VARIATION OF TOTAL CROSS SECTIONS AND COULOMB-NUCLEAR EFFECTS

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FOR CALCULATIONAL METHOD DETAILS
SEE: A.J.B., C. CHASMAN, S.N. WHITE,
NUCL. INST. + METH. IN PHYS. RES. A 417, 1 (199

SEE ALSO: A.J.B., M.J. RHOADES-BROWN, &
J. WENESER, PHYS. REV. E 54, 4233 (1996

VARIANT OF OPTICAL GLAUBER FOR PROBABILI
OF AT LEAST ONE MUTUAL NUCLEAR
DISSOCIATION

$$P_N(b) = \left(1 - e^{-P_1(b)}\right)$$

$$P_1(b) = \int dx\,dy\,dz_p\,\rho_p(x-b, y, z_p)\left(1 - e^{-\sigma_{NN}\int dz_T \rho_T(x,y,z)}\right)$$

$$\sigma_N = 2\pi \int P_N(b)\, b\, db$$

$a = .535$ Au + Au $\sigma_{NN} = 41$ mb

R	$\sigma_{TOT}^{OPTICAL}$ (KHARZEEV, BAKER)	σ_N (A.J.B.)
6.38	7.03	6.81
6.15	6.71	6.49
6.10	6.64	6.43
6.00	6.50	6.29

3% LESS

MUTUAL COULOMB DISSOCIATION

Calculate heavy ion Coulomb dissociation in terms of the (generally experimentally known) photonuclear absorption cross section $\underline{\sigma_{ph}(\omega)}$ Fig 1 (Weizsacker-Williams formula):

$$\sigma_{dis} = \frac{2\alpha Z_p^2}{\pi\gamma^2} \int d\omega\omega\underline{\sigma_{ph}(\omega)} \int_{b_0}^{\infty} b\, db K_1^2(\frac{b\omega}{\gamma})$$

or

$$\sigma_{dis} = 2\pi \int_{b_0}^{\infty} P(b) b\, db$$

with

$$P(b) = \frac{\alpha Z_p^2}{\pi^2\gamma^2} \int d\omega\omega\sigma_{ph}(\omega) K_1^2(\frac{b\omega}{\gamma}).$$

The first order forward-backward mutual Coulomb dissociation cross section is then given by

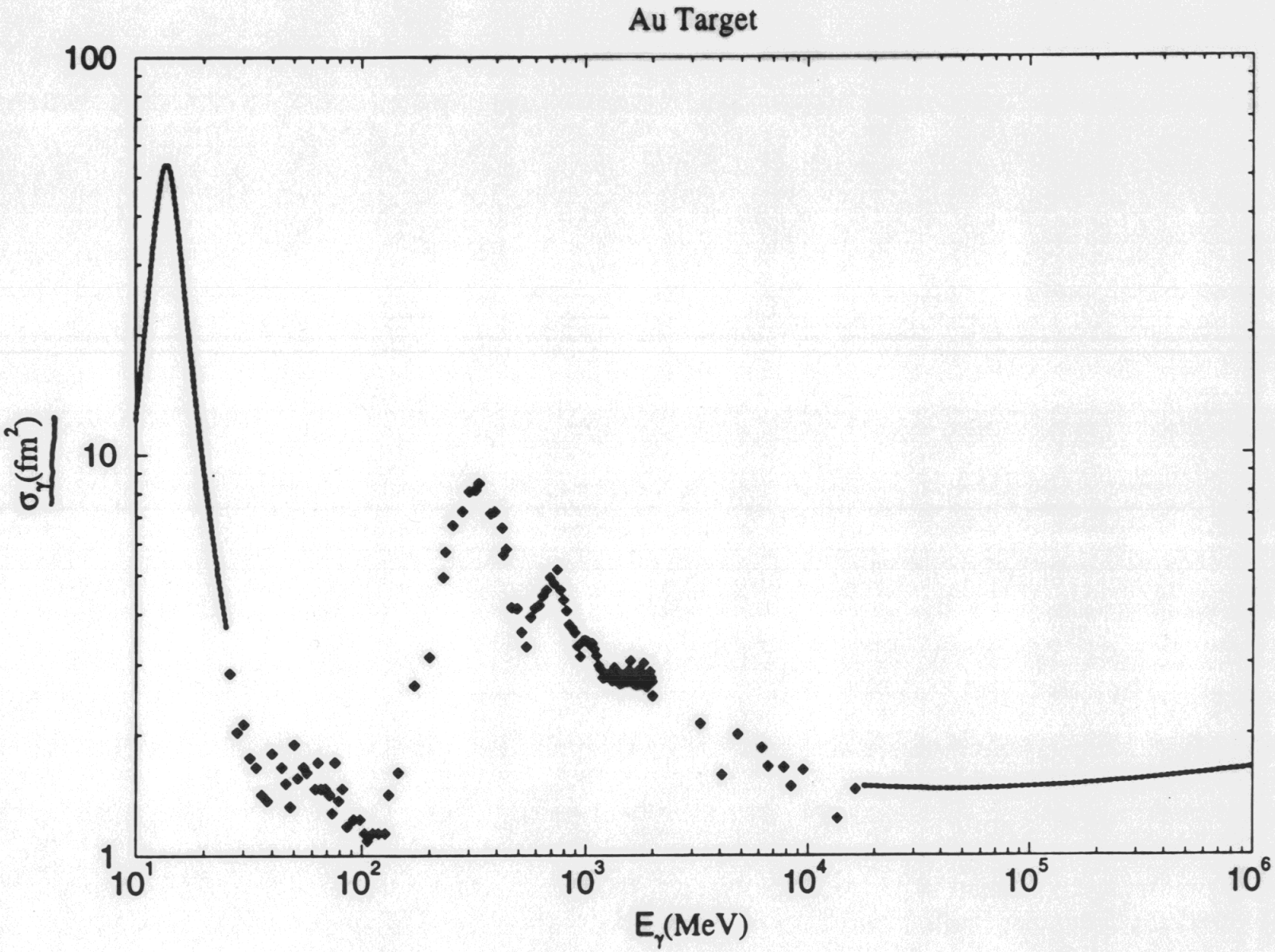
$$\sigma_{cd}^1 = 2\pi \int_{b_0}^{\infty} [P(b)]^2 b\, db$$

and the corresponding unitarity corrected cross section is

$$\sigma_{cd} = 2\pi \int_{b_0}^{\infty} [1 - e^{-P(b)}]^2 b\, db.$$

See Tables I and II.

Photonuclear Absorption Cross Section



INPUT TO WEIZSACKER-WILLIAMS FORMULA

Fig 1

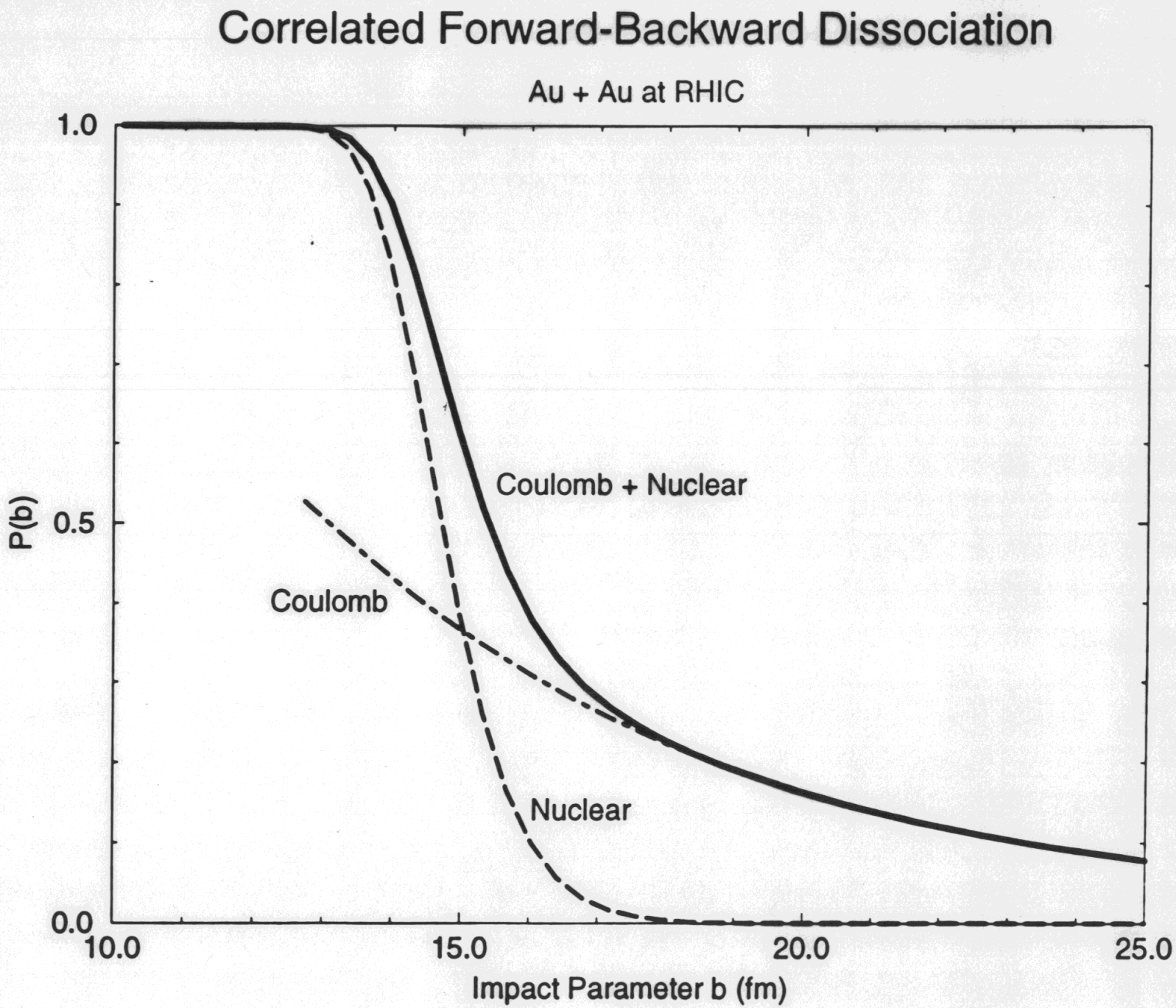

Correlated Forward-Backward Dissociation
Au + Au at RHIC
1.0
0.5
0.0
P(b)
10.0
15.0
20.0
25.0
Impact Parameter b (fm)
Coulomb + Nuclear
Coulomb
Nuclear

Fig. 2

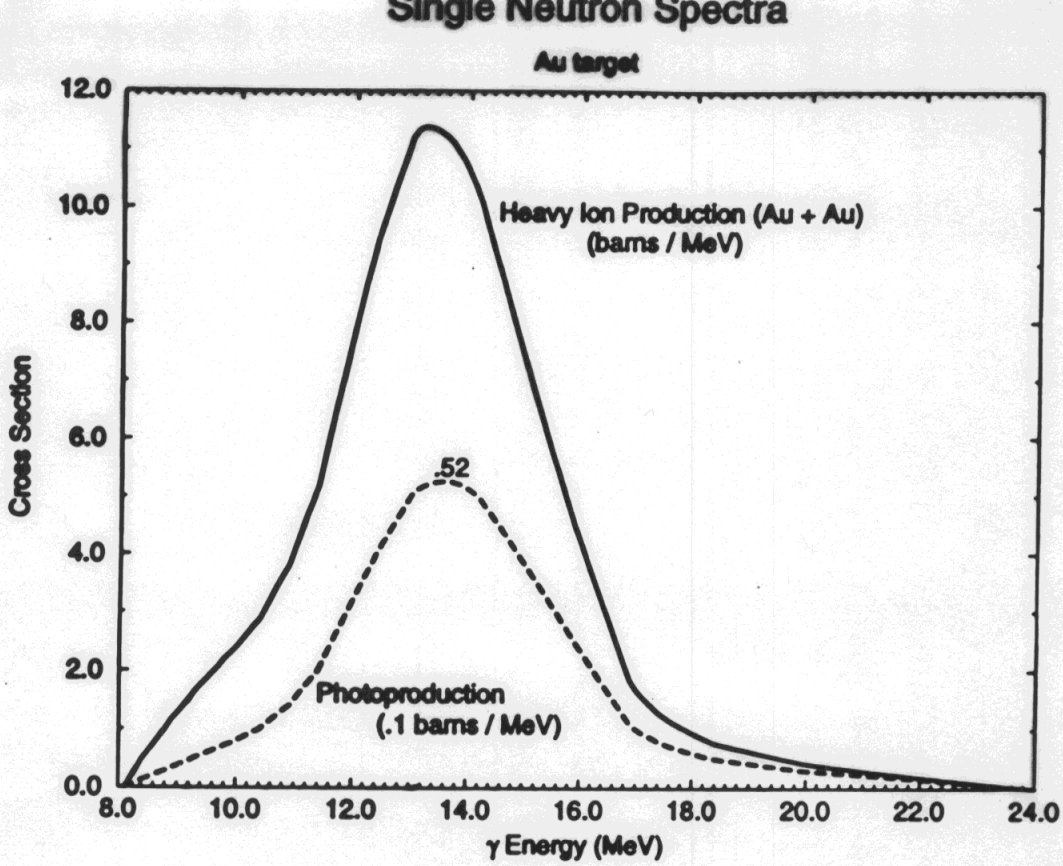

Single Neutron Spectra
Au target
Heavy Ion Production (Au + Au)
(barns / MeV)
.52
Photoproduction
(.1 barns / MeV)
Cross Section
γ Energy (MeV)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
22.0
24.0

Fig. 3

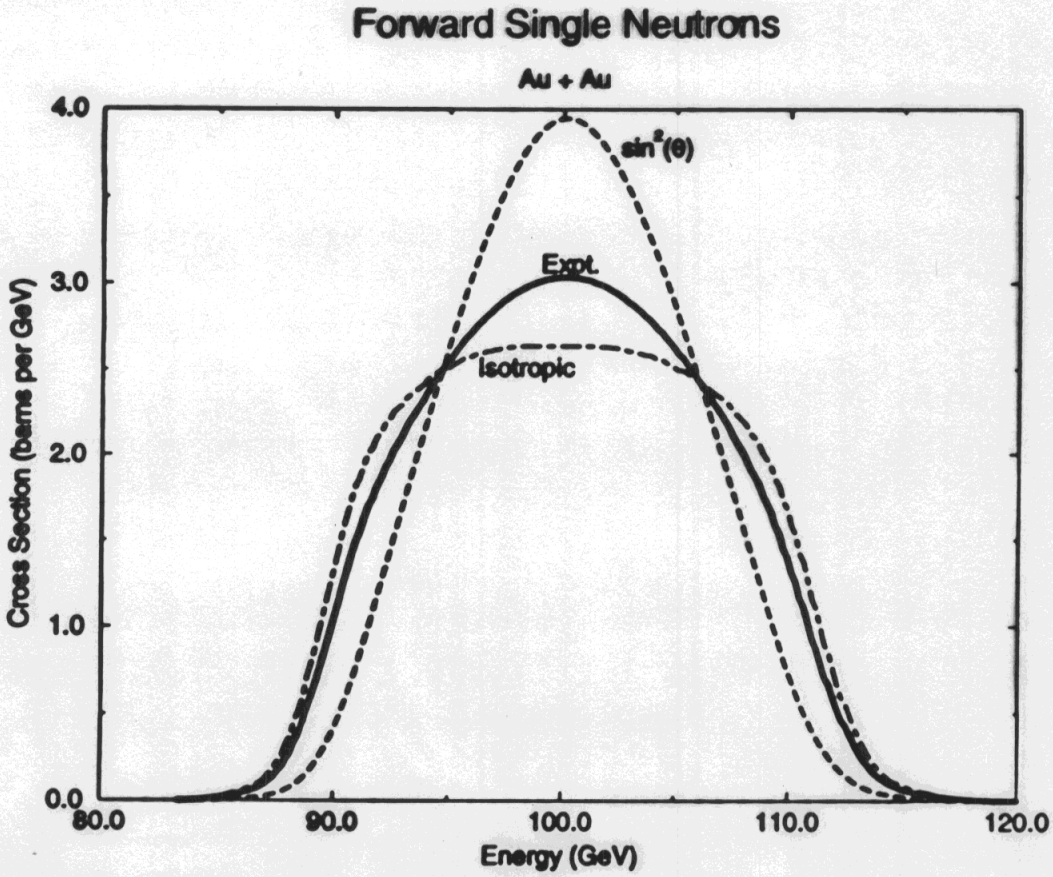

Forward Single Neutrons
Au + Au
sin²(θ)
Expt.
Isotropic
Cross Section (barns per GeV)
Energy (GeV)
4.0
3.0
2.0
1.0
0.0
80.0
90.0
100.0
110.0
120.0

Fig. 4

TABLE IV. Dependence of various cross sections (in barns) on the nuclear density radius R.

	Au + Au at RHIC		Pb + Pb at LHC	
R	6.38	6.50	6.624	6.75
$\sigma_{1n,1n}$	.449	.445	.537	.533
$\sigma_{1n,xn}$	1.364	1.349	1.897	1.881
$\sigma_{xn,xn}$	10.90	11.01	14.75	14.85
σ_{1n}	49.20	49.18	105.93	105.91
σ_{xn}	102.35	102.42	227.28	227.34

Au + Au a = .535

R	σ_{NN}	E	σ_N^{TOT}	$\sigma(1n,1n)$	$\sigma(1n,Xn)$	$\sigma(Xn,Xn)$	$\sigma(1n)$	$\sigma(Xn)$
6.5	41	70X70	6.98	.45	1.34	10.79	45.46	93.23
		100X100		.45	1.36	10.94	49.19	102.37
				−.69			−.43	
6.38	41	70X70	6.81	(−10%) .46	1.36	10.68	45.48	93.19
		100X100		.45	1.37	10.84	49.29	102.31
							(−4%)	
6.0	41	70X70	6.29	.47	1.40	10.36	45.56	92.99
		100X100	(+1.6%)	.46	1.36	10.53	49.29	102.12
						+0.7%		
6.5	50	70X70	7.09	.45	1.34	10.86	45.44	93.30
		100X100		.45	1.35	11.01	49.18	102.42
6.38	50	70X70	6.92	.46	1.35	10.75	45.47	93.23
		100X100		.45	1.36	10.90	49.20	102.35
6.0	50	70X70	6.39	.47	1.40	10.43	45.55	93.03
		100X100		.46	1.41	10.59	49.28	102.15