Precise tetraquark masses from hypersphere surface volume (HSSV) factoring

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Abstract

The factoring of tetraquark masses with hypersphere surface volumes has two major benefits: the determination of tetraquark masses to a high degree of accuracy (8 digits), and, insight into their structure. This paper will explain the factoring technique, and the theory behind it, and give numerous factoring examples. A major part of the paper is devoted to displaying over 100 meson (tetraquark) factorings in a six page long mass spectrum (or factoring spectrum) where the masses calculated from factorings are compared with experimental masses.

Contents

1. Introduction

Hypersphere surface volume factoring is a powerful and relatively simple technique for determining the masses of mesons to high precision (to the precision of Planck's constant, which is about 8 digits), and for theoretically probing their structure. It is based on the theory, basically, that quarks are not particles in 3D space, but hypersphere surfaces of various dimensions filled with energy. And mesons are not composed of *two quark particles* orbiting one another in 3D space, but rather they are constructed of *two intersecting hypersphere surfaces of energy*. (And tetraquarks are not *four quark particles* orbiting one another in 3D space, but *four intersecting hypersphere surfaces of energy*.) They have a 3D part, obviously, but it is connected to their higher dimensional parts, and all parts should be considered together in order to understand them fully. This seemingly simple theory gives theorists an easy way to calculate the masses of mesons very accurately (to 8 digits), and provides insights into their structure.

One may immediately object to this theory on the grounds that space is 3D, and hyperspheres are higher dimensional, so cannot possibly exist in our 3D space. That is correct. They do not exist in our 3D space - entirely. The higher dimensional parts of a meson's structure reside in the n-space that is immediately adjacent to our 3D space. What we experience of mesons is the intersection of their higher dimensional components with our 3D space. Just like 2D space (a plane) has zero thickness in the third dimensional direction, our 3D space has zero thickness in the fourth (and higher) dimensional directions, so every point in our 3D space is immediately adjacent to higher dimensional space. The main assumption of the theory is that the 'quark material' of which particles are made, can *move around in,* or, *orbit in* higher dimensional space, but the particles (the mesons, the baryons, and, maybe the leptons) they make cannot. The purpose of this paper is to disseminate evidence supporting belief in the validity of this new theory of particle structure.

2. Tetraquark Structure

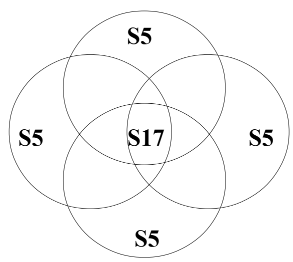
(cccc = $(S5)^4 \sim$ S17)

According to quark theory, a cccc tetraquark, is constructed of four quarks orbiting one another in 3D space. According to hypersphere theory, a cccc tetraquark is constructed of four energy filled 5-sphere surfaces that all intersect one another, and, the surface of the universe's hypersphere.

Since 5-spheres are five dimensional, that means part of a tetraquark's structure protrudes out into 5 dimensional space. That is possible because the surface of the universe's hypersphere (the 3D 'space' we live in) has zero thickness in the fourth, and higher, dimensional directions, so every point in our 3D space is immediately adjacent to "higher dimensional space". Higher dimensional space was put in quotation marks because there is no higher dimensional space for us. We are made of matter that has been hadronized (particlized) and hadronized particles can only move around with three degrees of dimensional freedom of movement (can only move around as if in 3D space) as if they were somehow 'attached' to the surface of the universe's hypersphere (which might be just a location, or it might be a physical thing). The quark material, the 5D matter that the 5-spheres are made of, however, can move around in 5D space, but for whatever reason, doesn't travel far into 5D space. It stays very close to the surface of the universe's hypersphere's surface, orbiting within the surface of a tiny 5-sphere, which intersects other identical tiny 5-spheres, formimg diquarks, triquarks, tetraquarks, etc. and each group also intersects the universe's hypersphere's surface, presumably with half their mass on one side and half on the other side of it.

An abstract representation of the intersection of four 5-spheres is shown below, using circles to represent the 5-sphere surfaces. The abstract representation shown below is just that, an abstract representation. How the 5-spheres are arranged in 5-space, the degree to which they intersect, and other details about their intersection in 5D space is unknown. The size (or 'type') of the 'intersection' of the four 5-spheres, for purposes of factoring, is found by *raising* the equation for the surface volume of a single unit radius 5-sphere (S5) *to the 4th power*. The resulting expression, (4096 / 81) ($\boldsymbol{\pi}^8$ $\mathbf{r}^{16}$), has the same $\boldsymbol{\pi}$ power and **r** power in it as the expression for the surface volume of a 17-sphere (S17) does. The only difference between the two expressions is a difference of their constants of multiplication. The cccc intersection expression is 200200 times bigger than the expression for the surface volume of a 17-sphere (S17).

S5 = 8/3 $\boldsymbol{\pi}^2$ $\mathbf{r}^4$



$(\mathbf{S5})^4$ = (4096 / 81) ($\boldsymbol{\pi}^8$ $\mathbf{r}^{16}$)

Intersection Volume Equation of cccc Tetraquarks

Quark Theory Name	HSSV Theory Name		Intersection Volume Eqtn		Equivalent HSS Vol Eqtn
cccc	$\mathbf{(S5)^4}$	=	4096/81 $\boldsymbol{\pi}^8\mathbf{r}^{16}$	=	200200 **S17**

Any cccc tetraquark can be factored with unit radius expressions of $(\mathbf{S5})^4$h or **S17**h. (h = 6.62607015 is a conversion factor that converts hypersphere surface volume to MeV/c^2.) Throughout this paper $(\mathbf{S5})^4$h, with appropriate divisors, will be used to factor tetraquarks. Its value is given below.

cccc Tetraquark's Basic Unit of Factorization = $(\mathbf{S5})^4$h = 3179288.507 MeV/c^2

Since the basic unit of factorization above is hundreds of times larger than the average meson's mass, it should be divided by at least 1000 to reduce it to an optimal size for factoring. By trial and error you will find that most mesons also need a divisor of a power of seven to get rid of power of seven fractions in the factoring results. The most numerous category of tetraquarks seems to be those that factor with divisors of the *basic unit of factorization* that are powers of 7. The second most numerous group of tetraquarks are those that factor with divisors of the *basic unit of factorization* that are powers of 7 and 3 multiplied together. One tetraquark (Ds*+) has been found that factors unequivocally with a divisor of 11 (and 2, 5, and 7). Its factoring can be found in the section 'Some cs Mesons Factored as Tetraquarks'.

Some Mesons Factored with $(S5)^4$ h/ $7^2$1000

$(S5)^4$ h/ 49000 = 64.88343891 Mev/c^2

In the table below are some tetraquarks that have been factored with a unit of factorization generated by dividing the *basic unit of factorization* by $7^2$1000, which when totally factored is $7^2 5^3 2^3$. This unit of factorization is still rather large. It is 64.88343891 Mev/c^2, yet , as can be seen displayed in the table below, seven tetraquarks factor to small integer multiples of it over a rather narrow mass range, which suggests the correlation is unlikely to be due entirely to chance.

Factoring		Thr Mass	Exp Mass	+/-	TM-EM	Meson	Source
56.	**$(S5)^4$ h** / 49000 =	3633.4725	3633.6	1.7 /0.6	.13	**nc**(2S)	[1]
60.	**$(S5)^4$ h** / 49000 =	3893.0063	3893.0	2.3 / 19.9	.006	**Zc**(3900)o	[5]
62.	**$(S5)^4$ h** / 49000 =	4022.7732	4022.9	0.8 / 2.7	.13	**X**(4020)	[1]
64.	**$(S5)^4$ h** / 49000 =	4152.5400	4152.5	1.7 / 6.2	.04	**Xc1**(4140)	[1]
67.	**$(S5)^4$ h** / 49000 =	4347.1904	4347	6 / 3	.19	**Xc1**(4140)	[1]
68.	**$(S5)^4$ h** / 49000 =	4412.0738	4412	15	.07	**Ψ**(4415)	[1]
90.	**$(S5)^4$ h** / 49000 =	5839.5095	5839.6	1.1 / 0.7	.10	**Bs2***(5840)o	[1]

Notice that these mesons all factor to *integer multiples* of the unit of factorization, $(S5)^4$ h/ 49000. This, according to the theme of the paper, is evidence that their underlying structure is that of the structure proposed above for cccc tetraquarks, which is the intersection of four 5-sphere energy filled surfaces. What the factorings mean exactly in terms of structure is currently unknown. Factoring is just a first step toward understanding the structure of mesons. The hope is that correlation studies between the way mesons are factored and their other known properties will reveal more about their structure, or at least, suggest new avenues of investigation.

3. Tetraquark mass spectrum - Overview

A mass spectrum (or factoring spectrum) of tetraquarks of divisor types 7^1, 7^2, and 7^3, which seem to be the most numerous types of tetraquarks, is presented below. It shows that there are not only tetraquarks among the cc mesons (the charmoniums), but also among the light unflavored mesons, the c mesons, the cs mesons, the bs mesons, and the bb mesons (the bottomoniums). Even some baryons factor as cccc tetraquarks. (The Lambda baryon factors as a divisor type 7^7 cccc tetraquark.) Other mesons that factor as tetraquarks, but with other divisors, such as $7^2 3^4$, are not shown in the table below.

Notice that most of the factorings in the table below involve *integer* multipliers of the unit of factorization or an *integer and a half* multiplier. Also notice that the difference between the theoretical and experimental mass for almost every tetraquark factored is less than .5 MeV. Many are less than .1 MeV. Consider that together with the fact that the size of the unit of factorization is approximately 9.26 MeV, and it can be seen that it is highly unlikely that the good correlation between theoretical and experimental masses is due entirely to chance.

4. Tetraquark mass spectrum specified by $(S5)^4\, h/\, 7^3 1000$ factoring

UoF = Unit of Factorization = $(S5)^4\, h/7^3 1000$ = 9.269062702 MeV/c^2

973 MeV **- 11030** MeV

Factoring			Thr Mass	Exp Mass	+/-	Meson	TM-EM	Source
105	UoF	=	973.251584					
105.5	UoF	=	977.886115					
106	**UoF**	**=**	**982.520646**	**982.5**	**1.6/1.1**	**ao(980)**	.02	
106.5	UoF	=	987.155178					
107	UoF	=	991.789709					
107.5	UoF	=	996.424240					
108	UoF	=	1001.05877					
108.5	UoF	=	1005.69330					
109	UoF	=	1010.32783					
109.5	UoF	=	1014.96237					
110	UoF	=	1019.59690					
110.5	UoF	=	1024.23143					
111	UoF	=	1028.86596					
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125	UoF	=	1158.63284					
125.5	UoF	=	1163.26737					
126	**UoF**	**=**	**1167.90190**	**1168**	**4**	**h1(1170)**	**.1**	
126.5	UoF	=	1172.53643					
127	UoF	=	1177.17096					
127.5	UoF	=	1181.80549					
128	UoF	=	1186.44003					
128.5	UoF	=	1191.07456					
129	**UoF**	**=**	**1195.70909**	**1196**	**4/5**	**a1(1260)**	**.3**	
129.5	UoF	=	1200.34362					
130	UoF	=	1204.97815					
130.25	**UoF**	**=**	**1207.29542**	**1207**	**5/8**	**a1(1260)**	**.3**	
130.50	**UoF**	**=**	**1209.61268**	**1210**	**7/2**	**a1(1260)**	**.4**	
131	UoF	=	1214.24721					
131.5	UoF	=	1218.88175					
132	UoF	=	1223.51628					
132.5	UoF	=	1228.15081					
133	UoF	=	1232.78534					
133.5	UoF	=	1237.41987					
134	UoF	=	1242.05440					
134.5	UoF	=	1246.68893					
135	**UoF**	**=**	**1251.32346**	**1251**	**8**	**b1(1235)**	**.3**	
135.5	UoF	=	1255.95800					
136	UoF	=	1260.59253					
136.5	**UoF**	**=**	**1265.22706**	**1265**	**8**	**f1(1270)**	**.2**	
137	**UoF**	**=**	**1269.86159**	**1269.7**	**5.2**	**f1(1270)**	**.2**	
137.25	**UoF**	**=**	**1272.17886**	**1272**	**4**	**f1(1270)**	**.2**	
137.5	UoF	=	1274.49612					
137.75	**UoF**	**=**	**1276.81339**	**1277**	**4**	**f1(1270)**	**.2**	
138	**UoF**	**=**	**1279.13065**	**1279**	**5**	**f1(1270)**	**.1**	
138.5	UoF	=	1283.76518					
138.75	**UoF**	**=**	**1286.08245**	**1286**	**1**	**f1(1270)**	**.08**	
139	**UoF**	**=**	**1288.39972**	**1288**	**4/5**	**f1(1285**	.4	
139.5	UoF	=	1293.03425					
140	**UoF**	**=**	**1297.66878**					
140.5	**UoF**	**=**	**1302.30331**	**1302**	**9/8**	**η**(1295)	.3	
141	UoF	=	1306.93784					
141.5	UoF	=	1311.57237					
142	UoF	=	1316.20690					
142.5	UoF	=	1320.84144					
143	UoF	=	1325.47597					
143.5	UoF	=	1330.11050					
144	UoF	=	1334.74503					
144.5	UoF	=	1339.37956					
145	**UoF**	**=**	**1344.01409**					
145.5	UoF	=	1348.64862					
146	UoF	=	1353.28315					
146.5	UoF	=	1357.91769					
147	UoF	=	1362.55222					
147.5	UoF	=	1367.18675					

148	UoF	=	1371.82128				
148.5	UoF	=	1376.45581				
149	**UoF**	**=**	**1381.09034**				
149.5	UoF	=	1385.72487				
149.75	**UoF**	**=**	**1388.04214**	**1388**	**4**	**η(1405)**	**.04**
150	UoF	=	1390.35941				
150.5	**UoF**	**=**	**1394.99394**				
151	**UoF**	**=**	**1399.62847**				
151.5	**UoF**	**=**	**1404.26300**	**1404**	**6**	**η**(1405)	.3
152	**UoF**	**=**	**1408.89753**	**1409.0**	**1.7**	**η**(1405)	.1
152.5	**UoF**	**=**	**1413.53206**				
153	UoF	=	1418.16659				
153.5	**UoF**	**=**	**1422.80112**	**1423**	**2.1/7.3**	**h_1(1415)**	**.2**
154	UoF	=	1427.43566				
154.5	UoF	=	1432.07019				
155	UoF	=	1436.70472				
155.25	**UoF**	**=**	**1439.02198**	**1439**	**5/6**	**f_2(1430)**	**.02**
155.5	UoF	=	1441.33925				
156	**UoF**	**=**	**1445.97378**	**1446**	**5**	**f_o(1500)**	**.03**
156.5	UoF	=	1450.60831				
157	UoF	=	1455.24284				
157.5	**UoF**	**=**	**1459.87738**	**1460**	**10**	**η(1475)**	**.1**
158	**UoF**	**=**	**1464.51191**	**1464**	**10**	**η(1475)**	**.5**
158.5	**UoF**	**=**	**1469.14644**	**1469**	**14/13**	**η(1475)**	**.1**
159	UoF	=	1473.78097				
159.5	**UoF**	**=**	**1478.41550**	**1478**	**6**	**f_o(1500)**	**.4**
160	UoF	=	1483.05003				
160.5	UoF	=	1487.68456				
161	UoF	=	1492.31910				
161.5	**UoF**	**=**	**1496.95363**	**1497**	**10**	**f_o(1500)**	**.05**
162	**UoF**	**=**	**1501.58816**	**1502**	**10**	**f_o(1500)**	**.4**
162.5	UoF	=	1506.22269				
163	**UoF**	**=**	**1510.85722**	**1511**	**9**	**f_o(1500)**	**.1**
163.5	**UoF**	**=**	**1515.49175**	**1515**	**12**	**f_o(1500)**	**.5**
164	**UoF**	**=**	**1520.12628**	**1520**	**25**	**f_o(1500)**	**.1**
164.5	**UoF**	**=**	**1524.76081**	**1525**	**5**	**f_o(1500)**	**.2**
165	UoF	=	1529.39535				
165.5	UoF	=	1534.02988				
166	**UoF**	**=**	**1538.66441**	**1539**	**20**	**f_o(1500)**	**.3**
166.5	UoF	=	1543.29894				
167	UoF	=	1547.93347				
167.5	UoF	=	1552.56800				
168	UoF	=	1557.20253				
168.5	UoF	=	1561.83707				
169	UoF	=	1566.47160				
169.5	UoF	=	1571.10613				
170	UoF	=	1575.74066				
170.5	UoF	=	1580.37519				
171	UoF	=	1585.00972				
171.5	UoF	=	1589.64425				
172	**UoF**	**=**	**1594.27878**	**1594**	**15**	**h_1(1595)**	**.3**
172.5	UoF	=	1598.91332				
173	UoF	=	1603.54785				
173.5	UoF	=	1608.18238				
174	**UoF**	**=**	**1612.81691**	**1613**	**8**	**η_2(1645)**	**.2**
174.5	**UoF**	**=**	**1617.45144**	**1617**	**8**	**η_2(1645)**	**.5**
174.75	**UoF**	**=**	**1619.76871**	**1620**	**20**	**η_2(1645)**	**.2**
175	UoF	=	1622.08597				
175.5	UoF	=	1626.72050				
176	UoF	=	1631.35504				
176.5	UoF	=	1635.98957				
177	**UoF**	**=**	**1640.62410**	**1640**	**5**	**f_2(1640)**	**.6**
177.25	**UoF**	**=**	**1642.94136**	**1643**	**7**	**f_2(1640)**	**.06**
177.5	UoF	=	1645.25863				
178	**UoF**	**=**	**1649.89316**	**1650**	**12**	**ω_3(1670)**	**.1**
178.5	UoF	=	1654.52769				
179	**UoF**	**=**	**1659.16222**	**1659**	**6**	**f_2(1640)**	**.2**
179.5	**UoF**	**=**	**1663.79676**	**1664**	**8/10**	**π_1(1600)**	**.2**
180	**UoF**	**=**	**1668.43129**	**1669**	**11**	**ω_3(1670)**	**.6**
180.5	**UoF**	**=**	**1673.06582**	**1673**	**12**	**ω_3(1670)**	**.07**
181	**UoF**	**=**	**1677.70035**	**1678**	**12**	**ρ_3(1690)**	**.3**
181.5	UoF	=	1682.33488				

182	**UoF**	**=**	**1686.96941**	**1687**	**9/15**	**π2(1670)**	**.03**
182.5	UoF	=	1691.60394				
183	**UoF**	**=**	**1696.23847**	**1696**	**5**	**fo(1710)**	**.2**
183.5	**UoF**	**=**	**1700.87301**	**1701**	**5**	**fo(1710)**	**.1**
184	**UoF**	**=**	**1705.50754**	**1706**	**4/5**	**fo(1710)**	**.5**
184.5	**UoF**	**=**	**1710.14207**	**1710**	**20**	**π2(1670)**	**.1**
185	UoF	=	1714.77660				
185.5	UoF	=	1719.41113				
186	UoF	=	1724.04566				
186.5	UoF	=	1728.68019				
187	**UoF**	**=**	**1733.31473**	**1733**	**10/10**	**Φ(1680)**	**.3**
187.5	**UoF**	**=**	**1737.94926**	**1738**	**30**	**fo(1710)**	**.05**
188	UoF	=	1742.58379				
188.5	**UoF**	**=**	**1747.21832**	**1747**	**5**	**fo(1710)**	**.2**
189	UoF	=	1751.85285				
189.5	**UoF**	**=**	1756.48738				
190	UoF	=	1761.12191				
190.5	**UoF**	**=**	1765.75644				
191	**UoF**	**=**	**1770.39098**	**1770**	**12**	**fo(1710)**	**.4**
191.5	**UoF**	**=**	**1775.02551**	**1775**	**7/10**	**π(1800)**	**.03**
192	UoF	=	1779.66004				
192.5	UoF	=	1784.29457				
193	UoF	=	1788.92910				
193.5	**UoF**	**=**	1793.56363				
194	**UoF**	**=**	**1798.19816**	**1799**	**15**	**f2(1810)**	**.9**
194.5	UoF	=	1802.83270				
195	UoF	=	1807.46723				
195.5	UoF	=	1812.10176				
196	UoF	=	1816.73629				
196.5	UoF	=	1821.37082				
197	UoF	=	1826.00535				
197.5	**UoF**	**=**	**1830.63988**	**1831**	**7**	**X(1835)**	**.4**
198	**UoF**	**=**	**1835.27441**	**1835**	**12**	**η2(1870)**	**.3**
198.5	**UoF**	**=**	**1839.90895**	**1840**	**25**	**η2(1870)**	**.1**
198.75	**UoF**	**=**	**1842.22621**	**1842.2**	**4.2**	**X(1840)**	**.03**
199	**UoF**	**=**	**1844.54348**	**1844**	**13**	**η2(1870)**	**.5**
199.5	UoF	=	1849.17801				
200	**UoF**	**=**	**1853.81254**	**1854**	**7**	**Φ3(1850)**	**.2**
200.5	**UoF**	**=**	**1858.44707**	**1859**	**3/10**	**X(1835)**	**.6**
201	**UoF**	**=**	**1863.08160**	**1863**	**9/10**	**π(1800)**	**.08**
201.5	UoF	=	1867.71613				
202	UoF	=	1872.35067				
202.5	**UoF**	**=**	**1876.98520**	**1877.3**	**6.3**	**X(1835)**	**.3**
203	UoF	=	1881.61973				
203.5	UoF	=	1886.25426				
204	UoF	=	1890.88879				
204.5	UoF	=	1895.52332				
205	UoF	=	1900.15785				
205.5	UoF	=	1904.79239				
206	**UoF**	**=**	**1909.42692**	**1909.5**	**15.9**	**X(1835)**	**.07**
206.5	UoF	=	1914.06145				
207	**UoF**	**=**	**1918.69598**	**1918**	**12**	**f2(1950)**	**.7**
207.5	UoF	=	1923.33051				
208	UoF	=	1927.96504				
208.5	UoF	=	1932.59957				
209	UoF	=	1937.23410				
209.5	UoF	=	1941.86864				
210	UoF	=	1946.50317				
210.5	UoF	=	1951.13770				
211	UoF	=	1955.77223				
211.5	UoF	=	1960.40676				
212	UoF	=	1965.04129				
212.5	UoF	=	1969.67582				
213	**UoF**	**=**	**1974.31036**				
213.5	UoF	=	1978.94489				
214	UoF	=	1983.57942				
214.5	**UoF**	**=**	**1988.21395**	**1988**	**7**	**f4(2050)**	**.2**
215	UoF	=	1992.84848				
215.5	UoF	=	1997.48301				
216	UoF	=	2002.11754				
216.5	UoF	=	2006.75207				
217	UoF	=	2011.38661				
217.5	UoF	=	2016.02114				

218	UoF	=	2020.65567				
218.5	UoF	=	2025.29020				
219	UoF	=	2029.92473				
219.5	UoF	=	2034.55926				
220	UoF	=	2039.19379				
220.5	UoF	=	2043.82833				
221	UoF	=	2048.46286				
221.5	UoF	=	2053.09739				
222	UoF	=	2057.73192				
222.5	UoF	=	2062.36645				
223	UoF	=	2067.00098				
223.5	UoF	=	2071.63551				
224	UoF	=	2076.27005				
224.5	**UoF**	**=**	**2080.90458**	**2081**	**13**	**fo(2100)**	**.1**
225	**UoF**	**=**	**2085.53911**	**2086**	**20/24**	**fo(2100)**	**.6**
225.5	**UoF**	**=**	**2090.17364**	**2090**	**30**	**fo(2100)**	**.2**
226	UoF	=	2094.80817				
226.5	**UoF**	**=**	**2099.44270**	**2099**	**17**	**fo(2100)**	**.4**
227	**UoF**	**=**	**2104.07723**	**2104**	**~**	**fo(2100)**	**.08**
227.5	UoF	=	2108.71176				
228	UoF	=	2113.34630				
228.5	UoF	=	2117.98083				
229	**UoF**	**=**	**2122.61536**	**2122**	**~**	**fo(2100)**	**.6**
229.5	UoF	=	2127.24989				
230	UoF	=	2131.88442				
230.5	UoF	=	2136.51895				
231	UoF	=	2141.15348				
231.5	UoF	=	2145.78802				
232	**UoF**	**=**	**2150.42255**	**2150**	**40/50**	**ρ(2150)**	**.4**
232.5	UoF	=	2155.05708				
233	UoF	=	2159.69161				
233.5	UoF	=	2164.32614				
234	**UoF**	**=**	**2168.96067**				
234.5	UoF	=	2173.59520				
235	UoF	=	2178.22973				
235.5	UoF	=	2182.86427				
236	**UoF**	**=**	**2187.49880**	**2188**	**17/16**	**fo(2200)**	**.5**
236.5	**UoF**	**=**	**2192.13333**	**2192**	**14**	**f(2170)**	**.1**
237	**UoF**	**=**	**2196.76786**	**2197**	**17**	**fo(2200)**	**.2**
237.5	UoF	=	2201.40239				
238	**UoF**	**=**	**2206.03692**	**2206**	**12/8**	**fo(2200)**	**.04**
238.5	UoF	=	2210.67145				
239	UoF	=	2215.30599				
239.5	UoF	=	2219.94052				
240	UoF	=	2224.57505				
240.5	UoF	=	2229.20958				
241	UoF	=	2233.84411				
241.5	UoF	=	2238.47864				
242	UoF	=	2243.11317				
242.5	UoF	=	2247.74771				
243	UoF	=	2252.38224				
243.5	UoF	=	2257.01677				
244	UoF	=	2261.65130				
244.5	UoF	=	2266.28583				
245	UoF	=	2270.92036				
245.5	UoF	=	2275.55489				
246	UoF	=	2280.18942				
246.5	UoF	=	2284.82396				
247	UoF	=	2289.45849				
247.5	UoF	=	2294.09302				
248	UoF	=	2298.72755				
248.5	UoF	=	2303.36208				
249	**UoF**	**=**	**2307.99661**	**2308**	**17/32**	**D0*(2300)o**	**.01**
250	**UoF**	**=**	**2317.26568**	**2317.3**	**0.4/0.8**	**Ds0*(2317)**	**.03**
250.25	**UoF**	**=**	**2319.58294**	**2319.6**	**0.2/1.4**	**Ds0*(2317)**	**.02**
260	UoF	=	2409.95630				
270	UoF	=	2502.64693				
280	UoF	=	2595.33756				
284.5	**UoF**	**=**	**2637.04833**	**2637**	**2/6**	**D*(2640)+**	**.05**
290	**UoF**	**=**	**2688.02818**	**2688**	**4/3**	**Ds1*(2700)**	**.03**
300	UoF	=	2780.71881				
310	UoF	=	2873.40944				
320	UoF	=	2966.10006				
330	UoF	=	3058.79069				

340	UoF	=	3151.48132					
350	UoF	=	3244.17195					
360	UoF	=	3336.86257					
370	UoF	=	3429.55320					
380	UoF	=	3522.24383					
390	UoF	=	3614.93445					
392	**UoF**	**=**	**3633.47258**	**3633.6**	**1.7/0.6**	**nc(2S)**	**.1**	
395.5	**UoF**	**=**	**3665.91429**	**3666**	**10**			[2]
400	UoF	=	3707.62508					
410	UoF	=	3800.31571					
420	**UoF**	**=**	**3893.00633**	**3893.0**	**2.3/19.1**	**Zc(3900)o**	**.006**	[4]
430	UoF	=	3985.69696					
434	**UoF**	**=**	**4022.77321**	**4022.9**	**0.8/2.7**	**X(4020)**	**.1**	
437.375	**UoF**	**=**	**4054.05629**	**4054**	**3/1**	**X(4055)**	**.06**	
440	UoF	=	4078.38759					
448	**UoF**	**=**	**4152.54009**	**4152.5**	**1.7/6.2**	**Xc1(4140)**	**.04**	
450	UoF	=	4171.07822					
452.375	**UoF**	**=**	**4193.09224**	**4193**	**7**	**Y(4160)**	**.09**	
455.5	**UoF**	**=**	**4222.05806**	**4222.0**	**3.1/1.4**	**Y(4260)**	**.06**	
459.5	**UoF**	**=**	**4259.13431**	**4259**	**8/2**	**Y(4260)**	**.1**	
460	UoF	=	4263.76884					
469	**UoF**	**=**	**4347.19041**	**4347**	**6/3**	**Y(4360)**	**.2**	
470	UoF	=	4356.45947					
470.5	**UoF**	**=**	**4361.09400**	**4361**	**9/9**	**Y(4360)**	**.09**	
476	**UoF**	**=**	**4412.07385**	**4412**	**15**	**Y(4415)**	**.07**	
480	UoF	=	4449.15010					
483.875	**UoF**	**=**	**4485.06771**	**4485**	**2**			[3]
490	UoF	=	4541.84072					
500	**UoF**	**=**	**4634.53135**	**4634**	**8/7**	**Y(4600)**	**.5**	
507.50	**UoF**	**=**	**4704.04932**	**4704**	**10/14**	**Xc0(4700)**	**.05**	
510	UoF	=	4727.22198					
520	UoF	=	4819.91261					
530	UoF	=	4912.60323					
540	UoF	=	5005.29386					
550	UoF	=	5097.98449					
560	UoF	=	5190.67511					
570	UoF	=	5283.36574					
579	**UoF**	**=**	**5366.78730**	**5366.83**	**.25/.25**	**Bs0**	**.04**	
580	UoF	=	5376.05637					
584.25	**UoF**	**=**	**5415.44988**	**5415.4**	**1.8/1.5**	**Bs***	**.05**	
590	UoF	=	5468.74699					
600	UoF	=	5561.43762					
610	UoF	=	5654.12825					
620	UoF	=	5746.81888					
630	**UoF**	**=**	**5839.50950**	**5839.6**	**1.1/0.7**	**Bs2*(5840)o**	.1	
640	UoF	=	5932.20013					
650	UoF	=	6024.89076					
660	UoF	=	6117.58138					
668.888	***UoF***	***=***	***6199.97032***	***6200***	**----**	***X(6200)*** *is type*	***(7^3 x 9)***	**[6]**
670	UoF	=	6210.27201					
680	UoF	=	6302.96264					
690	UoF	=	6395.65326					
700.000	**UoF**	**=**	**6488.34389**	**6500**	**----**	**X(6500)** *is type*	***(7^2 x 10)***	**[6]**
710	UoF	=	6581.03452					
720	UoF	=	6673.72515					
730	UoF	=	6766.41577					
740	UoF	=	6859.10640					
742.857	***UoF***	***=***	***6885.58943***	***6886***	*11/11*	***X(6900)*** *is type*	***(7^4 x 10)***	**[5]**
750	UoF	=	6951.79703					
760	UoF	=	7044.48765					
770	UoF	=	7137.17828					
777.777	***UoF***	***=***	***7209.27099***	***7200***	**----**	***X(7200)*** *is type*	***(7^2 x 9)***	**[6]**
780	UoF	=	7229.86891					
790	UoF	=	7322.55953					
800	UoF	=	7415.25016					
810	UoF	=	7507.94079					
820	UoF	=	7600.63142					
830	UoF	=	7693.32204					
840	UoF	=	7786.01267					
850	UoF	=	7878.70330					
860	UoF	=	7971.39392					
870	UoF	=	8064.08455					
880	UoF	=	8156.77518					
890	UoF	=	8249.46580					

900	UoF	=	8342.15643				
910	UoF	=	8434.84706				
920	UoF	=	8527.53769				
930	UoF	=	8620.22831				
940	UoF	=	8712.91894				
950	UoF	=	8805.60957				
960	UoF	=	8898.30019				
970	UoF	=	8990.99082				
980	UoF	=	9083.68145				
990	UoF	=	9176.37207				
1000	UoF	=	9269.06270				
1010	UoF	=	9361.75333				
1013.25	**UoF**	**=**	**9391.87778**	**9391.8**	**6.6/2.0**	**nb(1S)**	**.08**
1013.50	**UoF**	**=**	**9394.19505**	**9394.2**	**4.8/4.9**	**nb(1S)**	**.005**
1020	UoF	=	9454.44396				
1030	UoF	=	9547.13458				
1040	UoF	=	9639.82521				
1050	UoF	=	9732.51584				
1060	UoF	=	9825.20646				
1068	**UoF**	**=**	**9899.35896**	**9899.3**	**0.4/1.0**	**hb(1P)**	**.06**
1068.25	**UoF**	**=**	**9901.67623**	**9902**	**4/2**	**hb(1P)**	**.3**
1070	UoF	=	9917.89709				
1078.75	**UoF**	**=**	**9999.00139**	**9999.0**	**3.5/2.8**	**nb(2S)**	**.001**
1080	UoF	=	10010.5877				
1090	UoF	=	10103.2783				
1096.25	**UoF**	**=**	**10161.2100**	**10161.1**	**0.6/1.6**	**Y2(1D)**	**.1**
1096.50	**UoF**	**=**	**10163.5273**	**10163.7**	**1.4**	**Y2(1D)**	**.2**
1100	UoF	=	10195.9690				
1110	UoF	=	10288.6596				
1120	UoF	=	10381.3502				
1130	UoF	=	10474.0409				
1134	**UoF**	**=**	**10511.1171**	**10511.3**	**1.7/2.5**	**Xb1(3P)**	**.2**
1134.25	**UoF**	**=**	**10513.4344**	**10513.42**	**.41/.53**	**Xb1(3P)**	**.01**
1134.50	**UoF**	**=**	**10515.7516**	**10515.7**	**2.2/3.9**	**Xb1(3P)**	**.05**
1136	**UoF**	**=**	**10529.6552**	**10530**	**5/9**	**Xb1(3P)**	
1140	UoF	=	10566.7315				
1143.50	**UoF**	**=**	**10599.1732**	**10599**	**6/3**	**Zb(10610)**	**.3**
1144.50	**UoF**	**=**	**10608.4423**	**10608.5**	**3.4/3.7**	**Zb(10610)**	**.06**
1144.75	**UoF**	**=**	**10610.7595**	**10611**	**4/3**	**Zb(10610)**	**.2**
1150	UoF	=	10659.4221				
1160	UoF	=	10752.1127				
1170	UoF	=	10844.8034				
1172.50	**UoF**	**=**	**10867.9760**	**10868**	**6/5**	**Y(10860)**	**.02**
1174	**UoF**	**=**	**10881.8796**	**10881.8**	**1.0/1.1**	**Y(10860)**	**.08**
1175	**UoF**	**=**	**10891.1487**	**10891.1**	**3.2/1.2**	**Y(10860)**	**.05**
1180	UoF	=	10937.4940				
1190	UoF	=	11030.1846				

If not cited explicitly, all experimental mass data is from the Particle Data Group:
P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

5. Some **c** **Mesons** Factored as **Tetraquarks**

D0*(2300)o $(S5)^4h/\ 7^3 1000 = 9.269062702$ MeV/c^2

Factoring		Thr Mass	Exp Mass	+/-	TM-EM
249.	$(S5)^4h/\ 7^3 1000$ =	**2307.9966**	**2308**	17/32	.004
247.8125	$(S5)^4h/\ 7^3 1000$ =	**2296.9896**	**2297**	8/20	.002

D0*(2300)+ $(S5)^4h/\ 7^4 3^3 = 49.0426598$ MeV/c^2

Factoring		Thr Mass	Exp Mass	+/-	TM-EM
48.	$(S5)^4h/\ 7^4 3^3$ =	**2354.0476**	**2354**	7/11	.05
48.125	$(S5)^4h/\ 7^4 3^3$ =	**2360.1780**	**2360**	15/30	.18
49.	$(S5)^4h/\ 7^4 3^3$ =	**2403.0903**	**2403**	14/35	.09

D2*(2460)o UoF = $(S5)^4h/\ 7^5 5^2 3^1 2^1 = 1.26109696$ MeV/c^2

Factoring		Thr Mass	Exp Mass	+/-	Events	TM-EM
1951	UoF =	2460.4001	**2460.4**	0.1/0.1	675k	.0001
1951.5	UoF =	2461.0307	**2461**	**3**/1	675k	.03
1952	UoF =	2461.6612	**2461.6**	2.1/3.3	126	.06
1952.5	UoF =	2462.2918	**2462.2**	**0**.1/0.8	243k	.09
1954.25	UoF =	2464.4987	**2464.5**	**1**.1/1.9	5.8k	.001

D3*(2750) $(S5)^4h/\ 7^3 3^2 100 = 10.29895856$ MeV/c^2

Factoring		Thr Mass	Exp Mass	+/-	TM-EM
267.25	$(S5)^4h/\ 7^3 3^2 100$ =	**2752.3966**	**2752.4**	1.7/2.7	.003
268.	$(S5)^4h/\ 7^3 3^2 100$ =	**2760.1208**	**2760.1**	5.1/6.5	.02
268.3125	$(S5)^4h/\ 7^3 3^2 100$ =	**2763.3393**	**2763.3**	2.3/2.3	.04
268.9375	$(S5)^4h/\ 7^3 3^2 100$ =	**2769.7761**	**2769.7**	3.8/1.5	.08
269.125	$(S5)^4h/\ 7^3 3^2 100$ =	**2771.7072**	**2771.7**	1.7/3.8	.007
269.5	$(S5)^4h/\ 7^3 3^2 100$ =	**2775.5693**	**2775.5**	4.5/6.5	.07

D(3000)o

Factoring		Thr Mass	Exp Mass	+/-	TM-EM
53.	$(S5)^4h/\ 7^1 3^4 100$ =	**2971.8217**	**2971.8**	8.7	.02

Source of all experimental mass data on this page is from the Particle Data Group:
P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

6. Some **cs Mesons** Factored as **Tetraquarks**

Ds*+ $(S5)^4h/\ 11^1 7^3 2^1$ = 421.3210319 MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
250.	$(S5)^4h/\ 11^1 7^3 100$	=	**2106.6051**	**2106.6**	2.1/2.7	.005
5.	$(S5)^4h/\ 11^1 7^3 2^1$	=	**2106.6051**	**2106.6**	2.1/2.7	.005

Dso*(2317)+ $(S5)^4h/\ 7^3 1000$ = 9.269062702 MeV/c^2

Initial Factoring			Thr Mass	Exp Mass	+/-	TM-EM
250.	$(S5)^4h/\ 7^3 1000$	=	**2317.2656**	**2317.3**	.4/.8	.03
250.25	$(S5)^4h/\ 7^3 1000$	=	**2319.5829**	**2319.6**	.2/1.4	.02

Fully Reduced Factoring						
1.	$(S5)^4h/\ 7^3 2^2$	=	**2317.2656**	**2317.3**	.4/.8	.03
1.001	$(S5)^4h/\ 7^3 2^2$	=	**2319.5829**	**2319.6**	.2/1.4	.02

The **2317.3** resonance factors to the base **$(S5)^4h/\ 7^3 2^2$** which suggests another possible base factoring twice as big: **$(S5)^4h/\ 7^3 2^1$ = 4634.5313.** One of the resonances of **Y(4600)** reported by PDG matches this mass, and it can be seen listed in the Tetraquark Mass Spectrum in another section at position **500.** There it is seen factored as **500 $(S5)^4h/\ 7^3 1000$.**

Factoring			Thr Mass	Exp Mass	+/-	Meson
250.	$(S5)^4h/\ 7^3 1000$	=	**2317.2656**	**2317.3**	.4/.8	**Dso*(2317)+**
500.	$(S5)^4h/\ 7^3 1000$	=	**4634.5313**	**4634**	15	**Y(4600)**
1.	$(S5)^4h/\ 7^3 2^2$	=	**2317.2656**			
2.	$(S5)^4h/\ 7^3 2^2$	=	**4634.5313**			

Ds1(2536)+ UoF = $(S5)^4h/\ 2^1 3^1 11^1 19^1\ 1000$ = 2.535317789 MeV

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
999.71875	UoF	=	**2534.6047**	2534.6	.3/.7	.005
999.78125	UoF	=	**2534.7631**	2534.78	.31/.40	.02
999.875	UoF	=	**2535.0008**	2535	.6/1	.0008
999.90625	UoF	=	**2535.0801**	2535.08	.01/.15	.0001
1000.	UoF	=	**2535.3177**	2535.3	0.7	.02
1000.10	UoF	=	**2535.5713**	2535.57	.44/.41	.001
1000.15	UoF	=	**2535.6980**	2535.7	0.6/0.5	.002
1000.25	UoF	=	**2535.9516**	2535.9	0.6/2.0	.05
1000.50	UoF	=	**2536.5854**	2536.6	0.7/0.4	.02

Source of all experimental mass data on this page is from the Particle Data Group:
P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

Ds2*(2573) (S5)^{4}h/ $7^2 3^6 10$ = 8.900334556 MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
288.6875	(S5)^{4}h/ $7^2 3^6 10$	=	**2569.4153**	**2569.4**	1.6/0.5	.02
288.750	(S5)^{4}h/ $7^2 3^6 10$	=	**2569.9716**	**2570.0**	4.3	.03
289.	(S5)^{4}h/ $7^2 3^6 10$	=	**2572.1966**	**2572.2**	0.3/1.0	.003
289.125	(S5)^{4}h/ $7^2 3^6 10$	=	**2573.3092**	**2573.2**	1.7/1.6	.1
289.250	(S5)^{4}h/ $7^2 3^6 10$	=	**2574.4217**	**2574.5**	3.3/1.6	.08
202.	(S5)^{4}h/ $7^3 3^6 10$	=	**2568.3822**	**2568.39**	.29/.26	.01

Ds1*(2700)+ (S5)^{4}h/ $7^3 1000$ = 9.269062702 MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
290.	(S5)^{4}h/ $7^3 1000$	=	**2688.0281**	**2688**	4/3	.03

Ds1*(2860)+ (S5)^{4}h/ $11^1 7^5 3^1$ = 5.732258938 MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
500.	(S5)^{4}h/ $11^1 7^5 3^1$	=	**2866.1294**	**2866.1**	1.0/6.3	.03
499.25	(S5)^{4}h/ $11^1 7^5 3^1$	=	**2861.8302**	**2862**	2/5	.2
498.75	(S5)^{4}h/ $11^1 7^5 3^1$	=	**2858.9641**	**2859**	12/24	.03

7. Some **cc Mesons** Factored as **Tetraquarks**

Ψ(4360) **(S5)^{4}h/ $7^3 1000$ = 9.26906270**2 MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
466.5	(S5)^{4}h/ $7^3 1000$	=	**4324.0177**	**4324**	24	.02
469.	(S5)^{4}h/ $7^3 1000$	=	**4347.1904**	**4347**	6/3	.2
470.5	(S5)^{4}h/ $7^3 1000$	=	**4361.0940**	**4361**	9/9	.09

Many more *cc mesons that factor as tetraquarks* are listed in the main mass spectrum, *Tetraquark mass spectrum*, starting on page 5.

Source of all experimental mass data on this page is from the Particle Data Group:
P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

8. Some **bs Mesons** Factored as **Tetraquarks**

If the factorings and theoretical masses below are correct, and specifically, if the theoretical mass 5366.9017 is correct, then that means the experimental measurement 5366.90 is accurate to 1 part in 3 million! The accuracy the experimentalists can achieve in some cases is truly amazing!

Bso $(S5)^4h/\ 7^2 3^4 100 = 8.0103011$ MeV/c²

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
670.375	$(S5)^4h/\ 7^2 3^4 100$	=	5369.9056	5369.9	2.3/1.3	.006
670.	$(S5)^4h/\ 7^2 3^4 100$	=	5366.9017	5366.90	.28/.23	.002
669.6875	$(S5)^4h/\ 7^2 3^4 100$	=	5364.3985	5364.4	1.3/0.7	.002
669.8888	$(S5)^4h/\ 7^2 3^4 100$	=	5366.0117	5366.01	.73/.33	.002

Bs2*(5840)o $(S5)^4h/\ 7^3 1000 = 9.269062702$ MeV/c²

Factoring			Thr Mass	Exp Mass	+/-	TM-EM
630.	$(S5)^4h/\ 7^3 1000$	=	5839.5095	5839.6	1.1/0.7	.09
630.0250	$(S5)^4h/\ 7^3 1000$	=	5839.7412	5839.7	.07	.04
630.0375	$(S5)^4h/\ 7^3 1000$	=	5839.8570	5839.86	.09/.17	.003
630.0500	$(S5)^4h/\ 7^3 1000$	=	5839.9729	5839.99	.05/.2	.02

Some Higher Order Tetraquarks

Factoring			Thr Mass	Exp Mass	+/-	Meson	TM-EM
3.	$(S5)^4h/\ 7^4 2^2$	=	993.1138	993.1	2.1	ao(980)	.01
37.	$(S5)^4h/\ 7^5 5^2 2^1$	=	1399.8176	1399.8	2.2	η(1405)	.02
370.	$(S5)^4h/\ 7^5 3^3$	=	2592.2548	2595.25	0.28	Λc (2595)+	.005
289.	$(S5)^4h/\ 7^7$	=	1115.6847	1115.683	.006	Λ	.002
364.	$(S5)^4h/\ 7^7$	=	1405.2223	1405.1	1.3/1.0	Λ(1405)	.1

Source of all experimental mass data on this page is from the Particle Data Group:
P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

9. **Factorization of the X(6900) Tetraquark**

The tetraquark **X(6900)** can be factored to **52.00 $(S5)^4h/\ 7^4 10$**. As can be seen, from the mass spectrum table above, many tetraquarks have been found that factor with **$(S5)^4h$** divided by 7^1, 7^2, and 7^3, but few that factor with **$(S5)^4h$** divided by 7^4 have been found.

X(6900) **$(S5)^4h/\ 7^4 10$ = 132.4151815** MeV/c^2

Factoring			Thr Mass	Exp Mass	+/-	TM-EM	Source
52.00	$(S5)^4h/\ 7^4 10$	=	**6885.5894**	**6886**	11/11	.4	[5]
26**.00**	$(S5)^4h/\ 7^4 5^1$	=	**6885.5894**	**6886**	11/11	.4	[5]

Another **7^4** type tetraquark may be the **Dj*(2600)**. Two of its experimental masses, as reported by PDG, are shown factored in the table below. The first resonance does look like it is a **7^4** type tetraquark. The second resonance may not be, because of the large difference between experimental and theoretical masses (TM-EM = .52), relative to error size (3.7/4.2).

Dj*(2600)

Factoring			Thr Mass	Exp Mass	+/-	Meson	TM-EM	Source
197.	$(S5)^4h/\ 7^4 100$	=	**2608.5790**	**2608.7**	2.4/2.5	Dj*(2600)	.12	[1]
198.	$(S5)^4h/\ 7^4 100$	=	**2621.8205**	**2621.3**	3.7/4.2	Dj*(2600)	.52	[1]

10. **Factorizations of the X(6200), X(6500), and X(7200) Tetraquarks**

The **X(6200), X(6500),** and **X(7200)** tetraquarks can all be factored with **$(S5)^4h/\ 7^2 3^2 100$.** The X(6500) and X(7200) can each be further reduced to a base state, that is, to a **1.000** constant of multiplication and a small integer divisor of **$(S5)^4h$.** The three are shown together below factored with the same divisors of $(S5)^4h$ to more easily see their exact relative masses.

X(6200), **X**(6500), **X**(7200) **$(S5)^4h/\ 7^2 3^2 100$ = 72.09270991** MeV/c²

Factoring		Thr Mass	Exp Mass	+/-	Meson	Source
86. $(S5)^4h/\ 7^2 3^2 100$	=	**6199.9730**	~**6200**	----	X(6200)	[6]
90. $(S5)^4h/\ 7^2 3^2 100$	=	**6488.3438**	~**6500**	----	X(6500)	[6]
100. $(S5)^4h/\ 7^2 3^2 100$	=	**7209.2709**	~**7200**	----	X(7200)	[6]

The factorings of **X(6500)** and **X(7200)** can be reduced to base state factorings, meaning, put in the form 1.00 $(S5)^4h/n$, where n is an integer. Not all factorings of tetraquarks can be put in this form. What it means, in simple terms, is that an integer can be found that when divided into $(S5)^4h$ gives the mass of the tetraquark. Such integers do exist for the factorings of the **X(6500)** and **X(7200).** They are **490** and **441** respectively, or $7^2 10$ and $7^2 3^2$. Those base factorings for the **X(6500)** and **X(7200)** are shown in the table below.

X(6500), **X**(7200) **$(S5)^4 h$ = 3179288.507** MeV/c²

Factoring		Thr Mass	Exp Mass	+/-	Meson
1.000 $(S5)^4h/\ 7^2 10$	=	**6488.3438**	~**6500**	----	X(6500)
1.000 $(S5)^4h/\ 7^2 3^{\mathbf{2}}$	=	**7209.2709**	~**7200**	----	X(7200)

An interesting thing about the X(7200) tetraquark is that it's mass can be divided by three to give the mass of another theoretical base state tetraquark, which has possibly been observed as a resonance of the c meson Do*(2300)+.

Do*(2300)+ **$(S5)^4h/\ 7^2 3^3$ = 2403.09033** MeV/c²

Factoring		Thr Mass	Exp Mass	+/-	Meson
1.000 $(S5)^4h/\ 7^2 3^{\mathbf{3}}$	=	**2403.0903**	**2403**	14/35	Do*(2300)+

11. Mass Spectrum of **Φ (1020)'s** Experimental Masses

(The spectrum is on the next page.)
Surprisingly, **Φ (1020)** factors with **S17h,** meaning it is most likely a tetraquark. Some of the experimental mass determinations made for this meson are amazingly accurate, assuming the theoretical masses calculated from the factorings are correct. Several experimental masses are accurate to better than one part per 10 million! For instance, 1019.483 vs 1019.48306, experimental vs theoretical. That's equivalent to measuring a 10 km distance to an accuracy of plus or minus one millimeter! **S17h** was used in this factoring spectrum rather than **$(S5)^4$ h**, because the difference between the largest and smallest of **Φ (1020)'s** plotted experimental masses is less than 1 MeV/c^2, and in order to factor masses that are that close together, it is better to use **S17h** (initially anyway, for easier discovery), because **S17h** is 200200 times smaller than **$(S5)^4$ h.** Once the correct factoring has been discovered with **S17h,** it can be easily converted to **$(S5)^4$ h** factoring if desired.

Φ (1020) **S17h / 1620 = .00980281603 MeV/c^2**

Factoring		Thr Mass	Exp Mass	+/-
104000	**S17h / 1620 =**	**1019.49287**	**1019.483**	.011/.025
14000	**$(S5)^4$ h / $11^1 7^2 3^4$ =**	**1019.49287**	**1019.483**	.011/.025

12. Mass Spectrum of **Ψ(2S)'s** Experimental Masses

(The spectrum is two pages ahead.)
This mass spectrum plots all seven experimental masses reported by Particle Data Group [1] for the **Ψ(2S)** meson. As can be seen in the heading, **Ψ(2S)** has been factored with **S17h**, so it is most likely a tetraquark. Six of the seven experimental masses agree with their correlated theoretical masses to six digits of accuracy, which, depending on the exact numbers, could be better than 1 part per million accuracy. (One part per million accuracy is equivalent to measuring a kilometer to plus or minus 1 mm.) One experimental mass agrees with its theoretical counterpart to seven digits. You could even say it agrees to nine digits, because the next two digits in its correlated theoretical mass is '00'. (3686.099 vs 3686.09900) **S17h** was used to produce this factoring spectrum rather than **$(S5)^4$ h**, because the difference between the largest and smallest of the seven experimental masses of **Ψ(2S)** is only 0.17 MeV/c^2, and in order to factor masses that are that close together it is better to use **S17h** (for easier discovery initially), because **S17h** is 200200 times smaller than **$(S5)^4$ h.**

Ψ(2S) **S17h / 1800 = .0088225344 MeV/c^2**

Factoring		Thr Mass	Exp Mass	+/-
51(8192)	**S17h/1800 =**	**3685.9843**	**3685.98**	.09/.04

Φ (1020)

S17h/1620 Factoring

Factoring		Ther Mass	Expr Mass	+/-	Block Factoring
103976	S17h/1620 =	1019.25760			
103977	S17h/1620 =	1019.26740			
103978	S17h/1620 =	1019.27721			
103979	S17h/1620 =	1019.28701			
103980	S17h/1620 =	1019.29681			
103981	S17h/1620 =	1019.30661	1019.30	.02/.10	
103982	S17h/1620 =	1019.31642			
103983	S17h/1620 =	1019.32622			
103984	S17h/1620 =	1019.33602			
103985	S17h/1620 =	1019.34582			
103986	S17h/1620 =	1019.35563			
103987	S17h/1620 =	1019.36543	1019.36	.12	
103988	S17h/1620 =	1019.37523			
103989	S17h/1620 =	1019.38504	1019.38	.07/.08	
103990	S17h/1620 =	1019.39484			
103991	S17h/1620 =	1019.40464	1019.40	.04/.05	
103992	S17h/1620 =	1019.41444	1019.411	.008	
103993	S17h/1620 =	1019.42425	1019.42	.05	
103994	S17h/1620 =	1019.43405			
103995	S17h/1620 =	1019.44385	1019.441	.008/.080	
103996	S17h/1620 =	1019.45366			
103997	S17h/1620 =	1019.46346	1019.463	.061	
103998	S17h/1620 =	1019.47326			
103999	S17h/1620 =	1019.48306	1019.483	.011/.025	
104000	**S17h/1620 =**	**1019.49287**			
104001	S17h/1620 =	1019.50267	1019.5	.4	
104002	S17h/1620 =	1019.51247	1019.51	.02/.05	
104003	S17h/1620 =	1019.52228	1019.52	.05/.05	
104004	S17h/1620 =	1019.53208			
104005	S17h/1620 =	1019.54188			
104006	S17h/1620 =	1019.55168			
104007	S17h/1620 =	1019.56149			
104008	S17h/1620 =	1019.57129			
104009	S17h/1620 =	1019.58109			
104010	S17h/1620 =	1019.59090			
104011	S17h/1620 =	1019.60070	1019.6	.5	
104012	S17h/1620 =	1019.61050			
104013	S17h/1620 =	1019.62030			
104014	S17h/1620 =	1019.63011	1019.63	.07	
104015	S17h/1620 =	1019.63991			
104016	S17h/1620 =	1019.64971			
104017	S17h/1620 =	1019.65952			
104018	S17h/1620 =	1019.66932	1019.67	.17	
104019	S17h/1620 =	1019.67912			
104020	S17h/1620 =	1019.68892			
104021	S17h/1620 =	1019.69873			
104022	S17h/1620 =	1019.70853	1019.7	.3	
104023	S17h/1620 =	1019.71833			
104024	S17h/1620 =	1019.72813			

Source of Exp Data: P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. **2020,** 083C01 (2020)

Ψ(2S)

S17h/1800 Factoring

	Block(1) Factoring		Ther Mass	Expr Mass	+/-	Block (8192) Factoring	
	417777	S17h/1800 =	3685.85197				
	417778	S17h/1800 =	3685.86079				
	417779	S17h/1800 =	3685.86961				
	417780	S17h/1800 =	3685.87843				
	417781	S17h/1800 =	3685.88726				
	417782	S17h/1800 =	3685.89608				
	417783	S17h/1800 =	3685.90490				
	417784	S17h/1800 =	3685.91372				
	417785	S17h/1800 =	3685.92255				
	417786	S17h/1800 =	3685.93137				
	417787	S17h/1800 =	3685.94019				
	417788	S17h/1800 =	3685.94901	3685.95	0.10		
	417789	S17h/1800 =	3685.95784				
	417790	S17h/1800 =	3685.96666				
	417791	S17h/1800 =	3685.97548				
-------	**417792**	**S17h/1800 =**	**3685.98430**	**3685.98**	**.09/.04**	**51(8192)**	**S17h/1800**
	417793	S17h/1800 =	3685.99313				
	417794	S17h/1800 =	3686.00195	3686.00	0.10		
	417795	S17h/1800 =	3686.01077				
	417796	S17h/1800 =	3686.01959				
	417797	S17h/1800 =	3686.02842				
	417798	S17h/1800 =	3686.03724				
	417799	S17h/1800 =	3686.04606				
+16	417800	S17h/1800 =	3686.05488				
	417801	S17h/1800 =	3686.06371				
	417802	S17h/1800 =	3686.07253				
	417803	S17h/1800 =	3686.08135				
	417804	S17h/1800 =	3686.09017				
	417805	S17h/1800 =	3686.09900	3686.099	.004/.009		
	417806	S17h/1800 =	3686.10782				
	417806.5	S17h/1800 =	3686.11223	3686.111	.025/.009		
	417807	S17h/1800 =	3686.11664	3686.114	.007/.011		
-------	**417808**	**S17h/1800 =**	**3686.12546**	**3686.12**	**.06/.10**	**(51(8192)+16)**	**S17h/1800**
	417809	S17h/1800 =	3686.13429				
	417810	S17h/1800 =	3686.14311				
	417811	S17h/1800 =	3686.15193				
	417812	S17h/1800 =	3686.16075				
	417813	S17h/1800 =	3686.16958				
	417814	S17h/1800 =	3686.17840				
	417815	S17h/1800 =	3686.18722				
	417816	S17h/1800 =	3686.19604				
	417817	S17h/1800 =	3686.20487				
	417818	S17h/1800 =	3686.21369				
	417819	S17h/1800 =	3686.22251				
	417820	S17h/1800 =	3686.23133				
	417821	S17h/1800 =	3686.24016				
	417822	S17h/1800 =	3686.24898				

Source of Exp Data: P.A. Zyla et al. (Particle Data Group), Prog. Theor. Exp. Phys. 2020, 083C01 (2020)

13. Conclusion

The excellent agreement between experimental tetraquark masses and the theoretical masses calculated from hypersphere surface volume factoring suggests tetraquarks have a higher dimensional structure. The exact structure of tetraquarks probably cannot be determined exactly from factoring alone, but it may aide in formulating or checking new more geometrically descriptive theories about their structure. To that end, a computerized correlation analysis of how a tetraquark factors versus its other properties may provide insights into, if not their structure per se, then, how to proceede with the search for their structure. What is needed for a definitive explanation of their structure, of course, is a single equation that will describe a tetraquark's total geometry and physics, the way the Schrodinger equation describes the geometry and physics of the hydrogen atom. Whether that needs new physics assumptions or just familiar 3d equations modified to work in higher dimensions is unknown. But, it is really not the structure of the tetraquarks that is the most interesting thing about them. It's the material of which they are made. Tetraquark structure is only interesting in as much as it can shed light on the nature of the material - the quark material - of which tetraquarks and other mesons are made.

14. Appendix

Hypersphere Surface Volume Equations

Sn = the Surface Volume of an **n**-sphere

S2 =	2 πr^{1}		**S20** =	nnn $\pi^{10} r^{19}$
S3 =	4 πr^{2}		**S21** =	nnn $\pi^{10} r^{20}$
S4 =	2 $\pi^{2} r^{3}$		**S22** =	nnn $\pi^{11} r^{21}$
S5 =	8/3 $\pi^{2} r^{4}$		**S23** =	nnn $\pi^{11} r^{22}$
S6 =	$\pi^{3} r^{5}$		**S24** =	nnn $\pi^{12} r^{23}$
S7 =	16/15 $\pi^{3} r^{6}$		**S25** =	nnn $\pi^{12} r^{24}$
S8 =	1/3 $\pi^{4} r^{7}$		**S26** =	nnn $\pi^{13} r^{25}$
S9 =	32/105 $\pi^{4} r^{8}$		**S27** =	nnn $\pi^{13} r^{26}$
S10 =	1/12 $\pi^{5} r^{9}$		**S28** =	nnn $\pi^{14} r^{27}$
S11 =	64/945 $\pi^{5} r^{10}$		**S29** =	nnn $\pi^{14} r^{28}$
S12 =	1/60 $\pi^{6} r^{11}$		**S30** =	nnn $\pi^{15} r^{29}$
S13 =	128/10395 $\pi^{6} r^{12}$		**S31** =	nnn $\pi^{15} r^{30}$
S14 =	1/360 $\pi^{7} r^{13}$			
S15 =	256/135135 $\pi^{7} r^{14}$			
S16 =	1/2520 $\pi^{8} r^{15}$			
S17 =	512/2027025 $\pi^{8} r^{16}$			
S18 =	1/20160 $\pi^{9} r^{17}$			
S19 =	1024/34459425 $\pi^{9} r^{18}$			

Hypersphere Surface Volumes
Times 'h'

Snh = the Surface Volume of a unit radius **n**-sphere times **h**

h = 6.62607015 MeV/c^2

S2h = 2 π **h** = **41.63282661** MeV
S3h = 4 π **h** = **83.26565322** MeV

S4h = 2 π^2 **h** = **130.7933822** MeV
S5h = 8/3 π^2 **h** = **174.3911763** MeV

S6h = π^3 **h** = **205.4497644** MeV
S7h = 16/15 π^3 **h** = **219.1464153** MeV

S8h = 1/3 π^4 **h** = **215.1464901** MeV
S9h = 32/105 π^4 **h** = **196.7053624** MeV

S10h = 1/12 π^5 **h** = **168.97565582** MeV
S11h = 64/945 π^5 **h** = **137.3262492** MeV

S12h = 1/60 π^6 **h** = **106.1705373** MeV
S13h = 128/10395 π^6 **h** = **78.44057013** MeV

S14h = 1/360 π^7 **h** = **55.59076334** MeV
S15h = 256/135135 π^7 **h** = **37.91204905** MeV

S16h = 1/2520 π^8 **h** = **24.94907624** MeV
S17h = 512/2027025 π^8 **h** = **15.88056197** MeV

S18h = 1/20160 π^9 **h** = **9.79747933** MeV
S19h = 1024/34459425 π^9 **h** = **5.86944198** MeV

S20h = 1/181440 π^{10} **h** = **3.419965454** MeV
S21h = 2048/654729075 π^{10} **h** = **1.940989032** MeV

cccc Tetraquark's Unit of Factorization

$(S5)^4$ h = $(4096/81)\pi^{10}$ **h** **= 3179288.507** MeV/c^2

15. References

[1] P.A. Zyla et al (Particle Data Group), Prog. Theor. Exp. Phys. **2020**, 083C01 (2020)

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