Entropy Production and Particle Yields in Heavy Ion Collisions at LHC

Béla Lukács

MTA KFKI RMKI, Budapest, Hungary

ECM [GeV]	S/N
17.3	51.4
19.4	52.2
130	57.5
200	58.6
7000	66.1
14000	67.8

TABLE I: Entropy densities at various energies of center of mass.

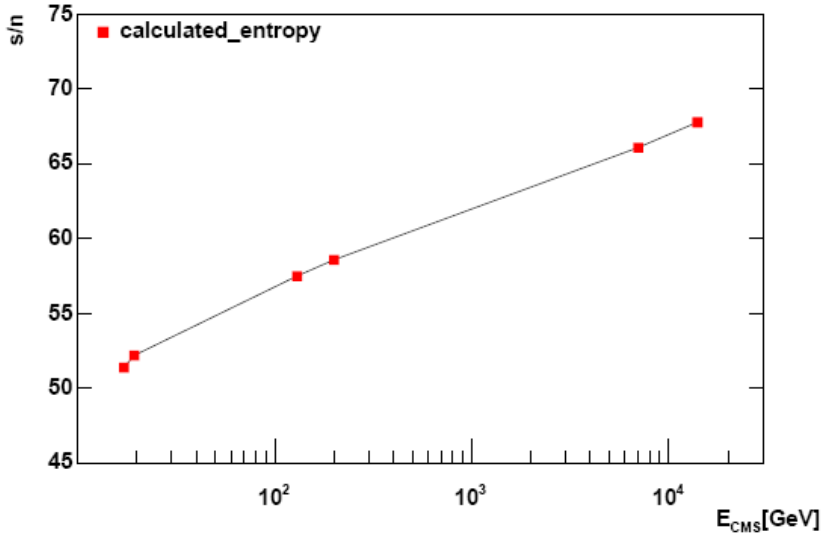

FIG. 1: Calculated specific entropies at different center of mass energies.

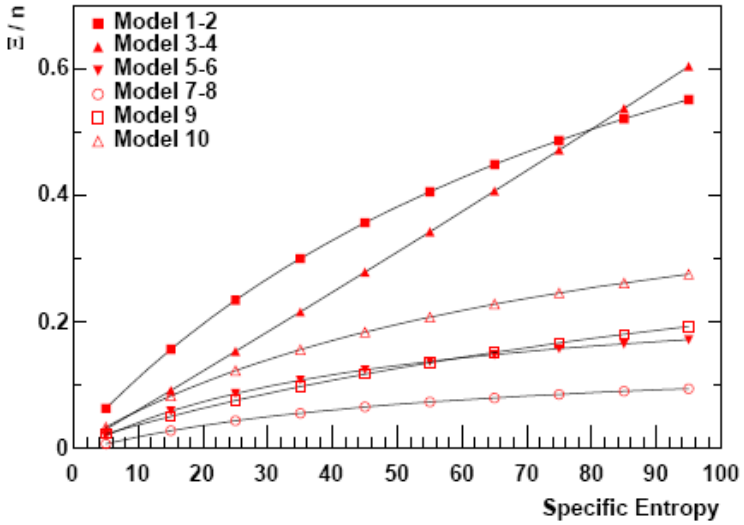

FIG. 2: Ξ/n ratios of model predictions above S/N=5.

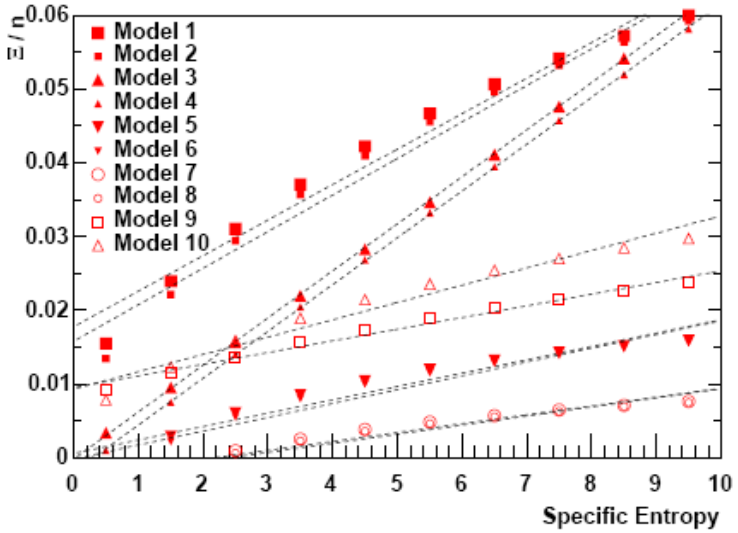

FIG. 3: Ξ/n ratios of model predictions between S/N=0 and 10.

Model	158 GeV fix	200 GeV fix	130 GeV	200 GeV
1 & 2	0.394	0.759	0.012	0.0503
3 & 4	1.326	2.819	0.009	0.0306
5 & 6	0.120	0.141	0.005	0.0330
7 & 8	0.165	0.283	0.005	0.0308
9	0.020	0.028	0.072	0.0950
10	0.084	0.176	0.054	0.1288

TABLE II: The average predictive errors of the individual models.

Particle symbolic	Model 100 (5)	**Model 110 (7)**	Model Hadr. M.(9)	110 with Max. Frag. (11)	Mass (Mev)
N	538.57	**484.23**	392.96	596.51	939
$\overline{N}$	338.57	**312.70**	158.93	379.23	939
Y	627.82	**731.65**	267.67	677.65	1174
$\overline{Y}$	428,02	**497.19**	118.35	478.38	1174
Ξ	81.64	**39.76**	61.49	27.76	1318
$\overline{\Xi}$	66.30	**32.10**	33.41	23.13	1318
Ω	20.48	**1.04**	8.32	0.35	1672
$\overline{\Omega}$	20.48	**1.04**	5.74	0.35	1672
π	3876.58	**3805.52**	1835.55	4235.64	138
K	1325.09	**1431.71**	996.78	1313.60	496
$\overline{K}$	1094.60	**1181.93**	785.35	1105.16	496
η	168.44	**129.90**	370.84	89.22	549

TABLE III: The quantities of Point 4 at 14 TeV. Y stands for (Λ, Σ). The bold column is our favoured prediction

	Conservation	Model 5	Model 7	Model 9	Model 11
Total ptcl N^o	-	8586.59	8648.77	5035.39	8926.98
Strangeness	0.00	0.83	0.00	1.79	0.09
Baryon N^o	414.00	415.14	413.65	414.01	421.18

TABLE IV: Conservation checks

Model	E_{tot}/414 GeV	M_{tot}/414 GeV	E_{transf}/414 GeV
5	7000	10.10	14.14
7	7000	10.10	14.18
9	7000	5.94	7.93
11	7000	10.08	14.32

TABLE V: Conversion of kinetic energy into anything.

Particle symbolic	Model 100 (5)	**Model 110** (7)	Model Hadr. M.(9)	110 with Max. Fragm. (11)	Model 110 S/N=75
p	269.28	**242.12**	196.48	298.26	269.30
$\overline{p}$	169.28	**156.35**	79.46	189.62	175.42
n	269.28	**242.12**	196.48	298.26	256.30
$\overline{n}$	169.28	**156.35**	79.46	189.62	175.42
Σ^+	104.64	**121.94**	44.61	112.94	133.52
$\overline{\Sigma^+}$	71.34	**82.86**	19.74	79.73	92.91
Σ^0	0	**0**	0	0	0
$\overline{\Sigma^0}$	0	**0**	0	0	0
Σ^-	104.64	**121.94**	44.61	112.94	133.52
$\overline{\Sigma^-}$	71.34	**82.86**	19.74	79.73	92.91
Λ	418.55	**488.43**	173.45	451.77	534.10
$\overline{\Lambda}$	185.35	**331.46**	78.90	318.92	371.64
Ξ^0	40.82	**19.88**	30.74	13.88	22.05
$\overline{\Xi^0}$	33.15	**16.05**	16.70	11.56	17.97

TABLE VI: The predicted hadronic observables in a central $Pb + Pb$ collision at 14 TeV/nucleon CM energy.

Ξ^-	40.82	**19.88**	30.74	13.88	22.05
$\overline{\Xi^-}$	33.15	**16.05**	16.70	11.56	17.97
Ω^-	20.48	**1.04**	8.32	0.35	1.17
$\overline{\Omega^-}$	20.48	**1.04**	5.74	0.35	1.17
π^+	1017.99	**989.05**	566.43	1084.78	1095.28
π^0	0	**0**	0	0	0
π^-	1017.99	**989.05**	566.43	1084.78	1095.28
K^-	662.54	**715.86**	498.39	656.80	789.77
K^+	547.30	**590.96**	392.68	552.58	659.76
K_L^0	604.92	**653.41**	445.53	604.69	724.77
K_S^0	604.92	**653.41**	445.53	604.69	724.77
η	0	**0**	0	0	0

TABLE VI: The predicted hadronic observables in a central $Pb + Pb$ collision at 14 TeV/nucleon CM energy.

	1987	5	7	9	11	7+
Note	14.5 GeV fix		Favourite	Hadronic	Enh. fragm.	S/N=75
K^+/π^+	0.24	0.538	0.598	0.693	0.509	0.602
K^-/π^-	$\approx$0	0.651	0.724	0.880	0.605	0.721

TABLE VII: K/π ratios.

Energy/nucl.	Ratios	Experiment	Reference	Value
158 GeV SPS	Ξ^0/Λ	WA97	[26]	0.14 ± 0.02
	$\overline{\Xi^0}/\overline{\Lambda}$	WA97	[26]	0.26 ± 0.05
	Ω/Ξ^0	WA97	[26]	0.19 ± 0.04
	$\overline{\Omega}/\overline{\Xi^0}$	WA97	[26]	0.30 ± 0.09
	$\overline{\Lambda}/\Lambda$	WA97, NA49	[26]	0.145 ± 0.024
	$\overline{\Xi^-}/\Xi^-$	WA97	[26]	0.27 ± 0.05
	$\overline{\Omega}/\Omega$	WA97	[26]	0.42 ± 0.12
	$(\Xi^- + \overline{\Xi^-})/(\Lambda + \overline{\Lambda})$	NA49	[26]	0.13 ± 0.03
	$\overline{\Lambda}/\overline{p}$	NA49	[34]	1.05 ± 0.16
	K^-/K^+	NA49	[27]	0.59 ± 0.05
200 GeV SPS	$\overline{\Lambda}/\overline{p}$	NA35	[25]	0.80 ± 0.25
	Ξ^-/Λ	WA85	[15]	0.19 ± 0.01
	$\overline{\Xi^-}/\overline{\Lambda}$	WA85	[15],[25]	0.21 ± 0.02
	$(\Omega + \overline{\Omega})/(\Xi^- + \overline{\Xi^-})$	NA35	[25]	0.80 ± 0.4
	$\overline{\Lambda}/\Lambda$	NA35	[32]	0.18 ± 0.06

TABLE VIII: Particle ratios from different reactions of collision energy.

130 GeV RHIC	$\overline{p}/p$	STAR	[27], [28]	0.64 ± 0.05
	$\overline{\Omega}/\Omega$	STAR	[29]	1.00 ± 0.2
	$\overline{\Lambda}/\Lambda$	STAR	[27], [28]	0.77 ± 0.05
	$\overline{\Xi^-}/\Xi^-$	STAR	[27], [28]	0.81 ± 0.05
	$\pi^-/\pi+$	PHOBOS	[28]	0.95 ± 0.06
	K^-/K^+	STAR	[28]	0.90 ± 0.05
200 GeV RHIC	$\overline{p}/p$	PHOBOS, PHENIX STAR, BRAHMS	[29], [30]	0.84 ± 0.04
	K^-/K^+	PHOBOS, PHENIX BRAHMS	[29], [30]	0.98 ± 0.04
	π^-/π^+	PHOBOS	[30]	1.02 ± 0.02
	K^-/π^-	STAR, BRAHMS	[29]	0.15 ± 0.02
	$\overline{p}/\pi^-$	BRAHMS	[29]	0.08 ± 0.01

TABLE VIII: Particle ratios from different reactions of collision energy.