			3.2	0.74194
		3.3	0.84648			3.3	0.72761
		3.4	0.82931			3.4	0.71403
		3.5	0.8125			3.5	0.7012
		3.6	0.79617			3.6	0.68908
		3.7	0.78039			3.7	0.67767
		3.8	0.76524			3.8	0.66693
		3.9	0.75075			3.9	0.65683
		4	0.73694			4	0.64733
		4.1	0.72382			4.1	0.6384
		4.2	0.71139			4.2	0.63001
		4.3	0.69962			4.3	0.62213
		4.4	0.68852			4.4	0.61472
		4.5	0.67805			4.5	0.60775
		4.6	0.66819			4.6	0.6012
		4.7	0.65891			4.7	0.59504
		4.8	0.65017			4.8	0.58924
		4.9	0.64196			4.9	0.58378
		5	0.63424			5	0.57864
		5.1	0.62698			5.1	0.57379
		5.2	0.62015			5.2	0.56921
		5.3	0.61373			5.3	0.56489
		5.4	0.60769			5.4	0.56081
		5.5	0.60201			5.5	0.55695
		5.6	0.59666			5.6	0.55329
		5.7	0.59162			5.7	0.54983
		5.8	0.58687			5.8	0.54655
		5.9	0.58239			5.9	0.54344
		6	0.57817			6	0.54049
		6.1	0.57419			6.1	0.53768
		6.2	0.57042			6.2	0.53501
		6.3	0.56686			6.3	0.53248
		6.4	0.5635			6.4	0.53006
		6.5	0.56032			6.5	0.52775
		6.6	0.5573			6.6	0.52555
		6.7	0.55444			6.7	0.52345
		6.8	0.55174			6.8	0.52144
		6.9	0.54917			6.9	0.51952
		7	0.54672			7	0.51769
		7.1	0.54441			7.1	0.51592
		7.2	0.5422			7.2	0.51424
		7.3	0.5401			7.3	0.51262
		7.4	0.5381			7.4	0.51106
		7.5	0.5362			7.5	0.50957
		7.6	0.53439			7.6	0.50813
		7.7	0.53266			7.7	0.50674
		7.8	0.531			7.8	0.50541
		7.9	0.52942			7.9	0.50412
		8	0.52792			8	0.50288
		8.1	0.52647			8.1	0.50169
		8.2	0.52509			8.2	0.50053
		8.3	0.52377			8.3	0.49941
		8.4	0.5225			8.4	0.49833
		8.5	0.52128			8.5	0.49728
		8.6	0.52012			8.6	0.49626
		8.7	0.51899			8.7	0.49527
		8.8	0.51792			8.8	0.49432

Detuning	G_exp	Detuning	G_th	Detuning	LG_exp	Detuning	LG_th
		8.9	0.51688			8.9	0.49339
		9	0.51589			9	0.49249
		9.1	0.51493			9.1	0.49161
		9.2	0.51401			9.2	0.49076
		9.3	0.51312			9.3	0.48992
		9.4	0.51226			9.4	0.48911
		9.5	0.51144			9.5	0.48833
		9.6	0.51064			9.6	0.48756
		9.7	0.50987			9.7	0.4868
		9.8	0.50912			9.8	0.48607
		9.9	0.5084			9.9	0.48535
		10	0.50771			10	0.48465

Fig. 4 - data

	Gexp	5% of D	LGexp	5% of F	LGexp/Gex	LGth/Gth
		B*(5)/100		D*(5)/100		
7.2	5.9	0.295	4.7	0.235	0.81	0.74
6.3	5.2	0.26	4.2	0.21	0.81	0.75
5.2	4.7	0.235	4	0.2	0.85	0.77
4.6	4.3	0.215	3.5	0.175	0.81	0.71
		--		--		

Theoretical calculations - code in Python

```
import numpy as np
import matplotlib.pyplot as plt
import scipy.integrate as integrate

#Definição das variáveis e constantes do experimento

c = 3*10**8
deltac = 0
deltamw = 0
gamma21 = 6*10**6
gamma31 = 3*10**3
omegap = 6*10**6
omegac = 2*10**6
kp = 2*np.pi/(780*10**-9)
```

```
kc = 2*np.pi/(480*10**-9)
z = 7.5*10**-2
epsilon0 = 8.854*10**(-12)
hbar = 1.054*10**-34
mu12 = (3.584*10**-29)
m = 85*1.66*10**(-27)
x = np.arange(-10*10**6, 10*10**6, 1*10**5) #\Delta_{p}
kb = 1.38*10**(-23)
T = 300
p = 10**(5.006 + 4.857 - 4215/T)
N = 0.7217*p/(kb*T) #densidade atômica
u = np.sqrt(2*kb*T/m) #root mean square velocity
print(N, u)
w0p = 170*10**-6 #integral é feita na região da cintura do feixe de prova
w0c = 190*10**-6

#----------------------------------Gaussiano--------------------------------
result_array = np.empty((0))
for i in range (-10*10**6, 10*10**6, 1*10**5):
   A1 = integrate.quad(lambda v:
np.exp(-v**2/u**2)*((2*N*z*kp*(mu12**2))/(u*np.sqrt(np.pi)*epsilon0*hbar*omegap))*np.imag
((1j*omegap/2)/((gamma21/2-1j*(i+kp*v)) + ((omegac**2)/4)/(gamma31/2 - 1j*(i + deltac +
kp*v - kc*v)))), -200, 200)
   result = np.exp(-A1[0]*z)
   result_array = np.append(result_array, [result], axis=0)

#-------------------------------------LG----------------------------------
result_arrayLG = np.empty((0))
for i in range (-10*10**6, 10*10**6, 1*10**5):
   f1 = lambda v, r:
r*(np.exp(-v**2/u**2)*((2*N*z*kp*(mu12**2))/(u*np.sqrt(np.pi)*epsilon0*hbar*omegap))*np.im
ag((1j*omegap/2)/((gamma21/2-1j*(i+kp*v)) +
(((omegac*np.sqrt(2)*(r/w0c)*np.exp(-(r/w0c)))**2)/4)/(gamma31/2 - 1j*(i + deltac + kp*v -
kc*v)))))
   A_LG1 = integrate.dblquad(f1, 0, w0p, lambda v: -200, lambda v: 200)
   result2 = A_LG1[0]*(2/w0p**2)
   result_arrayLG = np.append(result_arrayLG, [result2], axis=0)




plt.plot(x, result_array, label='Gaussian', color='b')
plt.plot(x, result_arrayLG, label='LG', color='black')
plt.xlabel('$\Delta_{p}$(Hz)')
plt.ylabel('Transmissão')
plt.legend()
plt.show()
```