

Relativistic description of dense matter equation of state and compatibility with neutron star observables: a Bayesian approach

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1. SUPPLEMENTAL MATERIAL

The general behavior of the nuclear equation of state (EOS), relevant for the description of neutron stars (NS), is studied within a Bayesian approach applied to a set of models based on a density dependent relativistic mean field description of nuclear matter Malik et al. (2022). The EOS is subjected to a minimal number of constraints based on nuclear saturation properties and the low density pure neutron matter EOS obtained from a precise next-to-next-to-next-to-leading order (N³LO) calculation in chiral effective field theory (χ EFT). The number of final sample parameters corresponding to the posterior sets are around fourteen thousand. We present five EOSs among them, namely DDBI, DDBm, DDBu1, DDBu2 and DDBx. The DDBI, DDBm, DDBu2 were chosen so that the radius of the $1.4M_{\odot}$ star has the lower limit, a medium value and the upper limit of the the 90% CI for the conditional probabilities $P(R|M)$. We have also included DDBu1 that has a slightly lower $R_{1.4}$ than the upper limit but lies completely inside the 90% CI for the conditional probabilities $P(R|M)$. DDBx is an extreme EOS that predicts a maximum mass of $2.5M_{\odot}$.

Table 1. The values of DDB{i} model parameters, namely $\Gamma_{\sigma,0}$, $\Gamma_{\omega,0}$, $\Gamma_{\varrho,0}$, a_{σ} , a_{ω} and a_{ϱ} . The nucleon, ω meson, σ meson and ϱ meson masses are 939, 783, 550 and 763 MeV, respectively.

Models	$\Gamma_{\sigma,0}$	$\Gamma_{\omega,0}$	$\Gamma_{\varrho,0}$	a_{σ}	a_{ω}	a_{ϱ}
DDBI	8.240253	9.500675	3.859083	0.08806	0.026829	0.534111
DDBm	9.180364	10.981329	3.826364	0.086372	0.054065	0.509147
DDBu1	9.690022	11.755566	4.140326	0.071467	0.04641	0.665711
DDBu2	9.661435	11.716068	3.972945	0.053373	0.026635	0.64007
DDBx	9.84668	11.989014	3.643052	0.052375	0.026387	0.660845

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Table 2. The nuclear matter properties along with a few neutron star properties for models DDBI, DDBm, DDBu1, DDBu2 and DDBx.

Quantity	Units	DDBI	DDBm	DDBu1	DDBu2	DDBx
ρ_0	fm^{-3}	0.147	0.150	0.147	0.152	0.147
ε_0		-15.91	-16.34	-16.18	-16.46	-16.22
K_0		191	233	269	302	300
Q_0		-284	-106	105	278	298
Z_0		2081	1597	1211	1111	1156
$J_{\text{sym},0}$	MeV	29.23	30.74	33.31	33.05	29.73
$L_{\text{sym},0}$		35.46	44.82	32.51	38.58	38.76
$K_{\text{sym},0}$		-125	-112	-102	-91	-62
$Q_{\text{sym},0}$		907	801	1292	1149	966
$Z_{\text{sym},0}$		-4909	-4814	-10122	-9428	-8564
M_{max}	M_{\odot}	2.023	2.172	2.353	2.441	2.499
$M_{\text{B,max}}$	M_{\odot}	2.401	2.587	2.826	2.952	3.030
c_s^2	c^2	0.64	0.62	0.66	0.70	0.71
ρ_c	fm^{-3}	1.117	0.985	0.866	0.824	0.790
ε_c	MeV fm^{-3}	1422	1252	1103	1053	1009
R_{max}		10.55	11.20	11.82	12.02	12.23
$R_{1.4}$	km	12.07	12.72	13.13	13.21	13.25
$R_{1.6}$		11.93	12.65	13.15	13.27	13.36
$R_{2.0}$		11.05	12.20	13.00	13.21	13.40
$\Lambda_{1.4}$		345	490	609	657	749
$\Lambda_{1.6}$		133	201	268	294	339
$\Lambda_{1.8}$	-	52	87	127	143	167
$\tilde{\Lambda}_{q=1.0}$		406	571	702	756	860

2. EOS TABLE

ρ	DDBI		DDBm		DDBu1		DDBu2		DDBx	
	ε	P	ε	P	ε	P	ε	P	ε	P
fm^{-3}	$\text{MeV} \cdot \text{fm}^{-3}$									
4.000E-02	3.775E+01	1.455E-01	3.776E+01	1.411E-01	3.792E+01	1.877E-01	3.789E+01	1.711E-01	3.783E+01	1.319E-01
4.598E-02	4.342E+01	1.823E-01	4.343E+01	1.773E-01	4.362E+01	2.152E-01	4.359E+01	1.974E-01	4.351E+01	1.514E-01
5.197E-02	4.910E+01	2.216E-01	4.911E+01	2.165E-01	4.932E+01	2.401E-01	4.928E+01	2.217E-01	4.919E+01	1.696E-01
5.795E-02	5.478E+01	2.635E-01	5.479E+01	2.591E-01	5.503E+01	2.629E-01	5.499E+01	2.447E-01	5.488E+01	1.877E-01
6.394E-02	6.047E+01	3.084E-01	6.048E+01	3.057E-01	6.074E+01	2.847E-01	6.069E+01	2.674E-01	6.057E+01	2.069E-01
6.992E-02	6.616E+01	3.567E-01	6.617E+01	3.571E-01	6.646E+01	3.069E-01	6.640E+01	2.912E-01	6.626E+01	2.288E-01
7.590E-02	7.185E+01	4.091E-01	7.186E+01	4.141E-01	7.217E+01	3.312E-01	7.210E+01	3.176E-01	7.195E+01	2.554E-01
8.189E-02	7.755E+01	4.663E-01	7.756E+01	4.778E-01	7.789E+01	3.592E-01	7.782E+01	3.484E-01	7.764E+01	2.888E-01
8.787E-02	8.326E+01	5.293E-01	8.327E+01	5.493E-01	8.361E+01	3.930E-01	8.353E+01	3.858E-01	8.334E+01	3.312E-01
9.386E-02	8.896E+01	5.989E-01	8.898E+01	6.300E-01	8.933E+01	4.349E-01	8.924E+01	4.318E-01	8.904E+01	3.852E-01
9.984E-02	9.468E+01	6.762E-01	9.469E+01	7.211E-01	9.505E+01	4.862E-01	9.496E+01	4.890E-01	9.474E+01	4.535E-01
1.058E-01	1.004E+02	7.624E-01	1.004E+02	8.242E-01	1.008E+02	5.480E-01	1.007E+02	5.592E-01	1.004E+02	5.389E-01
1.118E-01	1.061E+02	8.584E-01	1.061E+02	9.408E-01	1.065E+02	6.244E-01	1.064E+02	6.429E-01	1.062E+02	6.443E-01
1.178E-01	1.118E+02	9.657E-01	1.119E+02	1.072E+00	1.122E+02	7.186E-01	1.121E+02	7.445E-01	1.119E+02	7.728E-01

1.238E-01 1.176E+02 1.085E+00 1.176E+02 1.219E+00 1.180E+02 8.333E-01 1.179E+02 8.673E-01 1.176E+02 9.270E-01
 1.298E-01 1.233E+02 1.218E+00 1.234E+02 1.382E+00 1.237E+02 9.716E-01 1.236E+02 1.014E+00 1.233E+02 1.108E+00
 1.357E-01 1.291E+02 1.363E+00 1.291E+02 1.563E+00 1.295E+02 1.136E+00 1.294E+02 1.189E+00 1.291E+02 1.321E+00
 1.417E-01 1.348E+02 1.524E+00 1.349E+02 1.766E+00 1.353E+02 1.330E+00 1.351E+02 1.394E+00 1.348E+02 1.569E+00
 1.477E-01 1.406E+02 1.702E+00 1.407E+02 1.991E+00 1.410E+02 1.556E+00 1.409E+02 1.633E+00 1.406E+02 1.856E+00
 1.537E-01 1.463E+02 1.899E+00 1.465E+02 2.241E+00 1.468E+02 1.817E+00 1.467E+02 1.908E+00 1.464E+02 2.184E+00
 1.597E-01 1.521E+02 2.116E+00 1.522E+02 2.517E+00 1.526E+02 2.116E+00 1.525E+02 2.223E+00 1.522E+02 2.557E+00
 1.657E-01 1.579E+02 2.354E+00 1.581E+02 2.822E+00 1.584E+02 2.455E+00 1.583E+02 2.581E+00 1.580E+02 2.979E+00
 1.716E-01 1.637E+02 2.615E+00 1.639E+02 3.157E+00 1.642E+02 2.837E+00 1.641E+02 2.985E+00 1.638E+02 3.452E+00
 1.776E-01 1.695E+02 2.900E+00 1.697E+02 3.524E+00 1.701E+02 3.265E+00 1.699E+02 3.438E+00 1.696E+02 3.980E+00
 1.836E-01 1.753E+02 3.211E+00 1.755E+02 3.924E+00 1.759E+02 3.742E+00 1.758E+02 3.942E+00 1.755E+02 4.565E+00
 1.896E-01 1.811E+02 3.548E+00 1.814E+02 4.360E+00 1.818E+02 4.269E+00 1.817E+02 4.501E+00 1.814E+02 5.211E+00
 1.956E-01 1.870E+02 3.914E+00 1.873E+02 4.833E+00 1.876E+02 4.849E+00 1.875E+02 5.116E+00 1.873E+02 5.919E+00
 2.016E-01 1.928E+02 4.308E+00 1.931E+02 5.344E+00 1.935E+02 5.485E+00 1.934E+02 5.792E+00 1.932E+02 6.694E+00
 2.076E-01 1.987E+02 4.734E+00 1.990E+02 5.895E+00 1.995E+02 6.179E+00 1.994E+02 6.530E+00 1.991E+02 7.537E+00
 2.135E-01 2.045E+02 5.190E+00 2.050E+02 6.488E+00 2.054E+02 6.931E+00 2.053E+02 7.333E+00 2.051E+02 8.450E+00
 2.195E-01 2.104E+02 5.680E+00 2.109E+02 7.124E+00 2.114E+02 7.746E+00 2.113E+02 8.203E+00 2.111E+02 9.436E+00
 2.255E-01 2.163E+02 6.203E+00 2.169E+02 7.804E+00 2.173E+02 8.623E+00 2.173E+02 9.142E+00 2.171E+02 1.050E+01
 2.315E-01 2.222E+02 6.761E+00 2.228E+02 8.530E+00 2.234E+02 9.566E+00 2.233E+02 1.015E+01 2.232E+02 1.163E+01
 2.375E-01 2.282E+02 7.356E+00 2.288E+02 9.303E+00 2.294E+02 1.057E+01 2.293E+02 1.124E+01 2.293E+02 1.285E+01
 2.435E-01 2.341E+02 7.987E+00 2.348E+02 1.012E+01 2.354E+02 1.165E+01 2.354E+02 1.239E+01 2.354E+02 1.415E+01
 2.494E-01 2.401E+02 8.656E+00 2.409E+02 1.099E+01 2.415E+02 1.280E+01 2.415E+02 1.363E+01 2.416E+02 1.552E+01
 2.554E-01 2.460E+02 9.364E+00 2.469E+02 1.191E+01 2.476E+02 1.401E+01 2.477E+02 1.494E+01 2.477E+02 1.698E+01
 2.614E-01 2.520E+02 1.011E+01 2.530E+02 1.289E+01 2.538E+02 1.530E+01 2.538E+02 1.633E+01 2.540E+02 1.853E+01
 2.674E-01 2.581E+02 1.090E+01 2.591E+02 1.391E+01 2.600E+02 1.665E+01 2.600E+02 1.780E+01 2.602E+02 2.015E+01
 2.734E-01 2.641E+02 1.173E+01 2.652E+02 1.499E+01 2.662E+02 1.808E+01 2.663E+02 1.935E+01 2.665E+02 2.187E+01
 2.794E-01 2.701E+02 1.260E+01 2.713E+02 1.612E+01 2.724E+02 1.958E+01 2.725E+02 2.098E+01 2.728E+02 2.367E+01
 2.853E-01 2.762E+02 1.352E+01 2.775E+02 1.730E+01 2.787E+02 2.116E+01 2.788E+02 2.270E+01 2.792E+02 2.555E+01
 2.913E-01 2.823E+02 1.448E+01 2.837E+02 1.854E+01 2.850E+02 2.281E+01 2.852E+02 2.450E+01 2.856E+02 2.753E+01
 2.973E-01 2.884E+02 1.548E+01 2.899E+02 1.984E+01 2.913E+02 2.453E+01 2.916E+02 2.638E+01 2.921E+02 2.959E+01
 3.033E-01 2.945E+02 1.652E+01 2.962E+02 2.119E+01 2.977E+02 2.633E+01 2.980E+02 2.835E+01 2.986E+02 3.173E+01
 3.093E-01 3.007E+02 1.762E+01 3.025E+02 2.260E+01 3.041E+02 2.820E+01 3.044E+02 3.039E+01 3.051E+02 3.397E+01
 3.153E-01 3.068E+02 1.876E+01 3.088E+02 2.407E+01 3.106E+02 3.015E+01 3.109E+02 3.253E+01 3.117E+02 3.629E+01
 3.212E-01 3.130E+02 1.994E+01 3.151E+02 2.559E+01 3.171E+02 3.217E+01 3.175E+02 3.475E+01 3.183E+02 3.870E+01
 3.272E-01 3.192E+02 2.117E+01 3.215E+02 2.717E+01 3.236E+02 3.426E+01 3.241E+02 3.705E+01 3.250E+02 4.119E+01
 3.332E-01 3.255E+02 2.245E+01 3.278E+02 2.881E+01 3.301E+02 3.643E+01 3.307E+02 3.943E+01 3.317E+02 4.378E+01
 3.392E-01 3.317E+02 2.377E+01 3.343E+02 3.051E+01 3.367E+02 3.867E+01 3.374E+02 4.190E+01 3.385E+02 4.645E+01
 3.452E-01 3.380E+02 2.515E+01 3.407E+02 3.226E+01 3.434E+02 4.098E+01 3.441E+02 4.446E+01 3.453E+02 4.920E+01
 3.512E-01 3.443E+02 2.657E+01 3.472E+02 3.408E+01 3.501E+02 4.337E+01 3.508E+02 4.709E+01 3.522E+02 5.204E+01
 3.571E-01 3.506E+02 2.804E+01 3.537E+02 3.595E+01 3.568E+02 4.583E+01 3.576E+02 4.981E+01 3.591E+02 5.497E+01
 3.631E-01 3.570E+02 2.956E+01 3.603E+02 3.788E+01 3.636E+02 4.836E+01 3.645E+02 5.261E+01 3.660E+02 5.797E+01

3.691E-01 3.634E+02 3.113E+01 3.668E+02 3.987E+01 3.704E+02 5.096E+01 3.714E+02 5.549E+01 3.730E+02 6.107E+01
 3.751E-01 3.698E+02 3.274E+01 3.734E+02 4.192E+01 3.772E+02 5.364E+01 3.783E+02 5.846E+01 3.801E+02 6.424E+01
 3.811E-01 3.762E+02 3.441E+01 3.801E+02 4.402E+01 3.841E+02 5.638E+01 3.853E+02 6.150E+01 3.872E+02 6.750E+01
 3.871E-01 3.827E+02 3.612E+01 3.868E+02 4.619E+01 3.911E+02 5.920E+01 3.924E+02 6.463E+01 3.944E+02 7.084E+01
 3.931E-01 3.892E+02 3.789E+01 3.935E+02 4.841E+01 3.980E+02 6.208E+01 3.995E+02 6.783E+01 4.016E+02 7.427E+01
 3.990E-01 3.957E+02 3.970E+01 4.002E+02 5.069E+01 4.051E+02 6.503E+01 4.066E+02 7.112E+01 4.089E+02 7.777E+01
 4.050E-01 4.022E+02 4.156E+01 4.070E+02 5.303E+01 4.121E+02 6.805E+01 4.138E+02 7.448E+01 4.162E+02 8.135E+01
 4.110E-01 4.088E+02 4.348E+01 4.138E+02 5.542E+01 4.193E+02 7.114E+01 4.210E+02 7.792E+01 4.236E+02 8.502E+01
 4.170E-01 4.154E+02 4.544E+01 4.207E+02 5.787E+01 4.264E+02 7.430E+01 4.283E+02 8.144E+01 4.310E+02 8.876E+01
 4.230E-01 4.220E+02 4.745E+01 4.275E+02 6.038E+01 4.336E+02 7.752E+01 4.356E+02 8.503E+01 4.385E+02 9.258E+01
 4.290E-01 4.287E+02 4.951E+01 4.345E+02 6.295E+01 4.409E+02 8.081E+01 4.430E+02 8.870E+01 4.460E+02 9.648E+01
 4.349E-01 4.354E+02 5.162E+01 4.414E+02 6.557E+01 4.482E+02 8.416E+01 4.505E+02 9.245E+01 4.536E+02 1.005E+02
 4.409E-01 4.421E+02 5.378E+01 4.484E+02 6.825E+01 4.555E+02 8.758E+01 4.580E+02 9.627E+01 4.613E+02 1.045E+02
 4.469E-01 4.488E+02 5.599E+01 4.554E+02 7.098E+01 4.629E+02 9.106E+01 4.655E+02 1.002E+02 4.690E+02 1.086E+02
 4.529E-01 4.556E+02 5.825E+01 4.625E+02 7.377E+01 4.704E+02 9.461E+01 4.731E+02 1.041E+02 4.768E+02 1.128E+02
 4.589E-01 4.624E+02 6.056E+01 4.696E+02 7.661E+01 4.779E+02 9.822E+01 4.808E+02 1.082E+02 4.846E+02 1.171E+02
 4.649E-01 4.693E+02 6.292E+01 4.768E+02 7.951E+01 4.854E+02 1.019E+02 4.885E+02 1.123E+02 4.924E+02 1.215E+02
 4.708E-01 4.761E+02 6.532E+01 4.839E+02 8.246E+01 4.930E+02 1.056E+02 4.962E+02 1.165E+02 5.004E+02 1.259E+02
 4.768E-01 4.830E+02 6.778E+01 4.912E+02 8.547E+01 5.006E+02 1.094E+02 5.041E+02 1.207E+02 5.084E+02 1.304E+02
 4.828E-01 4.899E+02 7.028E+01 4.984E+02 8.852E+01 5.083E+02 1.133E+02 5.119E+02 1.251E+02 5.164E+02 1.349E+02
 4.888E-01 4.969E+02 7.284E+01 5.057E+02 9.164E+01 5.160E+02 1.172E+02 5.199E+02 1.295E+02 5.245E+02 1.396E+02
 4.948E-01 5.039E+02 7.544E+01 5.130E+02 9.480E+01 5.238E+02 1.212E+02 5.278E+02 1.339E+02 5.327E+02 1.443E+02
 5.008E-01 5.109E+02 7.809E+01 5.204E+02 9.802E+01 5.316E+02 1.252E+02 5.359E+02 1.385E+02 5.409E+02 1.491E+02
 5.067E-01 5.180E+02 8.078E+01 5.278E+02 1.013E+02 5.395E+02 1.293E+02 5.439E+02 1.431E+02 5.492E+02 1.539E+02
 5.127E-01 5.251E+02 8.353E+01 5.353E+02 1.046E+02 5.474E+02 1.335E+02 5.521E+02 1.477E+02 5.575E+02 1.588E+02
 5.187E-01 5.322E+02 8.632E+01 5.427E+02 1.080E+02 5.554E+02 1.377E+02 5.603E+02 1.525E+02 5.659E+02 1.638E+02
 5.247E-01 5.393E+02 8.916E+01 5.503E+02 1.114E+02 5.634E+02 1.420E+02 5.685E+02 1.573E+02 5.743E+02 1.689E+02
 5.307E-01 5.465E+02 9.205E+01 5.578E+02 1.149E+02 5.715E+02 1.463E+02 5.768E+02 1.622E+02 5.828E+02 1.740E+02
 5.367E-01 5.537E+02 9.499E+01 5.654E+02 1.184E+02 5.796E+02 1.507E+02 5.852E+02 1.671E+02 5.914E+02 1.792E+02
 5.427E-01 5.610E+02 9.797E+01 5.731E+02 1.220E+02 5.877E+02 1.551E+02 5.936E+02 1.721E+02 6.000E+02 1.845E+02
 5.486E-01 5.683E+02 1.010E+02 5.808E+02 1.256E+02 5.960E+02 1.596E+02 6.021E+02 1.772E+02 6.087E+02 1.898E+02
 5.546E-01 5.756E+02 1.041E+02 5.885E+02 1.293E+02 6.042E+02 1.642E+02 6.106E+02 1.823E+02 6.174E+02 1.952E+02
 5.606E-01 5.829E+02 1.072E+02 5.963E+02 1.330E+02 6.125E+02 1.688E+02 6.192E+02 1.875E+02 6.262E+02 2.007E+02
 5.666E-01 5.903E+02 1.104E+02 6.041E+02 1.368E+02 6.209E+02 1.734E+02 6.278E+02 1.928E+02 6.351E+02 2.062E+02
 5.726E-01 5.977E+02 1.136E+02 6.119E+02 1.406E+02 6.293E+02 1.782E+02 6.365E+02 1.981E+02 6.440E+02 2.118E+02
 5.786E-01 6.052E+02 1.169E+02 6.198E+02 1.445E+02 6.378E+02 1.829E+02 6.453E+02 2.035E+02 6.530E+02 2.174E+02
 5.845E-01 6.127E+02 1.202E+02 6.277E+02 1.484E+02 6.463E+02 1.878E+02 6.541E+02 2.090E+02 6.620E+02 2.232E+02
 5.905E-01 6.202E+02 1.235E+02 6.357E+02 1.524E+02 6.549E+02 1.927E+02 6.629E+02 2.145E+02 6.711E+02 2.289E+02
 5.965E-01 6.277E+02 1.269E+02 6.437E+02 1.564E+02 6.635E+02 1.976E+02 6.719E+02 2.201E+02 6.802E+02 2.348E+02
 6.025E-01 6.353E+02 1.304E+02 6.517E+02 1.604E+02 6.721E+02 2.026E+02 6.808E+02 2.257E+02 6.895E+02 2.407E+02
 6.085E-01 6.429E+02 1.338E+02 6.598E+02 1.645E+02 6.809E+02 2.076E+02 6.899E+02 2.314E+02 6.987E+02 2.467E+02

6.145E-01 6.506E+02 1.374E+02 6.680E+02 1.687E+02 6.896E+02 2.127E+02 6.990E+02 2.372E+02 7.080E+02 2.527E+02
 6.204E-01 6.583E+02 1.410E+02 6.761E+02 1.729E+02 6.984E+02 2.179E+02 7.081E+02 2.430E+02 7.174E+02 2.588E+02
 6.264E-01 6.660E+02 1.446E+02 6.843E+02 1.771E+02 7.073E+02 2.231E+02 7.173E+02 2.489E+02 7.269E+02 2.650E+02
 6.324E-01 6.738E+02 1.483E+02 6.926E+02 1.814E+02 7.162E+02 2.283E+02 7.266E+02 2.548E+02 7.364E+02 2.712E+02
 6.384E-01 6.816E+02 1.520E+02 7.009E+02 1.857E+02 7.252E+02 2.336E+02 7.359E+02 2.608E+02 7.459E+02 2.775E+02
 6.444E-01 6.894E+02 1.557E+02 7.092E+02 1.901E+02 7.342E+02 2.390E+02 7.453E+02 2.669E+02 7.556E+02 2.839E+02
 6.504E-01 6.973E+02 1.595E+02 7.176E+02 1.946E+02 7.432E+02 2.444E+02 7.547E+02 2.730E+02 7.653E+02 2.903E+02
 6.563E-01 7.052E+02 1.634E+02 7.260E+02 1.990E+02 7.524E+02 2.498E+02 7.642E+02 2.792E+02 7.750E+02 2.968E+02
 6.623E-01 7.131E+02 1.673E+02 7.344E+02 2.035E+02 7.615E+02 2.553E+02 7.737E+02 2.855E+02 7.848E+02 3.033E+02
 6.683E-01 7.211E+02 1.712E+02 7.429E+02 2.081E+02 7.707E+02 2.609E+02 7.833E+02 2.918E+02 7.947E+02 3.099E+02
 6.743E-01 7.291E+02 1.752E+02 7.515E+02 2.127E+02 7.800E+02 2.665E+02 7.930E+02 2.982E+02 8.046E+02 3.166E+02
 6.803E-01 7.371E+02 1.792E+02 7.600E+02 2.173E+02 7.893E+02 2.721E+02 8.027E+02 3.046E+02 8.146E+02 3.233E+02
 6.863E-01 7.452E+02 1.832E+02 7.687E+02 2.220E+02 7.987E+02 2.779E+02 8.124E+02 3.111E+02 8.246E+02 3.301E+02
 6.922E-01 7.533E+02 1.874E+02 7.773E+02 2.267E+02 8.081E+02 2.836E+02 8.223E+02 3.176E+02 8.347E+02 3.369E+02
 6.982E-01 7.615E+02 1.915E+02 7.860E+02 2.315E+02 8.175E+02 2.894E+02 8.321E+02 3.242E+02 8.448E+02 3.438E+02
 7.042E-01 7.697E+02 1.957E+02 7.948E+02 2.363E+02 8.270E+02 2.953E+02 8.421E+02 3.309E+02 8.551E+02 3.508E+02
 7.102E-01 7.779E+02 1.999E+02 8.035E+02 2.412E+02 8.366E+02 3.012E+02 8.521E+02 3.376E+02 8.653E+02 3.578E+02
 7.162E-01 7.861E+02 2.042E+02 8.124E+02 2.461E+02 8.462E+02 3.071E+02 8.621E+02 3.443E+02 8.757E+02 3.649E+02
 7.222E-01 7.944E+02 2.085E+02 8.212E+02 2.510E+02 8.559E+02 3.131E+02 8.722E+02 3.512E+02 8.861E+02 3.720E+02
 7.282E-01 8.028E+02 2.129E+02 8.301E+02 2.560E+02 8.656E+02 3.192E+02 8.824E+02 3.581E+02 8.965E+02 3.792E+02
 7.341E-01 8.111E+02 2.173E+02 8.391E+02 2.610E+02 8.754E+02 3.253E+02 8.926E+02 3.650E+02 9.070E+02 3.865E+02
 7.401E-01 8.195E+02 2.217E+02 8.481E+02 2.661E+02 8.852E+02 3.314E+02 9.029E+02 3.720E+02 9.176E+02 3.938E+02
 7.461E-01 8.280E+02 2.262E+02 8.571E+02 2.712E+02 8.950E+02 3.376E+02 9.132E+02 3.791E+02 9.282E+02 4.012E+02
 7.521E-01 8.364E+02 2.307E+02 8.662E+02 2.764E+02 9.049E+02 3.438E+02 9.236E+02 3.862E+02 9.389E+02 4.086E+02
 7.581E-01 8.449E+02 2.353E+02 8.753E+02 2.816E+02 9.149E+02 3.501E+02 9.341E+02 3.933E+02 9.497E+02 4.161E+02
 7.641E-01 8.535E+02 2.399E+02 8.844E+02 2.868E+02 9.249E+02 3.565E+02 9.446E+02 4.006E+02 9.605E+02 4.236E+02
 7.700E-01 8.621E+02 2.445E+02 8.936E+02 2.921E+02 9.350E+02 3.628E+02 9.552E+02 4.078E+02 9.714E+02 4.312E+02
 7.760E-01 8.707E+02 2.492E+02 9.029E+02 2.974E+02 9.451E+02 3.693E+02 9.658E+02 4.152E+02 9.823E+02 4.389E+02
 7.820E-01 8.793E+02 2.540E+02 9.121E+02 3.027E+02 9.552E+02 3.757E+02 9.764E+02 4.226E+02 9.933E+02 4.466E+02
 7.880E-01 8.880E+02 2.587E+02 9.215E+02 3.081E+02 9.654E+02 3.823E+02 9.872E+02 4.300E+02 1.004E+03 4.544E+02
 7.940E-01 8.968E+02 2.635E+02 9.308E+02 3.136E+02 9.757E+02 3.888E+02 9.980E+02 4.375E+02 1.015E+03 4.622E+02
 8.000E-01 9.055E+02 2.684E+02 9.402E+02 3.190E+02 9.860E+02 3.954E+02 1.009E+03 4.451E+02 1.027E+03 4.701E+02
 8.059E-01 9.143E+02 2.733E+02 9.497E+02 3.245E+02 9.964E+02 4.021E+02 1.020E+03 4.527E+02 1.038E+03 4.781E+02
 8.119E-01 9.231E+02 2.782E+02 9.591E+02 3.301E+02 1.007E+03 4.088E+02 1.031E+03 4.604E+02 1.049E+03 4.861E+02
 8.179E-01 9.320E+02 2.832E+02 9.687E+02 3.357E+02 1.017E+03 4.156E+02 1.042E+03 4.681E+02 1.060E+03 4.942E+02
 8.239E-01 9.409E+02 2.882E+02 9.782E+02 3.413E+02 1.028E+03 4.224E+02 1.053E+03 4.759E+02 1.072E+03 5.023E+02
 8.299E-01 9.499E+02 2.932E+02 9.878E+02 3.470E+02 1.038E+03 4.292E+02 1.064E+03 4.837E+02 1.083E+03 5.105E+02
 8.359E-01 9.589E+02 2.983E+02 9.975E+02 3.527E+02 1.049E+03 4.361E+02 1.075E+03 4.916E+02 1.095E+03 5.187E+02
 8.418E-01 9.679E+02 3.035E+02 1.007E+03 3.584E+02 1.060E+03 4.431E+02 1.086E+03 4.995E+02 1.106E+03 5.270E+02
 8.478E-01 9.769E+02 3.086E+02 1.017E+03 3.642E+02 1.070E+03 4.500E+02 1.098E+03 5.075E+02 1.118E+03 5.354E+02
 8.538E-01 9.860E+02 3.138E+02 1.027E+03 3.700E+02 1.081E+03 4.571E+02 1.109E+03 5.156E+02 1.130E+03 5.438E+02

8.598E-01 9.952E+02 3.191E+02 1.036E+03 3.759E+02 1.092E+03 4.641E+02 1.120E+03 5.237E+02 1.142E+03 5.522E+02
 8.658E-01 1.004E+03 3.244E+02 1.046E+03 3.818E+02 1.103E+03 4.713E+02 1.132E+03 5.318E+02 1.153E+03 5.607E+02
 8.718E-01 1.014E+03 3.297E+02 1.056E+03 3.877E+02 1.114E+03 4.784E+02 1.143E+03 5.400E+02 1.165E+03 5.693E+02
 8.778E-01 1.023E+03 3.351E+02 1.066E+03 3.937E+02 1.125E+03 4.856E+02 1.155E+03 5.483E+02 1.177E+03 5.780E+02
 8.837E-01 1.032E+03 3.405E+02 1.076E+03 3.997E+02 1.136E+03 4.929E+02 1.167E+03 5.566E+02 1.189E+03 5.866E+02
 8.897E-01 1.041E+03 3.459E+02 1.086E+03 4.058E+02 1.147E+03 5.002E+02 1.178E+03 5.650E+02 1.201E+03 5.954E+02
 8.957E-01 1.051E+03 3.514E+02 1.096E+03 4.119E+02 1.158E+03 5.076E+02 1.190E+03 5.734E+02 1.213E+03 6.042E+02
 9.017E-01 1.060E+03 3.569E+02 1.106E+03 4.180E+02 1.169E+03 5.149E+02 1.202E+03 5.819E+02 1.225E+03 6.131E+02
 9.077E-01 1.069E+03 3.625E+02 1.116E+03 4.242E+02 1.180E+03 5.224E+02 1.214E+03 5.904E+02 1.238E+03 6.220E+02
 9.137E-01 1.079E+03 3.681E+02 1.127E+03 4.304E+02 1.191E+03 5.299E+02 1.226E+03 5.990E+02 1.250E+03 6.309E+02
 9.196E-01 1.088E+03 3.737E+02 1.137E+03 4.366E+02 1.203E+03 5.374E+02 1.238E+03 6.077E+02 1.262E+03 6.400E+02
 9.256E-01 1.098E+03 3.794E+02 1.147E+03 4.429E+02 1.214E+03 5.450E+02 1.250E+03 6.164E+02 1.275E+03 6.490E+02
 9.316E-01 1.108E+03 3.851E+02 1.157E+03 4.492E+02 1.225E+03 5.526E+02 1.262E+03 6.251E+02 1.287E+03 6.582E+02
 9.376E-01 1.117E+03 3.908E+02 1.168E+03 4.556E+02 1.237E+03 5.602E+02 1.274E+03 6.339E+02 1.300E+03 6.674E+02
 9.436E-01 1.127E+03 3.966E+02 1.178E+03 4.619E+02 1.248E+03 5.679E+02 1.286E+03 6.428E+02 1.312E+03 6.766E+02
 9.496E-01 1.136E+03 4.025E+02 1.188E+03 4.684E+02 1.260E+03 5.757E+02 1.298E+03 6.517E+02 1.325E+03 6.859E+02
 9.555E-01 1.146E+03 4.083E+02 1.199E+03 4.748E+02 1.271E+03 5.835E+02 1.311E+03 6.606E+02 1.338E+03 6.953E+02
 9.615E-01 1.156E+03 4.142E+02 1.209E+03 4.813E+02 1.283E+03 5.913E+02 1.323E+03 6.697E+02 1.350E+03 7.047E+02
 9.675E-01 1.166E+03 4.202E+02 1.220E+03 4.879E+02 1.295E+03 5.992E+02 1.336E+03 6.787E+02 1.363E+03 7.141E+02
 9.735E-01 1.176E+03 4.261E+02 1.231E+03 4.944E+02 1.306E+03 6.071E+02 1.348E+03 6.878E+02 1.376E+03 7.237E+02
 9.795E-01 1.185E+03 4.322E+02 1.241E+03 5.010E+02 1.318E+03 6.151E+02 1.361E+03 6.970E+02 1.389E+03 7.332E+02
 9.855E-01 1.195E+03 4.382E+02 1.252E+03 5.077E+02 1.330E+03 6.231E+02 1.373E+03 7.062E+02 1.402E+03 7.429E+02
 9.914E-01 1.205E+03 4.443E+02 1.263E+03 5.144E+02 1.342E+03 6.312E+02 1.386E+03 7.155E+02 1.415E+03 7.526E+02
 9.974E-01 1.215E+03 4.504E+02 1.273E+03 5.211E+02 1.354E+03 6.393E+02 1.399E+03 7.248E+02 1.428E+03 7.623E+02
 1.003E+00 1.225E+03 4.566E+02 1.284E+03 5.278E+02 1.366E+03 6.474E+02 1.411E+03 7.342E+02 1.441E+03 7.721E+02
 1.009E+00 1.235E+03 4.628E+02 1.295E+03 5.346E+02 1.378E+03 6.556E+02 1.424E+03 7.437E+02 1.455E+03 7.819E+02
 1.015E+00 1.245E+03 4.690E+02 1.306E+03 5.415E+02 1.390E+03 6.638E+02 1.437E+03 7.531E+02 1.468E+03 7.919E+02
 1.021E+00 1.256E+03 4.753E+02 1.317E+03 5.483E+02 1.402E+03 6.721E+02 1.450E+03 7.627E+02 1.481E+03 8.018E+02
 1.027E+00 1.266E+03 4.816E+02 1.328E+03 5.552E+02 1.414E+03 6.804E+02 1.463E+03 7.723E+02 1.495E+03 8.118E+02
 1.033E+00 1.276E+03 4.880E+02 1.339E+03 5.622E+02 1.427E+03 6.888E+02 1.476E+03 7.819E+02 1.508E+03 8.219E+02
 1.039E+00 1.286E+03 4.944E+02 1.350E+03 5.691E+02 1.439E+03 6.972E+02 1.489E+03 7.916E+02 1.522E+03 8.320E+02
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 1.057E+00 1.317E+03 5.137E+02 1.383E+03 5.902E+02 1.476E+03 7.227E+02 1.529E+03 8.210E+02 1.563E+03 8.627E+02
 1.063E+00 1.327E+03 5.203E+02 1.394E+03 5.974E+02 1.488E+03 7.312E+02 1.542E+03 8.309E+02 1.576E+03 8.730E+02
 1.069E+00 1.338E+03 5.269E+02 1.405E+03 6.045E+02 1.501E+03 7.398E+02 1.555E+03 8.409E+02 1.590E+03 8.834E+02
 1.075E+00 1.348E+03 5.335E+02 1.417E+03 6.117E+02 1.513E+03 7.485E+02 1.569E+03 8.509E+02 1.604E+03 8.939E+02
 1.081E+00 1.359E+03 5.401E+02 1.428E+03 6.189E+02 1.526E+03 7.572E+02 1.582E+03 8.609E+02 1.618E+03 9.044E+02
 1.087E+00 1.369E+03 5.468E+02 1.439E+03 6.262E+02 1.539E+03 7.660E+02 1.596E+03 8.711E+02 1.632E+03 9.149E+02
 1.093E+00 1.380E+03 5.535E+02 1.451E+03 6.334E+02 1.551E+03 7.747E+02 1.610E+03 8.812E+02 1.646E+03 9.256E+02
 1.099E+00 1.390E+03 5.603E+02 1.462E+03 6.408E+02 1.564E+03 7.836E+02 1.623E+03 8.914E+02 1.660E+03 9.362E+02

1.105E+00 1.401E+03 5.671E+02 1.474E+03 6.481E+02 1.577E+03 7.925E+02 1.637E+03 9.017E+02 1.674E+03 9.469E+02
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 1.117E+00 1.422E+03 5.807E+02 1.497E+03 6.630E+02 1.603E+03 8.103E+02 1.664E+03 9.224E+02 1.703E+03 9.685E+02
 1.123E+00 1.433E+03 5.876E+02 1.508E+03 6.704E+02 1.616E+03 8.193E+02 1.678E+03 9.328E+02 1.717E+03 9.794E+02
 1.129E+00 1.444E+03 5.946E+02 1.520E+03 6.779E+02 1.629E+03 8.284E+02 1.692E+03 9.433E+02 1.732E+03 9.903E+02
 1.135E+00 1.455E+03 6.015E+02 1.532E+03 6.854E+02 1.642E+03 8.375E+02 1.706E+03 9.538E+02 1.746E+03 1.001E+03
 1.141E+00 1.466E+03 6.086E+02 1.543E+03 6.930E+02 1.655E+03 8.466E+02 1.720E+03 9.644E+02 1.760E+03 1.012E+03
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 1.153E+00 1.488E+03 6.227E+02 1.567E+03 7.083E+02 1.681E+03 8.650E+02 1.749E+03 9.857E+02 1.790E+03 1.035E+03
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 1.213E+00 1.599E+03 6.955E+02 1.687E+03 7.865E+02 1.816E+03 9.594E+02 1.893E+03 1.095E+03 1.939E+03 1.149E+03
 1.219E+00 1.610E+03 7.029E+02 1.699E+03 7.945E+02 1.829E+03 9.691E+02 1.908E+03 1.106E+03 1.954E+03 1.161E+03
 1.225E+00 1.622E+03 7.104E+02 1.711E+03 8.026E+02 1.843E+03 9.788E+02 1.923E+03 1.118E+03 1.970E+03 1.173E+03
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 1.255E+00 1.679E+03 7.485E+02 1.773E+03 8.433E+02 1.913E+03 1.028E+03 1.998E+03 1.175E+03 2.047E+03 1.232E+03
 1.261E+00 1.691E+03 7.562E+02 1.786E+03 8.516E+02 1.927E+03 1.038E+03 2.013E+03 1.187E+03 2.063E+03 1.244E+03
 1.267E+00 1.702E+03 7.640E+02 1.798E+03 8.599E+02 1.941E+03 1.048E+03 2.028E+03 1.198E+03 2.079E+03 1.256E+03
 1.273E+00 1.714E+03 7.718E+02 1.811E+03 8.682E+02 1.955E+03 1.058E+03 2.044E+03 1.210E+03 2.094E+03 1.269E+03
 1.279E+00 1.726E+03 7.796E+02 1.823E+03 8.765E+02 1.969E+03 1.068E+03 2.059E+03 1.222E+03 2.110E+03 1.281E+03
 1.285E+00 1.737E+03 7.875E+02 1.836E+03 8.849E+02 1.983E+03 1.078E+03 2.074E+03 1.233E+03 2.126E+03 1.293E+03
 1.291E+00 1.749E+03 7.954E+02 1.849E+03 8.933E+02 1.998E+03 1.088E+03 2.090E+03 1.245E+03 2.142E+03 1.306E+03
 1.297E+00 1.761E+03 8.033E+02 1.862E+03 9.018E+02 2.012E+03 1.099E+03 2.105E+03 1.257E+03 2.158E+03 1.318E+03
 1.303E+00 1.773E+03 8.113E+02 1.874E+03 9.103E+02 2.026E+03 1.109E+03 2.121E+03 1.269E+03 2.174E+03 1.331E+03
 1.309E+00 1.785E+03 8.193E+02 1.887E+03 9.188E+02 2.041E+03 1.119E+03 2.136E+03 1.281E+03 2.190E+03 1.343E+03
 1.315E+00 1.797E+03 8.273E+02 1.900E+03 9.274E+02 2.055E+03 1.130E+03 2.152E+03 1.293E+03 2.206E+03 1.356E+03
 1.321E+00 1.809E+03 8.354E+02 1.913E+03 9.359E+02 2.070E+03 1.140E+03 2.168E+03 1.305E+03 2.223E+03 1.368E+03
 1.327E+00 1.821E+03 8.435E+02 1.926E+03 9.446E+02 2.084E+03 1.150E+03 2.183E+03 1.317E+03 2.239E+03 1.381E+03
 1.333E+00 1.833E+03 8.516E+02 1.939E+03 9.532E+02 2.099E+03 1.161E+03 2.199E+03 1.330E+03 2.255E+03 1.394E+03
 1.339E+00 1.845E+03 8.598E+02 1.952E+03 9.619E+02 2.114E+03 1.171E+03 2.215E+03 1.342E+03 2.272E+03 1.406E+03
 1.344E+00 1.857E+03 8.680E+02 1.965E+03 9.706E+02 2.128E+03 1.182E+03 2.231E+03 1.354E+03 2.288E+03 1.419E+03

1.350E+00 1.869E+03 8.762E+02 1.978E+03 9.794E+02 2.143E+03 1.192E+03 2.247E+03 1.367E+03 2.305E+03 1.432E+03
 1.356E+00 1.881E+03 8.845E+02 1.991E+03 9.882E+02 2.158E+03 1.203E+03 2.263E+03 1.379E+03 2.321E+03 1.445E+03
 1.362E+00 1.893E+03 8.928E+02 2.004E+03 9.970E+02 2.173E+03 1.214E+03 2.279E+03 1.391E+03 2.338E+03 1.458E+03
 1.368E+00 1.906E+03 9.012E+02 2.017E+03 1.006E+03 2.188E+03 1.224E+03 2.295E+03 1.404E+03 2.355E+03 1.471E+03
 1.374E+00 1.918E+03 9.096E+02 2.031E+03 1.015E+03 2.203E+03 1.235E+03 2.312E+03 1.416E+03 2.371E+03 1.484E+03
 1.380E+00 1.930E+03 9.180E+02 2.044E+03 1.024E+03 2.218E+03 1.246E+03 2.328E+03 1.429E+03 2.388E+03 1.497E+03
 1.386E+00 1.943E+03 9.264E+02 2.057E+03 1.033E+03 2.233E+03 1.257E+03 2.344E+03 1.442E+03
 1.392E+00 1.955E+03 9.349E+02 2.071E+03 1.042E+03 2.248E+03 1.268E+03 2.360E+03 1.454E+03
 1.398E+00 1.967E+03 9.434E+02 2.084E+03 1.051E+03 2.263E+03 1.279E+03 2.377E+03 1.467E+03
 1.404E+00 1.980E+03 9.520E+02 2.097E+03 1.060E+03 2.278E+03 1.289E+03 2.393E+03 1.480E+03
 1.410E+00 1.992E+03 9.606E+02 2.111E+03 1.069E+03 2.293E+03 1.300E+03 2.410E+03 1.493E+03
 1.416E+00 2.005E+03 9.692E+02 2.124E+03 1.078E+03 2.309E+03 1.311E+03 2.426E+03 1.506E+03
 1.422E+00 2.018E+03 9.779E+02 2.138E+03 1.087E+03 2.324E+03 1.323E+03 2.443E+03 1.519E+03
 1.428E+00 2.030E+03 9.866E+02 2.152E+03 1.096E+03 2.339E+03 1.334E+03 2.460E+03 1.532E+03
 1.434E+00 2.043E+03 9.953E+02 2.165E+03 1.105E+03 2.355E+03 1.345E+03 2.477E+03 1.545E+03
 1.440E+00 2.056E+03 1.004E+03 2.179E+03 1.115E+03 2.370E+03 1.356E+03 2.493E+03 1.558E+03
 1.446E+00 2.068E+03 1.013E+03 2.193E+03 1.124E+03 2.386E+03 1.367E+03
 1.452E+00 2.081E+03 1.022E+03 2.206E+03 1.133E+03 2.401E+03 1.378E+03
 1.458E+00 2.094E+03 1.031E+03 2.220E+03 1.143E+03 2.417E+03 1.390E+03
 1.464E+00 2.107E+03 1.039E+03 2.234E+03 1.152E+03 2.432E+03 1.401E+03
 1.470E+00 2.120E+03 1.048E+03 2.248E+03 1.161E+03 2.448E+03 1.413E+03
 1.476E+00 2.132E+03 1.057E+03 2.262E+03 1.171E+03 2.464E+03 1.424E+03
 1.482E+00 2.145E+03 1.066E+03 2.276E+03 1.180E+03 2.480E+03 1.435E+03
 1.488E+00 2.158E+03 1.075E+03 2.290E+03 1.190E+03 2.495E+03 1.447E+03
 1.494E+00 2.171E+03 1.084E+03 2.304E+03 1.199E+03 2.511E+03 1.458E+03
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 1.506E+00 2.198E+03 1.103E+03 2.332E+03 1.218E+03 2.543E+03 1.482E+03
 1.512E+00 2.211E+03 1.112E+03 2.346E+03 1.228E+03 2.559E+03 1.493E+03
 1.518E+00 2.224E+03 1.121E+03 2.360E+03 1.238E+03 2.575E+03 1.505E+03
 1.524E+00 2.237E+03 1.130E+03 2.374E+03 1.248E+03 2.591E+03 1.517E+03
 1.530E+00 2.250E+03 1.140E+03 2.388E+03 1.257E+03 2.608E+03 1.529E+03

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