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Heavy-Ion Fusion Reaction Calculations: Establishing the Theoretical Frameworks for ^{111}In Radionuclide Over the Coupled Channel Model

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S1. Abbreviation and Symbols

All abbreviations and symbols in the "2. Coupled Channel (CC) Model" section in the main text are in the following table.

Table S1. Abbreviation and symbols of Coupled Channel (CC) Model Section in the main text.

Abbreaviton - Symbol	Information	References
D(B)	barrier distribution function	[28,29]
B	barrier height	[28,29]
R_B	barrier radius	[28,29]
σ_{fus}	fusion cross-sections	[28,29]
E	incident energy	[28,29]
$T_l(B; E)$	barrier penetration probability	[28,29]
x	function argument	[28,29]
ħ	modified form of Planck's constant	[28,29]
μ	reduced mass of the system	[28,29]
l	angular momentum	[28,29]
$P_{CN}(E, l)$	penetration probability	[28,29]
V_B	barrier potential	[28,29]
CC	coupled channel model	[28,29]
CN	compound nucleus	[28,29]

S2. Calculations Results

All calculations in the "3. Results of The Heavy-Ion Fusion Cross-Sections, Barrier Distributions and Potential Energies on Mutual Orientations in the Reactions Planes" section in the main text are in the following tables.

Table S2. Heavy-ion fusion cross-section calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the quadrupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^* = 1.7266\ \mathrm{MeV};\ \beta_{2^+} = 0.1400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^* = 0.5959\ \mathrm{MeV};\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	60	4.355×10^{-5}	5.086×10^{-5}	4.97483×10^{-4}	3.02597×10^{-5}	1.51883×10^{-4}
63.82	2.36	60.5	1.316×10^{-4}	1.539×10^{-4}	0.00142	7.21809×10^{-5}	
65.15	6.82	61	3.919×10^{-4}	4.572×10^{-4}	0.0039	1.72197×10^{-4}	9.03251×10^{-4}
66.49	18.2	61.5	0.00114	0.00132	0.01029	4.10835×10^{-4}	
67.83	43.4	62	0.00325	0.00376	0.02663	9.80259×10^{-4}	0.00537
69.16	70.9	62.5	0.00918	0.01056	0.06816	0.00234	
70.5	108.7	63	0.02536	0.02899	0.17392	0.00558	0.03196
71.83	163.4	63.5	0.06895	0.07822	0.44532	0.01331	
73.16	204	64	0.186	0.208	1.13639	0.03171	0.18973
74.5	265	64.5	0.487	0.537	2.82161	0.07536	
-	-	65	1.245	1.345	6.53592	0.17802	1.11333
-	-	65.5	3.099	3.235	13.35325	0.41472	
-	-	66	7.242	7.171	23.40034	0.93911	6.11564
-	-	66.5	15.49	14.18	35.96809	2.02287	
-	-	67	29.44	24.65	50.52573	4.0583	25.82643
-	-	67.5	48.66	37.79	67.03921	7.50632	
-	-	68	71.47	53.04	85.58595	12.83312	66.83942
-	-	68.5	96.15	70.44	105.88535	20.45302	
-	-	69	121.4	89.55	127.36394	30.62599	117.40567
-	-	69.5	146.6	109.8	149.50704	43.31738	
-	-	70	171.6	130.9	172.02231	58.17984	168.98932
-	-	70.5	196.3	152.2	194.76502	74.72645	
-	-	71	220.6	173.9	217.66075	92.51441	219.55017
-	-	71.5	244.5	195.9	240.68765	111.21237	
-	-	72	268	218.1	263.75135	130.58893	268.77757
-	-	72.5	291.1	240.3	286.73777	150.48082	
-	-	73	313.9	262.5	309.57814	170.76506	316.66789
-	-	73.5	336.3	284.4	332.2354	191.34066	
-	-	74	358.3	306.1	354.65777	212.11766	363.26576
-	-	74.5	379.9	327.6	376.83475	233.00947	
-	-	75	401.2	348.7	398.73089	253.92865	408.62134
-	-	75.5	422.2	369.6	420.33562	274.79051	
-	-	76	442.9	390	441.64375	295.52343	452.7834
-	-	76.5	463.3	410.2	462.63452	316.07749	

-	-	77	483.2	430.1	483.33456	336.42503	495.79839
-	-	77.5	502.9	449.7	503.72702	356.55467	
-	-	78	522.2	468.9	523.78376	376.46434	537.71045
-	-	78.5	541.3	487.8	543.56785	396.15631	
-	-	79	560	506.4	563.03612	415.63414	578.56144
-	-	79.5	578.6	524.7	582.34789	434.90025	
-	-	80	596.8	542.8	601.09264	453.95464	618.39115

Table S3. Heavy-ion fusion barrier-distributions calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the quadrupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^{*} = 1.7266$ MeV; $\beta_{2^{+}} = 0.1400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^{*} = 0.5959$ MeV; $\beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	$\mathrm{d}^2(\mathrm{E}\sigma)/\mathrm{dE}^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$\mathrm{d}^2(\mathrm{E}\sigma)/\mathrm{dE}^2$ [mb / MeV]	60	0.00968	0.01022	0.02951
63.82	100.4	60.5	0.03083	0.03346	
65.15	265.5	61	0.07695	0.09752	0.1784
66.49	460	61.5	0.228	0.317	
67.83	338.2	62	0.995	1.127	1.07834
69.16	349.4	62.5	3.262	2.981	
70.5	459.6	63	5.086	4.774	6.50937
71.83	77.89	63.5	2.293	8.572	
73.16	370.1	64	19.16	40.38	38.97758
74.5	1131	64.5	132.2	148.4	
		65	398.4	346.5	222.48217
		65.5	767	579.1	
		66	1108	762.2	980.06719
		66.5	1298	836.5	
		67	1269	803.5	1667.09284
		67.5	1041	718.5	
		68	714	623.2	683.83759
		68.5	401.4	517.9	
		69	173.5	403.4	138.11693
		69.5	41.62	297.8	
		70	-17.99	220.9	23.65875
		70.5	-35.09	178.7	
		71	-33.13	155.3	3.936
		71.5	-26.5	129.5	
		72	-21.11	97.11	0.65162
		72.5	-17.95	65.41	
		73	-17.11	39.68	0.10779

-	-	73.5	-17.62	20.7	
-	-	74	-17.34	6.094	0.01783
-	-	74.5	-15.84	-6.135	
-	-	75	-14.99	-14.58	0.00295
-	-	75.5	-16.22	-17.13	
-	-	76	-19.25	-15.5	4.87701E-4
-	-	76.5	-22.21	-15.04	
-	-	77	-22.6	-18.75	8.06627E-5
-	-	77.5	-20.05	-24.13	
-	-	78	-13.47	-23.46	1.33411E-5
-	-	78.5	0.106	-9.38	
-	-	79	-40.98	-41.06	2.20653E-6
-	-	79.5	-43.44	-39.14	-
-	-	80	19.13	19.34	3.64947E-7

Table S4. Heavy-ion fusion cross-section calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the quadrupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^* = 3.0861\ \mathrm{MeV};\ \beta_{2^+} = 0.2400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^* = 0.5959\ \mathrm{MeV};\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	60	4.355×10^{-5}	5.646×10^{-5}	7.71599×10^{-4}	2.18727×10^{-4}	7.67335×10^{-5}
63.82	2.36	60.5	1.316×10^{-4}	1.703×10^{-4}	0.00202	5.277×10^{-4}	
65.15	6.82	61	3.919×10^{-4}	5.036×10^{-4}	0.00515	0.00127	4.58702×10^{-4}
66.49	18.2	61.5	0.00114	0.00145	0.01292	0.00307	
67.83	43.4	62	0.00325	0.00408	0.03249	0.00741	0.00274
69.16	70.9	62.5	0.00918	0.0113	0.08262	0.01784	
70.5	108.7	63	0.02536	0.03051	0.21335	0.04287	0.0164
71.83	163.4	63.5	0.06895	0.08095	0.55871	0.10232	
73.16	204	64	0.186	0.212	1.45152	0.24057	0.09799
74.5	265	64.5	0.487	0.537	3.58728	0.54829	
		65	1.245	1.323	7.99654	1.18304	0.58192
		65.5	3.099	3.14	15.46574	2.36266	
		66	7.242	6.913	26.01031	4.32398	3.33097
		66.5	15.49	13.75	39.10007	7.28475	
		67	29.44	24.19	54.12261	11.43699	16.03226
		67.5	48.66	37.52	70.73217	16.96202	
		68	71.47	52.92	88.932	24.04836	49.7067
		68.5	96.15	70.15	108.79369	32.89584	
		69	121.4	88.84	130.06112	43.68048	97.58319
		69.5	146.6	108.7	152.15681	56.46127	
		70	171.6	129.4	174.56687	71.08938	148.33811
		70.5	196.3	150.5	197.09271	87.24189	

		71	220.6	171.8	219.78979	104.55739	198.44321
		71.5	244.5	193.4	242.73676	122.73295	
		72	268	215.4	265.83068	141.54326	247.28587
		72.5	291.1	237.5	288.85737	160.82506	
		73	313.9	259.6	311.68165	180.45849	294.81145
		73.5	336.3	281.4	334.23172	200.35338	
		74	358.3	302.9	356.47896	220.44005	341.05598
		74.5	379.9	324.2	378.4483	240.66178	
		75	401.2	345.2	400.12367	260.96616	386.06787
		75.5	422.2	366	421.54895	281.29665	
		76	442.9	386.4	442.64252	301.592	429.89533
		76.5	463.3	406.5	463.52377	321.79632	
		77	483.2	426.3	484.00143	341.86888	472.58443
		77.5	502.9	445.8	504.23911	361.78553	
		78	522.2	465	524.11047	381.53455	514.17894
		78.5	541.3	483.9	543.84573	401.11207	
		79	560	502.4	563.02094	420.51873	554.72042
		79.5	578.6	520.6	582.41846	439.75683	
		80	596.8	538.6	600.92161	458.8269	594.24837

Table S5. Heavy-ion fusion barrier-distributions calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the quadrupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^{*} = 3.0861$ MeV; $\beta_{2^{+}} = 0.2400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^{*} = 0.5959$ MeV; $\beta_{2} = -0.2370; \beta_{4} = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	60	0.00968	0.01122	0.01499
63.82	100.4	60.5	0.03083	0.03759	
65.15	265.5	61	0.07695	0.11	0.09112
66.49	460	61.5	0.228	0.339	
67.83	338.2	62	0.995	1.157	0.55371
69.16	349.4	62.5	3.262	3.114	
70.5	459.6	63	5.086	5.309	3.36234
71.83	77.89	63.5	2.293	9.002	
73.16	370.1	64	19.16	37.51	20.33106
74.5	1131	64.5	132.2	139	
		65	398.4	333.9	119.83418
		65.5	767	573.5	
		66	1108	771.1	610.30857
		66.5	1298	856.3	
		67	1269	816.7	1618.10792

		67.5	1041	705.6	
		68	714	585	1047.92601
		68.5	401.4	478.1	
		69	173.5	382	245.47507
		69.5	41.62	293.6	
		70	-17.99	222.3	43.08599
		70.5	-35.09	181.4	
		71	-33.13	164.4	7.16661
		71.5	-26.5	147.7	
		72	-21.11	116.8	1.18131
		72.5	-17.95	76.02	
		73	-17.11	38.42	0.19443
		73.5	-17.62	14.04	
		74	-17.34	3.277	0.03199
		74.5	-15.84	-1.192	
		75	-14.99	-5.379	0.00526
		75.5	-16.22	-9.19	
		76	-19.25	-11.61	8.66182×10^{-4}
		76.5	-22.21	-14.09	
		77	-22.6	-18.09	1.42522×10^{-4}
		77.5	-20.05	-23.35	
		78	-13.47	-23.68	2.34507×10^{-5}
		78.5	0.106	-9.895	
		79	-40.98	-49.49	3.85859×10^{-6}
		79.5	-43.44	-47.07	
		80	19.13	22.97	6.34895×10^{-7}

Table S6. Heavy-ion fusion cross-section calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the octupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^* = 3.1035$ MeV; $\beta_{3^-} = 0.3200$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^* = 0.5959$ MeV; $\beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	60	4.355×10^{-5}	5.025×10^{-5}	0.00187	0.00133	4.72276×10^{-5}
63.82	2.36	60.5	1.316×10^{-4}	1.558×10^{-4}	0.00536	0.00325	
65.15	6.82	61	3.919×10^{-4}	4.723×10^{-4}	0.01565	0.0079	2.79424×10^{-4}
66.49	18.2	61.5	0.00114	0.00139	0.04546	0.01919	
67.83	43.4	62	0.00325	0.004	0.1273	0.04642	0.00165
69.16	70.9	62.5	0.00918	0.01136	0.33141	0.11121	
70.5	108.7	63	0.02536	0.03136	0.79066	0.26078	0.00979
71.83	163.4	63.5	0.06895	0.08495	1.752	0.58637	
73.16	204	64	0.186	0.226	3.66803	1.23196	0.05791
74.5	265	64.5	0.487	0.58	7.31992	2.37314	

		65	1.245	1.442	13.82516	4.17782	0.34145
		65.5	3.099	3.437	24.03242	6.78367	
		66	7.242	7.551	37.59431	10.29971	1.97
		66.5	15.49	14.85	53.36735	14.81809	
		67	29.44	25.73	70.71251	20.42671	10.16225
		67.5	48.66	39.31	89.58744	27.22068	
		68	71.47	54.84	109.6929	35.31232	36.63706
		68.5	96.15	72.16	130.50717	44.83534	
		69	121.4	90.96	151.80708	55.92833	81.01482
		69.5	146.6	110.9	173.50945	68.67542	
		70	171.6	131.7	195.62523	83.01926	130.81939
		70.5	196.3	152.8	218.17411	98.73794	
		71	220.6	174.1	241.22511	115.5315	180.56866
		71.5	244.5	195.8	264.54902	133.12321	
		72	268	217.9	287.89874	151.29998	229.16565
		72.5	291.1	240	311.06408	169.90834	
		73	313.9	262.1	333.72995	188.83862	276.46912
		73.5	336.3	283.9	356.30293	208.01159	
		74	358.3	305.5	378.07689	227.36991	322.50034
		74.5	379.9	326.8	400.12088	246.87248	
		75	401.2	347.8	421.24138	266.48852	367.30509
		75.5	422.2	368.5	442.70704	286.18857	
		76	442.9	388.9	463.36319	305.93426	410.93093
		76.5	463.3	408.9	483.90758	325.67623	
		77	483.2	428.7	504.10115	345.36466	453.42366
		77.5	502.9	448.2	523.79319	364.96106	
		78	522.2	467.6	543.54083	384.44119	494.82683
		78.5	541.3	486.3	562.00555	403.79226	
		79	560	505.2	580.35091	423.00922	535.18183
		79.5	578.6	523	604.5039	442.09182	
		80	596.8	541.2	614.20488	461.04142	574.52795

Table S7. Heavy-ion fusion barrier-distributions calculations for $^{37}Cl + {}^{74}Ge$ (in the octupole vibrational state for the ^{37}Cl: $E^* = 3.1035$ MeV; $\beta_{3^-} = 0.3200$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{74}Ge: $E^* = 0.5959$ MeV; $\beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	60	0.00968	0.01055	0.00912
63.82	100.4	60.5	0.03083	0.03462	
65.15	265.5	61	0.07695	0.103	0.05487
66.49	460	61.5	0.228	0.344	

67.83	338.2	62	0.995	1.231	0.33005
69.16	349.4	62.5	3.262	3.216	
70.5	459.6	63	5.086	5.092	1.98433
71.83	77.89	63.5	2.293	9.453	
73.16	370.1	64	19.16	44.21	11.90023
74.5	1131	64.5	132.2	158.9	
		65	398.4	365.3	70.30403
		65.5	767	604.3	
		66	1108	787.7	380.71463
		66.5	1298	851.7	
		67	1269	795.3	1338.88094
		67.5	1041	680.7	
		68	714	567.5	1379.92264
		68.5	401.4	468.5	
		69	173.5	376.2	405.33248
		69.5	41.62	289.2	
		70	-17.99	219.9	75.41459
		70.5	-35.09	182.3	
		71	-33.13	167.7	12.78229
		71.5	-26.5	149.9	
		72	-21.11	115.2	2.13189
		72.5	-17.95	71.65	
		73	-17.11	34.26	0.35461
		73.5	-17.62	11.65	
		74	-17.34	1.066	0.05896
		74.5	-15.84	-5.687	
		75	-14.99	-11.98	0.0098
		75.5	-16.22	-14.67	
		76	-19.25	-10.84	0.00163
		76.5	-22.21	-4.709	
		77	-22.6	-3.467	2.70897×10^{-4}
		77.5	-20.05	-12.63	
		78	-13.47	-25.15	4.50355×10^{-5}
		78.5	0.106	-31.53	
		79	-40.98	-42.39	7.48698×10^{-6}
		79.5	-43.44	-24.04	
		80	19.13	10.99	1.24468×10^{-6}

Table S8. Heavy-ion fusion cross-section calculations for $^{37}Cl + {}^{74}Ge$ (in the octupole vibrational state for the ^{37}Cl: $E^* = 4.0100$ MeV; $\beta_{3^-} = 0.3300$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{74}Ge: $E^* = 0.5959$ MeV; $\beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	60	4.355×10^{-5}	4.071×10^{-5}	0.00151	0.00168	4.4379×10^{-5}
63.82	2.36	60.5	1.316×10^{-4}	1.266×10^{-4}	0.00411	0.0041	
65.15	6.82	61	3.919×10^{-4}	3.843×10^{-4}	0.0115	0.00999	2.59907×10^{-4}
66.49	18.2	61.5	0.00114	0.00113	0.03268	0.02428	
67.83	43.4	62	0.00325	0.00325	0.0928	0.05867	0.00152
69.16	70.9	62.5	0.00918	0.0092	0.2533	0.14004	
70.5	108.7	63	0.02536	0.02533	0.64027	0.32545	0.00892
71.83	163.4	63.5	0.06895	0.06854	1.48201	0.71952	
73.16	204	64	0.186	0.183	3.1658	1.47543	0.05225
74.5	265	64.5	0.487	0.471	6.32629	2.76542	
		65	1.245	1.178	11.9161	4.74417	0.30509
		65.5	3.099	2.835	20.92301	7.53464	
		66	7.242	6.341	33.61148	11.23401	1.74782
		66.5	15.49	12.84	49.27112	15.92553	
		67	29.44	23.07	67.0319	21.69001	9.06597
		67.5	48.66	36.43	86.5941	28.6163	
		68	71.47	52.05	107.80222	36.81078	33.70446
		68.5	96.15	69.64	129.99865	46.40149	
		69	121.4	88.77	152.46399	57.52313	76.94795
		69.5	146.6	109.1	174.93474	70.2611	
		70	171.6	130.2	197.54111	84.56586	126.44074
		70.5	196.3	151.5	220.45305	100.22568	
		71	220.6	173.1	243.69474	116.94802	176.10458
		71.5	244.5	194.9	267.30208	134.46018	
		72	268	217	290.85592	152.55135	224.66008
		72.5	291.1	239.3	314.41763	171.06965	
		73	313.9	261.5	337.58309	189.90675	271.93056
		73.5	336.3	283.6	360.3622	208.9847	
		74	358.3	305.4	382.95363	228.24756	317.93098
		74.5	379.9	326.9	404.74169	247.65573	
		75	401.2	348	426.78941	267.1801	362.70596
		75.5	422.2	368.9	447.70863	286.79352	
		76	442.9	389.4	469.29505	306.46071	406.30285
		76.5	463.3	409.6	489.41666	326.13456	
		77	483.2	429.5	510.39606	345.7653	448.7674
		77.5	502.9	449.1	529.6871	365.31291	
		78	522.2	468.5	550.19963	384.75137	490.14311
		78.5	541.3	487.5	567.97487	404.06647	

		79	560	506.4	588.43077	423.2522	530.47135
		79.5	578.6	524.8	604.32739	442.30771	
		80	596.8	542.9	623.68368	461.23425	569.79137

Table S9. Heavy-ion fusion barrier-distributions calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the octupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^* = 4.0100\ \mathrm{MeV};\ \beta_{3^-} = 0.3300$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^* = 0.5959\ \mathrm{MeV};\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	60	0.00968	0.00875	0.00848
63.82	100.4	60.5	0.03083	0.02972	
65.15	265.5	61	0.07695	0.08613	0.05046
66.49	460	61.5	0.228	0.263	
67.83	338.2	62	0.995	0.94	0.30044
69.16	349.4	62.5	3.262	2.724	
70.5	459.6	63	5.086	4.909	1.78809
71.83	77.89	63.5	2.293	7.57	
73.16	370.1	64	19.16	30.45	10.61785
74.5	1131	64.5	132.2	121.7	
		65	398.4	310.1	62.21675
		65.5	767	555.2	
		66	1108	771	337.64453
		66.5	1298	880.5	
		67	1269	860.5	1246.95831
		67.5	1041	754.8	
		68	714	625.5	1447.37844
		68.5	401.4	501.6	
		69	173.5	387.1	460.65874
		69.5	41.62	284.1	
		70	-17.99	204.7	88.16812
		70.5	-35.09	162.4	
		71	-33.13	149.8	15.14945
		71.5	-26.5	141.9	
		72	-21.11	120.8	2.55418
		72.5	-17.95	85.26	
		73	-17.11	44.92	0.42925
		73.5	-17.62	12.61	
		74	-17.34	-4.509	0.0721
		74.5	-15.84	-9.934	
		75	-14.99	-11.85	0.01211

		75.5	-16.22	-14.65	
		76	-19.25	-17.12	0.00203
		76.5	-22.21	-16.04	
		77	-22.6	-10.52	3.41574×10^{-4}
		77.5	-20.05	-7.099	
		78	-13.47	-4.641	5.73673×10^{-5}
		78.5	0.106	11.72	
		79	-40.98	-89.7	9.63482×10^{-6}
		79.5	-43.44	-96.34	
		80	19.13	46.51	1.61816×10^{-6}

Table S10. Heavy-ion fusion potential energies on mutual orientations in the reactions plane calculations for $^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$, $^{26}\mathrm{Mg} + {}^{85}\mathrm{Rb}$, $^{30}\mathrm{Si} + {}^{81}\mathrm{Br}$, and $^{46}\mathrm{Ca} + {}^{65}\mathrm{Cu}$ reactions.

Reactions	Orientation [°]	Radius [fm]	Energy [MeV]
$^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the quadrupole vibrational state for the $^{37}\mathrm{Cl}$: $\mathrm{E}^* = 1.7266\ \mathrm{MeV};\ \beta_{2^+} = 0.1400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $\mathrm{E}^* = 0.5959\ \mathrm{MeV};\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework)	±95	11.29	65.5403
	±91.2	11.29	65.5269
	±87.4	11.29	65.5299
	±83.6	11.29	65.5495
	±79.8	11.29	65.5867
	±76	11.29	65.6434
	±72.2	11.29	65.7213
	±68.4	11.29	65.8215
	±64.6	11.29	65.944
	±60.8	11.29	66.0869
	±57	11.29	66.2462
	±53.2	11.29	66.4162
	±49.4	11.29	66.5895
	±45.6	11.29	66.7587
	±41.8	11.29	66.9165
	±38	11.29	67.0571
	±34.2	11.29	67.1768
	±30.4	11.29	67.2739
	±26.6	11.29	67.3489
	±22.8	11.29	67.4039
	±19	11.29	67.4420
	±15.2	11.29	67.4667
	±11.4	11.29	67.4816
	±7.6	11.29	67.4899
	±3.8	11.29	67.4938
	0	11.29	67.4950

$^{37}Cl + {}^{74}Ge$ (in the quadrupole vibrational state for the ^{37}Cl: $E^* = 3.0861\ MeV;\ \beta_{2^+} = 0.2400$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{74}Ge: $E^* = 0.5959\ MeV;\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework)	±95	11.29	65.8705
	±91.2	11.29	65.8593
	±87.4	11.29	65.8618
	±83.6	11.29	65.8781
	±79.8	11.29	65.9094
	±76	11.29	65.9571
	±72.2	11.29	66.0231
	±68.4	11.29	66.1084
	±64.6	11.29	66.2131
	±60.8	11.29	66.3358
	±57	11.29	66.4729
	±53.2	11.29	66.6194
	±49.4	11.29	66.7689
	±45.6	11.29	66.9147
	±41.8	11.29	67.0503
	±38	11.29	67.1707
	±34.2	11.29	67.2725
	±30.4	11.29	67.3543
	±26.6	11.29	67.4166
	±22.8	11.29	67.4612
	±19	11.29	67.4911
	±15.2	11.29	67.5096
	±11.4	11.29	67.5200
	±7.6	11.29	67.5252
	±3.8	11.29	67.5273
	0	11.29	67.5279
$^{37}Cl + {}^{74}Ge$ (in the octupole vibrational state for the ^{37}Cl: $E^* = 3.1035\ MeV;\ \beta_{3^-} = 0.3200$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{74}Ge: $E^* = 0.5959\ MeV;\ \beta_2 = -0.2370; \beta_4 = -0.0360$ framework)	±95	11.29	66.1312
	±91.2	11.29	66.1214
	±87.4	11.29	66.1236
	±83.6	11.29	66.1380
	±79.8	11.29	66.1655
	±76	11.29	66.2077
	±72.2	11.29	66.2662
	±68.4	11.29	66.3421
	±64.6	11.29	66.4356
	±60.8	11.29	66.5452
	±57	11.29	66.6677
	±53.2	11.29	66.7985
	±49.4	11.29	66.9318
	±45.6	11.29	67.0611
	±41.8	11.29	67.1808
	±38	11.29	67.2862

	±34.2	11.29	67.3742
	±30.4	11.29	67.4438
	±26.6	11.29	67.4955
	±22.8	11.29	67.5312
	±19	11.29	67.5539
	±15.2	11.29	67.5667
	±11.4	11.29	67.5728
	±7.6	11.29	67.5750
	±3.8	11.29	67.5754
	0	11.29	67.5754
$^{37}\mathrm{Cl} + {}^{74}\mathrm{Ge}$ (in the octupole vibrational state for the $^{37}\mathrm{Cl}$: $E^* = 4.0100$ MeV; $\beta_{3^-} = 0.3300$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{74}\mathrm{Ge}$: $E^* = 0.5959$ MeV; $\beta_2 = -0.2370; \beta_4 = -0.0360$ framework)	±95	11.15	66.2855
	±91.2	11.15	66.2722
	±87.4	11.15	66.2752
	±83.6	11.15	66.2947
	±79.8	11.15	66.3320
	±76	11.15	66.3887
	±72.2	11.15	66.4667
	±68.4	11.15	66.5673
	±64.6	11.15	66.6905
	±60.8	11.15	66.8344
	±57	11.15	66.9952
	±53.2	11.15	67.1671
	±49.4	11.15	67.3428
	±45.6	11.15	67.5145
	±41.8	11.15	67.6750
	±38	11.15	67.8184
	±34.2	11.15	67.9407
	±30.4	11.15	68.0401
	±26.6	11.15	68.1172
	±22.8	11.15	68.1738
	±19	11.15	68.2132
	±15.2	11.15	68.2388
	±11.4	11.15	68.2544
	±7.6	11.15	68.2631
	±3.8	11.15	68.2673
	0	11.15	68.2685
$^{26}\mathrm{Mg} + {}^{85}\mathrm{Rb}$ (in the quadrupole and hexadecapole rotational (deformed) state for the $^{26}\mathrm{Mg}$: $E^* = 1.8087$ MeV; $\beta_2 = -0.3510; \beta_4 = 0.1620$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{85}\mathrm{Rb}$: $E^* = 0.1512$ MeV; $\beta_2 = 0.0640; \beta_4 = -0.0100$ framework)	±95	10.77	55.7097
	±91.2	10.77	55.6201
	±87.4	10.77	55.6407
	±83.6	10.77	55.7684
	±79.8	10.77	55.9853
	±76	10.77	56.2629
	±72.2	10.77	56.5685

	±68.4	10.77	56.8721
	±64.6	10.77	57.1503
	±60.8	10.77	57.3882
	±57	10.77	57.5789
	±53.2	10.77	57.7212
	±49.4	10.77	57.8177
	±45.6	10.77	57.8727
	±41.8	10.77	57.8911
	±38	10.77	57.8777
	±34.2	10.77	57.8366
	±30.4	10.77	57.7721
	±26.6	10.77	57.6886
	±22.8	10.77	57.5910
	±19	10.77	57.4860
	±15.2	10.77	57.3812
	±11.4	10.77	57.2857
	±7.6	10.77	57.2087
	±3.8	10.77	57.1587
	0	10.77	57.1413
$^{30}Si + {}^{81}Br$ (in the quadrupole and hexadecapole rotational (deformed) state for the ^{30}Si: $E^* = 2.2353$ MeV; $\beta_2 = -0.2360; \beta_4 = 0.0400$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{81}Br: $E^* = 0.2760$ MeV; $\beta_2 = 0.1400; \beta_4 = -0.0300$ framework)	±95	10.44	62.7453
	±91.2	10.44	62.7378
	±87.4	10.44	62.7395
	±83.6	10.44	62.7503
	±79.8	10.44	62.7700
	±76	10.44	62.7982
	±72.2	10.44	62.8346
	±68.4	10.44	62.8784
	±64.6	10.44	62.9288
	±60.8	10.44	62.9851
	±57	10.44	63.0461
	±53.2	10.44	63.1107
	±49.4	10.44	63.1778
	±45.6	10.44	63.2462
	±41.8	10.44	63.3146
	±38	10.44	63.3817
	±34.2	10.44	63.4464
	±30.4	10.44	63.5075
	±26.6	10.44	63.5640
	±22.8	10.44	63.6149
	±19	10.44	63.6594
	±15.2	10.44	63.6968
	±11.4	10.44	63.7265
	±7.6	10.44	63.7480

	±3.8	10.44	63.7610
	0	10.44	63.7654
$^{46}Ca + {}^{65}Cu$ (in the quadrupole vibrational state for the ^{46}Ca: $E^* = 1.3460$ MeV; $\beta_{2^+} = 0.1468$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework)	±95	10.75	72.5203
	±91.2	10.75	72.5043
	±87.4	10.75	72.5079
	±83.6	10.75	72.5311
	±79.8	10.75	72.5731
	±76	10.75	72.6329
	±72.2	10.75	72.7087
	±68.4	10.75	72.7984
	±64.6	10.75	72.8994
	±60.8	10.75	73.0092
	±57	10.75	73.1245
	±53.2	10.75	73.2425
	±49.4	10.75	73.3603
	±45.6	10.75	73.4751
	±41.8	10.75	73.5846
	±38	10.75	73.6869
	±34.2	10.75	73.7805
	±30.4	10.75	73.8642
	±26.6	10.75	73.9376
	±22.8	10.75	74.0003
	±19	10.75	74.0525
	±15.2	10.75	74.0945
	±11.4	10.75	74.1265
	±7.6	10.75	74.1490
	±3.8	10.75	74.1624
	0	10.75	74.1668
$^{46}Ca + {}^{65}Cu$ (in the octupole vibrational state for the ^{46}Ca: $E^* = 3.6140$ MeV; $\beta_{3^-} = 0.2040$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework)	±95	10.75	72.5346
	±91.2	10.75	72.5155
	±87.4	10.75	72.5199
	±83.6	10.75	72.5475
	±79.8	10.75	72.5976
	±76	10.75	72.6689
	±72.2	10.75	72.7595
	±68.4	10.75	72.8669
	±64.6	10.75	72.9881
	±60.8	10.75	73.1200
	±57	10.75	73.2592
	±53.2	10.75	73.4019
	±49.4	10.75	73.5449
	±45.6	10.75	73.6848
	±41.8	10.75	73.8189

±38	10.75	73.9446
±34.2	10.75	74.0602
±30.4	10.75	74.1643
±26.6	10.75	74.2559
±22.8	10.75	74.3348
±19	10.75	74.4007
±15.2	10.75	74.4540
±11.4	10.75	74.4949
±7.6	10.75	74.5237
±3.8	10.75	74.5409
0	10.75	74.5466

Table S11. Heavy-ion fusion cross-section calculations for $^{26}\mathrm{Mg} + {}^{85}\mathrm{Rb}$ (in the quadrupole and hexadecapole rotational (deformed) state for the $^{26}\mathrm{Mg}$: $\mathrm{E}^{*} = 1.8087$ MeV; $\beta_2 = -0.3510; \beta_4 = 0.1620$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{85}\mathrm{Rb}$: $\mathrm{E}^{*} = 0.1512$ MeV; $\beta_2 = 0.0640; \beta_4 = -0.0100$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	50	2.826×10^{-5}	5.525×10^{-4}	6.90747×10^{-4}	0.00421	1.95343×10^{-4}
		50.5	8.519×10^{-4}	0.00155	0.00194	0.00982	
		51	2.504×10^{-4}	0.00423	0.00538	0.02289	0.00103
		51.5	7.242×10^{-4}	0.01132	0.01471	0.05332	
		52	0.00205	0.02966	0.03942	0.12393	0.00545
		52.5	0.00565	0.07569	0.10265	0.28656	
		53	0.01534	0.19	0.25816	0.65495	0.02877
		53.5	0.04083	0.466	0.62383	1.46013	
		54	0.106	1.109	1.44353	3.10476	0.15181
		54.5	0.27	2.561	3.19346	6.12541	
		55	0.677	5.649	6.71038	10.99507	0.79559
		55.5	1.644	11.52	13.17439	17.92387	
		56	3.868	21.31	23.64915	26.85896	4.02116
		56.5	8.66	35.32	38.25786	37.6262	
		57	17.75	52.6	56.00392	50.0692	17.42606
		57.5	32.53	71.91	75.61677	64.12879	
		58	52.71	92.15	96.13604	79.85916	51.77034
		58.5	76.39	112.6	117.05209	97.37302	
		59	101.8	133	138.23931	116.71366	101.58804
		59.5	127.9	153.8	159.81651	137.71835	
		60	154	175.4	182.06898	160.00323	155.16363
		60.5	179.8	198	205.119	183.09726	
		61	205.3	221.4	228.80079	206.58721	208.13232
		61.5	230.3	245.4	252.8437	230.18064	

		62	254.8	269.4	277.0254	253.70142	259.60887
		62.5	278.9	293.4	301.16713	277.05795	
		63	302.5	317	325.11173	300.2123	309.49105
		63.5	325.7	340.3	348.7898	323.15977	
		64	348.5	363.2	372.08839	345.91643	357.82169
		64.5	370.9	385.7	394.99726	368.50802	
		65	392.8	407.8	417.52193	390.9556	404.66656
		65.5	414.3	429.6	439.58936	413.26093	
		66	435.4	450.9	461.29867	435.40364	450.09214
		66.5	456.1	471.9	482.48695	457.3529	
		67	476.5	492.5	503.38123	479.08119	494.16177
		67.5	496.5	512.7	524.1007	500.57135	
		68	516.2	532.6	543.8172	521.81749	536.93525
		68.5	535.5	552.1	563.6717	542.82288	
		69	554.5	571.3	583.45626	563.59647	578.46892
		69.5	573.1	590.1	601.89532	584.14789	
		70	591.4	608.6	620.71372	604.48123	618.81591

Table S12. Heavy-ion fusion barrier-distributions calculations for $^{26}Mg + {}^{85}Rb$ (in the quadrupole and hexadecapole rotational (deformed) state for the ^{26}Mg: $E^* = 1.8087$ MeV; $\beta_2 = -0.3510; \beta_4 = 0.1620$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{85}Rb: $E^* = 0.1512$ MeV; $\beta_2 = 0.0640; \beta_4 = -0.0100$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	50	0.00446	0.06546	0.02769
		50.5	0.01781	0.243	
		51	0.05345	0.829	0.14909
		51.5	0.128	2.389	
		52	0.37	5.296	0.80269
		52.5	1.322	8.903	
		53	3.769	20.85	4.31728
		53.5	6.301	74.56	
		54	7.398	212.2	23.09621
		54.5	30.25	430.6	
		55	138.6	666.1	120.07608
		55.5	377.4	834.2	
		56	700.2	870.5	540.35958
		56.5	994.6	761.8	
		57	1154	559.2	1360.7429
		57.5	1120	346.5	
		58	911.5	195.8	1003.23138

		58.5	621.4	141.5	
		59	351.7	169.1	279.99945
		59.5	156.3	230.3	
		60	42.76	274.2	56.64895
		60.5	-9.106	270.5	
		61	-25.92	220.4	10.69269
		61.5	-27.15	148.4	
		62	-23.3	81.04	1.99165
		62.5	-19.26	32.34	
		63	-17.17	4.087	0.37005
		63.5	-17.3	-9.015	
		64	-18.68	-13.78	0.06872
		64.5	-19.82	-14.73	
		65	-19.43	-14.49	0.01276
		65.5	-17.95	-14.79	
		66	-17	-15.75	0.00237
		66.5	-17.06	-16.97	
		67	-16.87	-17.88	4.40071×10^{-4}
		67.5	-16.27	-18.17	
		68	-12.45	-14.67	8.17194×10^{-5}
		68.5	2.082	0.184	
		69	-60.29	-57.69	1.51749×10^{-5}
		69.5	-63.55	-59.63	
		70	28.66	28.92	2.81792×10^{-6}

Table S13. Heavy-ion fusion cross-section calculations for $^{30}\mathrm{Si} + {}^{81}\mathrm{Br}$ (in the quadrupole and hexadecapole rotational (deformed) state for the ^{30}Si: $\mathrm{E}^* = 2.2353$ MeV; $\beta_2 = -0.2360; \beta_4 = 0.0400$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{81}Br: $\mathrm{E}^* = 0.2760$ MeV; $\beta_2 = 0.1400; \beta_4 = -0.0300$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	55	6.389×10^{-6}	8.787×10^{-5}	1.04862×10^{-4}	5.2762×10^{-4}	5.22663×10^{-5}
		55.5	1.939×10^{-5}	2.495×10^{-4}	2.89813×10^{-4}	0.00123	
		56	5.81×10^{-5}	6.976×10^{-4}	7.93524×10^{-4}	0.00289	2.81527×10^{-4}
		56.5	1.706×10^{-4}	0.00191	0.00216	0.00676	
		57	4.886×10^{-4}	0.0051	0.00582	0.01583	0.00152
		57.5	0.00138	0.01344	0.01558	0.037	
		58	0.00383	0.03478	0.0412	0.0863	0.00817
		58.5	0.01036	0.08793	0.10679	0.20027	
		59	0.02761	0.219	0.26932	0.45929	0.04405
		59.5	0.07247	0.534	0.65476	1.02749	

		60	0.185	1.26	1.52012	2.19509	0.23688
		60.5	0.466	2.854	3.34162	4.37123	
		61	1.154	6.089	6.86916	7.99396	1.25812
		61.5	2.753	11.81	12.97904	13.43801	
		62	6.288	20.63	22.26098	20.99764	6.27406
		62.5	13.4	32.76	34.69386	30.89193	
		63	25.52	47.82	49.81914	43.22489	24.75762
		63.5	42.84	65.32	67.08308	57.92752	
		64	64.08	84.75	86.04833	74.75715	63.09575
		64.5	87.28	105.4	106.40329	93.36505	
		65	111.2	126.8	127.83205	113.38059	111.3388
		65.5	135.4	148.7	149.98814	134.46066	
		66	159.4	171	172.53047	156.29328	161.00367
		66.5	183	193.3	195.22928	178.58782	
		67	206.4	215.6	217.95512	201.08934	209.74937
		67.5	229.3	238	240.60306	223.61029	
		68	251.8	260.2	263.12823	246.04004	257.16423
		68.5	274	282.2	285.47711	268.32365	
		69	295.7	304	307.59137	290.43409	303.22328
		69.5	317.1	325.5	329.43232	312.35475	
		70	338.1	346.6	350.93916	334.0736	347.96969
		70.5	358.7	367.4	372.14583	355.58299	
		71	379	387.9	392.97092	376.87929	391.45624
		71.5	399	408.1	413.47094	397.96042	-
		72	418.6	427.9	433.63575	418.82372	433.73494
		72.5	437.9	447.3	453.43798	439.46671	
		73	456.8	466.5	473.06106	459.88874	474.85534
		73.5	475.5	485.4	492.10743	480.09069	
		74	493.9	503.9	511.11595	500.07302	514.86438
		74.5	511.9	522.1	529.56041	519.83466	
		75	529.7	540	547.84901	539.37339	553.80651

Table S14. Heavy-ion fusion barrier-distributions calculations for $^{30}\mathrm{Si} + {}^{81}\mathrm{Br}$ (in the quadrupole and hexadecapole rotational (deformed) state for the $^{30}\mathrm{Si}$: $\mathrm{E}^{*} = 2.2353$ MeV; $\beta_2 = -0.2360; \beta_4 = 0.0400$ and the quadrupole and hexadecapole rotational (deformed) state of the $^{81}\mathrm{Br}$: $\mathrm{E}^{*} = 0.2760$ MeV; $\beta_2 = 0.1400; \beta_4 = -0.0300$ framework) reaction.

Exp.		Energy [MeV]	$\mathrm{d}^2(\mathrm{E}\sigma)/\mathrm{dE}^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$\mathrm{d}^2(\mathrm{E}\sigma)/\mathrm{dE}^2$ [mb / MeV]	55	0.00103	0.01378	0.00833

		55.5	0.00422	0.0481	
		56	0.0146	0.14	0.04566
		56.5	0.04094	0.382	
		57	0.09987	1.115	0.25042
		57.5	0.259	2.908	
		58	0.906	6.01	1.37284
		58.5	2.933	11.9	
		59	5.743	33.65	7.51331
		59.5	6.186	102.7	
		60	17.24	242.7	40.73414
		60.5	94.79	434.5	
		61	300.3	624.6	209.97927
		61.5	615.8	762.2	
		62	935.9	817.1	845.17429
		62.5	1143	785.4	
		63	1163	688.8	1453.18703
		63.5	991.8	557.2	
		64	705.8	419.9	683.96304
		64.5	417.1	303.7	
		65	198.6	218.8	157.66169
		65.5	65.32	159.3	
		66	0.189	119.7	30.09717
		66.5	-22.9	94.21	
		67	-26.57	74.17	5.53457
		67.5	-24.05	55.38	
		68	-20.93	37.81	1.01072
		68.5	-18.89	21.33	
		69	-18.04	6.673	0.18434
		69.5	-17.77	-4.256	
		70	-17.73	-10.82	0.03361
		70.5	-18.22	-14.25	
		71	-18.87	-16.35	0.00613
		71.5	-18.42	-18	
		72	-15.94	-17.74	0.00112
		72.5	-13.66	-15.97	
		73	-10.05	-11.53	2.03779×10^{-4}
		73.5	4.534	4.069	
		74	-68.11	-61.79	3.71566×10^{-5}
		74.5	-72.49	-65.29	
		75	32.55	32.64	6.77503×10^{-6}

Table S15. Heavy-ion fusion cross-section calculations for $^{46}Ca + {}^{65}Cu$ (in the quadrupole vibrational state for the ^{46}Ca: $E^* = 1.3460$ MeV; $\beta_{2^+} = 0.1468$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	65	9.247×10^{-7}	1.144×10^{-6}	9.34205×10^{-6}	7.0829×10^{-5}	7.93827×10^{-6}
		65.5	2.911×10^{-6}	3.588×10^{-6}	2.64889×10^{-5}	1.72025×10^{-4}	
		66	9.076×10^{-6}	1.112×10^{-5}	7.36098×10^{-5}	4.17833×10^{-4}	4.67868×10^{-5}
		66.5	2.756×10^{-5}	3.35×10^{-5}	2.02227×10^{-4}	0.00101	
		67	8.231×10^{-5}	9.887×10^{-5}	5.53035×10^{-4}	0.00247	2.75816×10^{-4}
		67.5	2.437×10^{-4}	2.887×10^{-4}	0.00151	0.00599	
		68	7.028×10^{-4}	8.191×10^{-4}	0.00415	0.01453	0.00163
		68.5	0.00199	0.00227	0.01141	0.03522	
		69	0.00559	0.00625	0.0312	0.08502	0.00959
		69.5	0.01531	0.01677	0.08419	0.2034	
		70	0.04117	0.04419	0.22132	0.47695	0.05653
		70.5	0.11	0.116	0.55934	1.07552	
		71	0.288	0.298	1.34311	2.27764	0.33186
		71.5	0.736	0.745	3.0362	4.45172	
		72	1.858	1.821	6.40348	8.00529	1.90242
		72.5	4.466	4.195	12.4095	13.35016	
		73	9.971	8.855	21.73814	20.88373	9.66831
		73.5	20.03	16.78	34.31923	30.93262	
		74	34.85	27.99	49.61964	43.62228	33.93025
		74.5	53.26	41.86	67.0936	58.76439	
		75	73.74	58	86.10597	75.91704	73.48371
		75.5	94.97	75.75	105.98409	94.56255	
		76	116.4	94.42	126.26688	114.23071	117.50586
		76.5	137.7	113.7	146.73534	134.53312	
		77	158.7	133.1	167.29636	155.16244	161.48408
		77.5	179.5	152.7	187.90051	175.89388	
		78	200	172.4	208.49639	196.58679	204.52262
		78.5	220.1	192.1	229.00936	217.17024	
		79	240	211.6	249.35406	237.61556	246.50278
		79.5	259.6	230.9	269.46777	257.91015	
		80	278.9	249.9	289.30045	278.04228	287.43859
		80.5	297.8	268.7	308.87224	297.99871	
		81	316.5	287.3	328.15885	317.76784	327.36449
		81.5	334.9	305.6	347.173	337.34161	
		82	353	323.6	365.88653	356.71528	366.31673
		82.5	370.9	341.3	384.35417	375.88682	

		83	388.4	358.8	402.49572	394.85694	404.33038
		83.5	405.7	376	420.44132	413.62872	
		84	422.7	393	438.04143	432.20606	441.43895
		84.5	439.6	409.8	455.48662	450.59137	
		85	456.2	426.2	472.54715	468.78465	477.67438

Table S16. Heavy-ion fusion barrier-distributions calculations for $^{46}Ca + {}^{65}Cu$ (in the quadrupole vibrational state for the ^{46}Ca: $E^* = 1.3460$ MeV; $\beta_{2^+} = 0.1468$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	65	1.902×10^{-4}	2.387×10^{-4}	0.00165
		65.5	7.009×10^{-4}	9.018×10^{-4}	
		66	0.00255	0.00316	0.00988
		66.5	0.00877	0.01012	
		67	0.02547	0.02852	0.05916
		67.5	0.0595	0.07145	
		68	0.147	0.192	0.35398
		68.5	0.547	0.619	
		69	2.091	1.944	2.11722
		69.5	4.706	4.311	
		70	3.861	6.257	12.62815
		70.5	5.916	15.98	
		71	65.45	71.62	74.08258
		71.5	258.6	218.7	
		72	582.9	450.4	395.08845
		72.5	932.6	697.5	
		73	1175	875	1326.47497
		73.5	1219	930.5	
		74	1058	869.3	1268.05218
		74.5	766.5	732.3	
		75	458.6	561.2	359.77983
		75.5	218.2	393.7	
		76	70.27	259.8	66.70328
		76.5	-2.347	168.8	
		77	-27.2	114.3	11.34738
		77.5	-28.78	81.96	
		78	-23.9	57.27	1.90184
		78.5	-20.39	34.84	
		79	-19.59	16.14	0.31795

		79.5	-19.78	2.785	
		80	-19.01	-5.018	0.05313
		80.5	-16.86	-9.563	
		81	-15.18	-14.19	0.00888
		81.5	-16.06	-18.86	
		82	-18.86	-19.87	0.00148
		82.5	-20.8	-16.69	
		83	-17.52	-9.749	2.4791×10^{-4}
		83.5	-6.044	6.202	
		84	-29.17	-60.97	4.14253×10^{-5}
		84.5	-28.64	-65.65	
		85	12.77	31.48	6.9221×10^{-6}

Table S17. Heavy-ion fusion cross-section calculations for $^{46}Ca + {}^{65}Cu$ (in the octupole vibrational state for the ^{46}Ca: $E^* = 3.6140$ MeV; $\beta_{3^-} = 0.2040$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework) reaction.

Exp.		Energy [MeV]	σ_{fus} [mb]				
			No Excitations	NRV	CCFULL	CCDEF	Wong's Formula
Energy [MeV]	σ_{fus} [mb]	65	9.247×10^{-7}	1.19×10^{-6}	2.60953×10^{-5}	2.72024×10^{-4}	7.93827×10^{-6}
		65.5	2.911×10^{-6}	3.818×10^{-6}	7.00649×10^{-5}	6.65173×10^{-4}	
		66	9.076×10^{-6}	1.208×10^{-5}	1.8768×10^{-4}	0.00163	4.67868×10^{-5}
		66.5	2.756×10^{-5}	3.712×10^{-5}	5.05757×10^{-4}	0.00398	
		67	8.231×10^{-5}	1.118×10^{-4}	0.00138	0.00972	2.75816×10^{-4}
		67.5	2.437×10^{-4}	3.334×10^{-4}	0.00381	0.02371	
		68	7.028×10^{-4}	9.66×10^{-4}	0.01065	0.05762	0.00163
		68.5	0.00199	0.00274	0.02982	0.1388	
		69	0.00559	0.00768	0.0825	0.32765	0.00959
		69.5	0.01531	0.02094	0.22057	0.74322	
		70	0.04117	0.05587	0.55818	1.58003	0.05653
		70.5	0.11	0.148	1.32211	3.08984	
		71	0.288	0.381	2.93509	5.53725	0.33186
		71.5	0.736	0.957	6.14033	9.17022	
		72	1.858	2.349	12.09671	14.21882	1.90242
		72.5	4.466	5.448	22.14205	20.90695	
		73	9.971	11.61	36.85969	29.45954	9.66831
		73.5	20.03	22.17	55.29799	40.08291	
		74	34.85	36.99	75.67716	52.88931	33.93025
		74.5	53.26	54.68	96.64641	67.78911	
		75	73.74	73.95	117.66273	84.47262	73.48371
		75.5	94.97	93.74	138.70121	102.52477	
		76	116.4	113.6	159.88516	121.546	117.50586
		76.5	137.7	133.5	181.22721	141.19952	

		77	158.7	153.6	202.61598	161.21388	161.48408
		77.5	179.5	173.7	223.91725	181.38191	
		78	200	193.8	245.06588	201.56457	204.52262
		78.5	220.1	213.8	265.98046	221.6866	
		79	240	233.6	286.59609	241.71834	246.50278
		79.5	259.6	253.1	306.9603	261.65305	
		80	278.9	272.3	327.07762	281.48735	287.43859
		80.5	297.8	291.2	346.81343	301.21081	
		81	316.5	309.8	366.39261	320.807	327.36449
		81.5	334.9	328.2	385.49234	340.25929	
		82	353	346.3	404.43581	359.55404	366.31673
		82.5	370.9	364.2	422.91374	378.68125	
		83	388.4	381.8	441.29243	397.63453	404.33038
		83.5	405.7	399.1	459.03337	416.41145	
		84	422.7	416.2	476.91751	435.01292	441.43895
		84.5	439.6	433	493.86638	453.4407	
		85	456.2	449.6	511.3725	471.69432	477.67438

Table S18. Heavy-ion fusion barrier-distributions calculations for $^{46}Ca + {}^{65}Cu$ (in the octupole vibrational state for the ^{46}Ca: $E^* = 3.6140$ MeV; $\beta_{3^-} = 0.2040$ and the quadrupole and hexadecapole rotational (deformed) state of the ^{65}Cu: $E^* = 1.4818$ MeV; $\beta_2 = -0.1250; \beta_4 = -0.0050$ framework) reaction.

Exp.		Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]		
			No Excitations	NRV	Wong's Formula
Energy [MeV]	$d^2(E\sigma)/dE^2$ [mb / MeV]	65	1.902×10^{-4}	2.481×10^{-4}	0.00165
		65.5	7.009×10^{-4}	9.556×10^{-4}	
		66	0.00255	0.00357	0.00988
		66.5	0.00877	0.01199	
		67	0.02547	0.03337	0.05916
		67.5	0.0595	0.07911	
		68	0.147	0.222	0.35398
		68.5	0.547	0.832	
		69	2.091	2.728	2.11722
		69.5	4.706	5.187	
		70	3.861	4.835	12.62815
		70.5	5.916	16.59	
		71	65.45	100	74.08258
		71.5	258.6	312.7	
		72	582.9	626.6	395.08845
		72.5	932.6	933.6	
		73	1175	1117	1326.47497
		73.5	1219	1106	

		74	1058	912.3	1268.05218
		74.5	766.5	627.2	
		75	458.6	361.5	359.77983
		75.5	218.2	183.7	
		76	70.27	100.5	66.70328
		76.5	-2.347	75.15	
		77	-27.2	67.7	11.34738
		77.5	-28.78	57.14	
		78	-23.9	39.13	1.90184
		78.5	-20.39	18.5	
		79	-19.59	0.657	0.31795
		79.5	-19.78	-11.84	
		80	-19.01	-17.7	0.05313
		80.5	-16.86	-17.25	
		81	-15.18	-13.51	0.00888
		81.5	-16.06	-11.34	
		82	-18.86	-13.58	0.00148
		82.5	-20.8	-18.1	
		83	-17.52	-18.98	2.4791×10^{-4}
		83.5	-6.044	-11.83	
		84	-29.17	-22.32	4.14253×10^{-5}
		84.5	-28.64	-18.26	
		85	12.77	8.328	6.9221×10^{-6}