

## 34. MONTE CARLO PARTICLE NUMBERING SCHEME

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The Monte Carlo particle numbering scheme presented here is intended to facilitate interfacing between event generators, detector simulators, and analysis packages used in particle physics. The numbering scheme was introduced in 1988 [1] and a revised version [2,3] was adopted in 1998 in order to allow systematic inclusion of quark model states which are as yet undiscovered and hypothetical particles such as SUSY particles. The numbering scheme is used in several event generators, *e.g.* HERWIG and PYTHIA/JETSET, and in the /HEPEVT/ [4] standard interface.

The general form is a 7-digit number:

$$\pm n n_r n_L n_{q_1} n_{q_2} n_{q_3} n_J.$$

This encodes information about the particle's spin, flavor content, and internal quantum numbers. The details are as follows:

1. Particles are given positive numbers, antiparticles negative numbers. The PDG convention for mesons is used, so that  $K^+$  and  $B^+$  are particles.
2. Quarks and leptons are numbered consecutively starting from 1 and 11 respectively; to do this they are first ordered by family and within families by weak isospin.
3. In composite quark systems (diquarks, mesons, and baryons)  $n_{q_{1-3}}$  are quark numbers used to specify the quark content, while the rightmost digit  $n_J = 2J + 1$  gives the system's spin (except for the  $K_S^0$  and  $K_L^0$ ). The scheme does not cover particles of spin  $J > 4$ .
4. Diquarks have 4-digit numbers with  $n_{q_1} \geq n_{q_2}$  and  $n_{q_3} = 0$ .
5. The numbering of mesons is guided by the nonrelativistic ( $L$ - $S$  decoupled) quark model, as listed in Tables 14.2 and 14.3.
  - a. The numbers specifying the meson's quark content conform to the convention  $n_{q_1} = 0$  and  $n_{q_2} \geq n_{q_3}$ . The special case  $K_L^0$  is the sole exception to this rule.
  - b. The quark numbers of flavorless, light ( $u, d, s$ ) mesons are: 11 for the member of the isotriplet ( $\pi^0, \rho^0, \dots$ ), 22 for the lighter isosinglet ( $\eta, \omega, \dots$ ), and 33 for the heavier isosinglet ( $\eta', \phi, \dots$ ). Since isosinglet mesons are often large mixtures of  $u\bar{u} + d\bar{d}$  and  $s\bar{s}$  states, 22 and 33 are assigned by mass and do not necessarily specify the dominant quark composition.
  - c. The special numbers 310 and 130 are given to the  $K_S^0$  and  $K_L^0$  respectively.
  - d. The fifth digit  $n_L$  is reserved to distinguish mesons of the same total ( $J$ ) but different spin ( $S$ ) and orbital ( $L$ ) angular momentum quantum numbers. For  $J > 0$  the numbers are: ( $L, S$ ) = ( $J - 1, 1$ )  $n_L = 0$ , ( $J, 0$ )  $n_L = 1$ , ( $J, 1$ )  $n_L = 2$  and ( $J + 1, 1$ )  $n_L = 3$ . For the exceptional case  $J = 0$  the numbers are (0,0)  $n_L = 0$  and (1,1)  $n_L = 1$  (*i.e.*  $n_L = L$ ). See Table 34.1.

**Table 34.1:** Meson numbering logic. Here  $qq$  stands for  $n_{q_2} n_{q_3}$ .

$J$	$L = J - 1, S = 1$			$L = J, S = 0$			$L = J, S = 1$			$L = J + 1, S = 1$		
	code	$J^{PC}$	$L$	code	$J^{PC}$	$L$	code	$J^{PC}$	$L$	code	$J^{PC}$	$L$
0	—	—	—	00qq1	$0^{++}$	0	—	—	—	10qq1	$0^{++}$	1
1	00qq3	$1^{--}$	0	10qq3	$1^{+-}$	1	20qq3	$1^{++}$	1	30qq3	$1^{--}$	2
2	00qq5	$2^{++}$	1	10qq5	$2^{+-}$	2	20qq5	$2^{--}$	2	30qq5	$2^{++}$	3
3	00qq7	$3^{--}$	2	10qq7	$3^{+-}$	3	20qq7	$3^{++}$	3	30qq7	$3^{--}$	4
4	00qq9	$4^{++}$	3	10qq9	$4^{+-}$	4	20qq9	$4^{--}$	4	30qq9	$4^{++}$	5

- e. If a set of physical mesons correspond to a (non-negligible) mixture of basis states, differing in their internal quantum numbers, then the lightest physical state gets the smallest basis state number. For example the  $K_1(1270)$  is numbered 10313 ( $1^1 P_1 K_{1B}$ ) and the  $K_1(1400)$  is numbered 20313 ( $1^3 P_1 K_{1A}$ ).

- f. The sixth digit  $n_r$  is used to label mesons radially excited above the ground state.
  - g. Numbers have been assigned for complete  $n_r = 0$   $S$ - and  $P$ -wave multiplets, even where states remain to be identified.
  - h. In some instances assignments within the  $q\bar{q}$  meson model are only tentative; here best guess assignments are made.
  - i. Many states appearing in the Meson Listings are not yet assigned within the  $q\bar{q}$  model. Here  $n_{q_{2-3}}$  and  $n_J$  are assigned according to the state's likely flavors and spin; all such unassigned light isoscalar states are given the flavor code 22. Within these groups  $n_L = 0, 1, 2, \dots$  is used to distinguish states of increasing mass. These states are flagged using  $n = 9$ . It is to be expected that these numbers will evolve as the nature of the states are elucidated. Codes are assigned to all mesons which are listed in the one-page table at the end of the Meson Summary Table as long as they have a preferred or established spin. Additional heavy meson states expected from heavy quark spectroscopy are also assigned codes.
6. The numbering of baryons is again guided by the nonrelativistic quark model, see Table 14.6.
    - a. The numbers specifying a baryon's quark content are such that in general  $n_{q_1} \geq n_{q_2} \geq n_{q_3}$ .
    - b. Two states exist for  $J = 1/2$  baryons containing 3 different types of quarks. In the lighter baryon ( $\Lambda, \Xi, \Omega, \dots$ ) the light quarks are in an antisymmetric ( $J = 0$ ) state while for the heavier baryon ( $\Sigma^0, \Xi', \Omega', \dots$ ) they are in a symmetric ( $J = 1$ ) state. In this situation  $n_{q_2}$  and  $n_{q_3}$  are reversed for the lighter state, so that the smaller number corresponds to the lighter baryon.
    - c. At present most Monte Carlos do not include excited baryons and no systematic scheme has been developed to denote them, though one is foreseen. In the meantime, use of the PDG 96 [5] numbers for excited baryons is recommended.
    - d. For pentaquark states  $n = 9$ ,  $n_r n_L n_{q_1} n_{q_2}$  gives the four quark numbers in order  $n_r \geq n_L \geq n_{q_1} \geq n_{q_2}$ ,  $n_{q_3}$  gives the antiquark number, and  $n_J = 2J + 1$ , with the assumption that  $J = 1/2$  for the states currently reported.
  7. The gluon, when considered as a gauge boson, has official number 21. In codes for glueballs, however, 9 is used to allow a notation in close analogy with that of hadrons.
  8. The pomeron and odderon trajectories and a generic reggeon trajectory of states in QCD are assigned codes 990, 9990, and 110 respectively, where the final 0 indicates the indeterminate nature of the spin, and the other digits reflect the expected "valence" flavor content. We do not attempt a complete classification of all reggeon trajectories, since there is currently no need to distinguish a specific such trajectory from its lowest-lying member.
  9. Two-digit numbers in the range 21–30 are provided for the Standard Model gauge bosons and Higgs.
  10. Codes 81–100 are reserved for generator-specific pseudoparticles and concepts.
  11. The search for physics beyond the Standard Model is an active area, so these codes are also standardized as far as possible.
    - a. A standard fourth generation of fermions is included by analogy with the first three.
    - b. The graviton and the boson content of a two-Higgs-doublet scenario and of additional  $SU(2) \times U(1)$  groups are found in the range 31–40.
    - c. "One-of-a-kind" exotic particles are assigned numbers in the range 41–80.
    - d. Fundamental supersymmetric particles are identified by adding a nonzero  $n$  to the particle number. The superpartner of a boson or a left-handed fermion has  $n = 1$  while the superpartner of a right-handed fermion has  $n = 2$ . When mixing occurs, such as between the winos and charged Higgsinos to give charginos, or between left and right sfermions, the lighter physical state is given the smaller basis state number.
    - e. Technicolor states have  $n = 3$ , with technifermions treated like ordinary fermions. States which are ordinary color singlets have  $n_r = 0$ . Color octets have  $n_r = 1$ . If a state has non-trivial quantum numbers under the topcolor groups

$SU(3)_1 \times SU(3)_2$ , the quantum numbers are specified by  $\text{tech}_{ij}$ , where  $i$  and  $j$  are 1 or 2.  $n_L$  is then  $2i + j$ . The colon,  $V_8$ , is a heavy gluon color octet and thus is 3100021.

- f. Excited (composite) quarks and leptons are identified by setting  $n = 4$ .
- g. Within several scenarios of new physics, it is possible to have colored particles sufficiently long-lived for color-singlet hadronic states to form around them. In the context of supersymmetric scenarios, these states are called  $R$ -hadrons, since they carry odd  $R$ -parity.  $R$ -hadron codes, defined here, should be viewed as templates for corresponding codes also in other scenarios, for any long-lived particle that is either an unflavored color octet or a flavored color triplet. The  $R$ -hadron code is obtained by combining the SUSY particle code with a code for the light degrees of freedom, with as many intermediate zeros removed from the former as required to make place for the latter at the end. (To exemplify, a sparticle  $n00000n_{\bar{q}}$  combined with quarks  $q_1$  and  $q_2$  obtains code  $n00n_{\bar{q}}n_{q_1}n_{q_2}n_J$ .) Specifically, the new-particle spin decouples in the limit of large masses, so that the final  $n_J$  digit is defined by the spin state of the light-quark system alone. An appropriate number of  $n_q$  digits is used to define the ordinary-quark content. As usual, 9 rather than 21 is used to denote a gluon/gluino in composite states. The sign of the hadron agrees with that of the constituent new particle (a color triplet) where there is a distinct new antiparticle, and else is defined as for normal hadrons. Particle names are  $R$  with the flavor content as lower index. A non-exhaustive list of  $R$ -hadron codes is given below.
- h. Kaluza-Klein excitations in models with extra dimensions have  $n = 5$  or  $n = 6$ , to distinguish excitations of left- or right-handed fermions or, in case of mixing, the lighter or heavier state (cf. 11d). The nonzero  $n_r$  digit gives the radial excitation number, in scenarios where the level spacing allow these to be distinguished. Should the model also contain supersymmetry, excited SUSY states would be denoted by an  $n_r > 0$ , with  $n = 1$  or 2 as usual. Should some colored states be long-lived enough that hadrons would form around them, the coding strategy of 11g applies, with the initial two  $mn_r$  digits preserved in the combined code. A non-exhaustive list of codes for the Kaluza-Klein states is given below.

12. Occasionally program authors add their own states. To avoid confusion, these should be flagged by setting  $mn_r = 99$ .
13. Concerning the non-99 numbers, it may be noted that only quarks, excited quarks, squarks, and diquarks have  $n_{q_3} = 0$ ; only diquarks, baryons (including pentaquarks), and the odderon have  $n_{q_1} \neq 0$ ; and only mesons, the reggeon, and the pomeron have  $n_{q_1} = 0$  and  $n_{q_2} \neq 0$ . Concerning mesons (not antimesons), if  $n_{q_1}$  is odd then it labels a quark and an antiquark if even.
14. Nuclear codes are given as 10-digit numbers  $\pm 10LZZZAAAII$ . For a (hyper)nucleus consisting of  $n_p$  protons,  $n_n$  neutrons and  $n_A$   $A$ 's,  $A = n_p + n_n + n_A$  gives the total baryon number,  $Z = n_p$  the total charge and  $L = n_A$  the total number of strange quarks.  $I$  gives the isomer level, with  $I = 0$  corresponding to the ground state and  $I > 0$  to excitations, see [9], where states denoted  $m, n, p, q$  translate to  $I = 1 - 4$ . As examples, the deuteron is 1000010020 and  $^{235}\text{U}$  is 1000922350. To avoid ambiguities, nuclear codes should not be applied to a single hadron, like  $p$ ,  $n$  or  $A^0$ , where quark-contents-based codes already exist.

This text and lists of particle numbers can be found on the WWW [6]. The StdHep Monte Carlo standardization project [7] maintains the list of PDG particle numbers, as well as numbering schemes from most event generators and software to convert between the different schemes.

#### References:

1. G.P. Yost *et al.*, Particle Data Group, Phys. Lett. **B204**, 1 (1988).
2. I. G. Knowles *et al.*, in "Physics at LEP2", CERN 96-01, vol. 2, p. 103.
3. C. Caso *et al.*, Particle Data Group, Eur. Phys. J. **C3**, 1 (1998).
4. T. Sjöstrand *et al.*, in "Z physics at LEP1", CERN 89-08, vol. 3, p. 327.
5. R.M. Barnett *et al.*, PDG, Phys. Rev. **D54**, 1 (1996).

6. [pdg.lbl.gov/2006/mcdata/mc\\_particle\\_id\\_contents.html](http://pdg.lbl.gov/2006/mcdata/mc_particle_id_contents.html).
7. L. Garren, StdHep, *Monte Carlo Standardization at FNAL*, Fermilab PM0091 and StdHep WWW site: <http://cepa.fnal.gov/psm/stdhep/>.
8. W.-M. Yao *et al.*, J. Phys. **G33**, 1 (2006).
9. G. Audi *et al.*, Nucl. Phys. **A729**, 3 (2003) See also [http://www.nndc.bnl.gov/amdc/web/nubase\\_en.html](http://www.nndc.bnl.gov/amdc/web/nubase_en.html).

#### QUARKS

$d$	1
$u$	2
$s$	3
$c$	4
$b$	5
$t$	6
$b'$	7
$t'$	8

#### LEPTONS

$e^-$	11
$\nu_e$	12
$\mu^-$	13
$\nu_\mu$	14
$\tau^-$	15
$\nu_\tau$	16
$\tau'^-$	17
$\nu_{\tau'}$	18

#### EXCITED PARTICLES

$d^*$	4000001
$u^*$	4000002
$e^*$	4000011
$\nu_e^*$	4000012

#### GAUGE AND HIGGS BOSONS

$g$	(9) 21
$\gamma$	22
$Z^0$	23
$W^+$	24
$h^0/H_1^0$	25
$Z'/Z_2^0$	32
$Z''/Z_3^0$	33
$W'/W_2^+$	34
$H^0/H_2^0$	35
$A^0/H_3^0$	36
$H^+$	37

#### DIQUARKS

$(dd)_1$	1103
$(ud)_0$	2101
$(ud)_1$	2103
$(uu)_1$	2203
$(sd)_0$	3101
$(sd)_1$	3103
$(su)_0$	3201
$(su)_1$	3203
$(ss)_1$	3303
$(cd)_0$	4101
$(cd)_1$	4103
$(cu)_0$	4201
$(cu)_1$	4203
$(cs)_0$	4301
$(cs)_1$	4303
$(cc)_1$	4403
$(bd)_0$	5101
$(bd)_1$	5103
$(bu)_0$	5201
$(bu)_1$	5203
$(bs)_0$	5301
$(bs)_1$	5303
$(bc)_0$	5401
$(bc)_1$	5403
$(bb)_1$	5503

#### TECHNICOLOR PARTICLES

$\pi_{\text{tech}}^0$	3000111
$\pi_{\text{tech}}^+$	3000211
$\pi_{\text{tech}}'^0$	3000221
$\eta_{\text{tech}}^0$	3100221
$\rho_{\text{tech}}^0$	3000113
$\rho_{\text{tech}}^+$	3000213
$\omega_{\text{tech}}^0$	3000223
$V_8$	3100021
$\pi_{\text{tech},22}^1$	3060111
$\pi_{\text{tech},22}^8$	3160111
$\rho_{\text{tech},11}$	3130113
$\rho_{\text{tech},12}$	3140113
$\rho_{\text{tech},21}$	3150113
$\rho_{\text{tech},22}$	3160113

<b>R-HADRONS</b>		<b>SUSY</b>		<b>LIGHT <math>I = 1</math> MESONS</b>		<b>LIGHT <math>I = 0</math> MESONS</b>	
$R_{g\bar{g}}^0$	1000993	<b>PARTICLES</b>		$\pi^0$	111	$(u\bar{u}, d\bar{d}, \text{ and } s\bar{s} \text{ Admixtures})$	
$R_{g\bar{d}\bar{d}}^0$	1009113	$\tilde{d}_L$	1000001	$\pi^+$	211	$\eta$	221
$R_{g\bar{u}\bar{d}}^+$	1009213	$\tilde{u}_L$	1000002	$a_0(980)^0$	9000111	$\eta'(958)$	331
$R_{g\bar{u}\bar{u}}^0$	1009223	$\tilde{s}_L$	1000003	$a_0(980)^+$	9000211	$f_0(600)$	9000221
$R_{g\bar{d}\bar{s}}^0$	1009313	$\tilde{c}_L$	1000004	$\pi(1300)^0$	100111	$f_0(980)$	9010221
$R_{g\bar{u}\bar{s}}^+$	1009323	$\tilde{b}_1$	1000005 <sup>a</sup>	$\pi(1300)^+$	100211	$\eta(1295)$	100221
$R_{g\bar{s}\bar{s}}^0$	1009333	$\tilde{t}_1$	1000006 <sup>a</sup>	$a_0(1450)^0$	10111	$f_0(1370)$	10221
$R_{g\bar{d}\bar{d}\bar{d}}^-$	1091114	$\tilde{e}_L$	1000011	$a_0(1450)^+$	10211	$\eta(1405)$	9020221
$R_{g\bar{u}\bar{d}\bar{d}}^0$	1092114	$\tilde{\nu}_{eL}$	1000012	$\pi(1800)^0$	9010111	$\eta(1475)$	100331
$R_{g\bar{u}\bar{u}\bar{d}}^+$	1092214	$\tilde{\mu}_L$	1000013	$\pi(1800)^+$	9010211	$f_0(1500)$	9030221
$R_{g\bar{s}\bar{d}\bar{d}}^-$	1093114	$\tilde{\nu}_{\mu L}$	1000014	$\rho(770)^0$	113	$f_0(1710)$	10331
$R_{g\bar{s}\bar{u}\bar{d}}^0$	1093214	$\tilde{\tau}_1$	1000015 <sup>a</sup>	$\rho(770)^+$	213	$\eta(1760)$	9040221
$R_{g\bar{s}\bar{s}\bar{u}}^+$	1093224	$\tilde{\nu}_{\tau L}$	1000016	$b_1(1235)^0$	10113	$f_0(2020)$	9050221
$R_{g\bar{s}\bar{d}\bar{d}}^-$	1093114	$\tilde{d}_R$	2000001	$b_1(1235)^+$	10213	$f_0(2100)$	9060221
$R_{g\bar{s}\bar{u}\bar{d}}^0$	1093214	$\tilde{u}_R$	2000002	$a_1(1260)^0$	20113	$f_0(2200)$	9070221
$R_{g\bar{s}\bar{s}\bar{u}}^+$	1093224	$\tilde{s}_R$	2000003	$a_1(1260)^+$	20213	$\eta(2225)$	9080221
$R_{g\bar{s}\bar{s}\bar{s}}^-$	1093334	$\tilde{c}_R$	2000004	$\pi_1(1400)^0$	9000113	$\omega(782)$	223
$R_{\tilde{t}_1\bar{d}}^+$	1000612	$\tilde{b}_2$	2000005 <sup>a</sup>	$\pi_1(1400)^+$	9000213	$\phi(1020)$	333
$R_{\tilde{t}_1\bar{u}}^0$	1000622	$\tilde{t}_2$	2000006 <sup>a</sup>	$\rho(1450)^0$	100113	$h_1(1170)$	10223
$R_{\tilde{t}_1\bar{s}}^+$	1000632	$\tilde{e}_R$	2000011	$\rho(1450)^+$	100213	$f_1(1285)$	20223
$R_{\tilde{t}_1\bar{c}}^0$	1000642	$\tilde{\mu}_R$	2000013	$\pi_1(1600)^0$	9010113	$h_1(1380)$	10333
$R_{\tilde{t}_1\bar{b}}^+$	1000652	$\tilde{\tau}_2$	2000015 <sup>a</sup>	$\pi_1(1600)^+$	9010213	$f_1(1420)$	20333
$R_{\tilde{t}_1\bar{d}\bar{d}_1}^0$	1006113	$\tilde{g}$	1000021	$a_1(1640)^0$	9020113	$\omega(1420)$	100223
$R_{\tilde{t}_1\bar{u}\bar{d}_0}^+$	1006211	$\tilde{\chi}_1^0$	1000022 <sup>b</sup>	$a_1(1640)^+$	9020213	$f_1(1510)$	9000223
$R_{\tilde{t}_1\bar{u}\bar{d}_1}^+$	1006213	$\tilde{\chi}_2^0$	1000023 <sup>b</sup>	$\rho(1700)^0$	30113	$h_1(1595)$	9010223
$R_{\tilde{t}_1\bar{u}\bar{u}_1}^{++}$	1006223	$\tilde{\chi}_1^+$	1000024 <sup>b</sup>	$\rho(1700)^+$	30213	$\omega(1650)$	30223
$R_{\tilde{t}_1\bar{s}\bar{d}_0}^0$	1006311	$\tilde{\chi}_3^0$	1000025 <sup>b</sup>	$\rho(1900)^0$	9030113	$\phi(1680)$	100333
$R_{\tilde{t}_1\bar{s}\bar{d}_1}^0$	1006313	$\tilde{\chi}_4^0$	1000035 <sup>b</sup>	$\rho(1900)^+$	9030213	$f_2(1270)$	225
$R_{\tilde{t}_1\bar{s}\bar{u}_0}^+$	1006321	$\tilde{\chi}_2^+$	1000037 <sup>b</sup>	$\rho(2150)^0$	9040113	$f_2(1430)$	9000225
$R_{\tilde{t}_1\bar{s}\bar{u}_1}^+$	1006323	$\tilde{G}$	1000039	$\rho(2150)^+$	9040213	$f_2'(1525)$	335
$R_{\tilde{t}_1\bar{s}\bar{s}_1}^0$	1006333			$a_2(1320)^0$	115	$f_2(1565)$	9010225
		<b>KALUZA-KLEIN</b>		$a_2(1320)^+$	215	$f_2(1640)$	9020225
<b>SPECIAL</b>		<b>EXCITATIONS</b>		$\pi_2(1670)^0$	10115	$\eta_2(1645)$	10225
<b>PARTICLES</b>		$d_L^{(1)}$	5100001*	$\pi_2(1670)^+$	10215	$f_2(1810)$	9030225
$G$ (graviton)	39	$u_L^{(1)}$	5100002*	$a_2(1700)^0$	9000115	$\eta_2(1870)$	10335
$R^0$	41	$e_L^{(1)-}$	5100011*	$a_2(1700)^+$	9000215	$f_2(1910)$	9040225
$LQ^c$	42	$\nu_{eL}^{(1)}$	5100012*	$\pi_2(2100)^0$	9010115	$f_2(1950)$	9050225
<i>reggeon</i>	110	$d_R^{(1)}$	6100001*	$\pi_2(2100)^+$	9010215	$f_2(2010)$	9060225
<i>pomeron</i>	990	$u_R^{(1)}$	6100002*	$\rho_3(1690)^0$	117	$f_2(2150)$	9070225
<i>odderon</i>	9990	$e_R^{(1)-}$	6100011*	$\rho_3(1690)^+$	217	$f_2(2300)$	9080225
		$\nu_{eR}^{(1)}$	6100012*	$\rho_3(1990)^0$	9000117	$f_2(2340)$	9090225
		$g^{(1)}$	5100021*	$\rho_3(1990)^+$	9000217	$\omega_3(1670)$	227
		$\gamma^{(1)}$	5100022*	$\rho_3(2250)^0$	9010117	$\phi_3(1850)$	337
		$Z^{(1)0}$	5100023*	$\rho_3(2250)^+$	9010217	$f_4(2050)$	229
		$W^{(1)+}$	5100024*	$a_4(2040)^0$	119	$f_J(2220)$	9000229
		$h^{(1)0}$	5100025*	$a_4(2040)^+$	219	$f_4(2300)$	9010229
		$G^{(1)}$	5100039*				

for MC internal  
use 81–100

**STRANGE  
MESONS**

$K_L^0$	130
$K_S^0$	310
$K^0$	311
$K^+$	321
$K_0^*(800)^0$	9000311
$K_0^*(800)^+$	9000321
$K_0^*(1430)^0$	10311
$K_0^*(1430)^+$	10321
$K(1460)^0$	100311
$K(1460)^+$	100321
$K(1830)^0$	9010311
$K(1830)^+$	9010321
$K_0^*(1950)^0$	9020311
$K_0^*(1950)^+$	9020321
$K^*(892)^0$	313
$K^*(892)^+$	323
$K_1(1270)^0$	10313
$K_1(1270)^+$	10323
$K_1(1400)^0$	20313
$K_1(1400)^+$	20323
$K^*(1410)^0$	100313
$K^*(1410)^+$	100323
$K_1(1650)^0$	9000313
$K_1(1650)^+$	9000323
$K^*(1680)^0$	30313
$K^*(1680)^+$	30323
$K_2^*(1430)^0$	315
$K_2^*(1430)^+$	325
$K_2(1580)^0$	9000315
$K_2(1580)^+$	9000325
$K_2(1770)^0$	10315
$K_2(1770)^+$	10325
$K_2(1820)^0$	20315
$K_2(1820)^+$	20325
$K_2^*(1980)^0$	9010315
$K_2^*(1980)^+$	9010325
$K_2(2250)^0$	9020315
$K_2(2250)^+$	9020325
$K_3^*(1780)^0$	317
$K_3^*(1780)^+$	327
$K_3(2320)^0$	9010317
$K_3(2320)^+$	9010327
$K_4^*(2045)^0$	319
$K_4^*(2045)^+$	329
$K_4(2500)^0$	9000319
$K_4(2500)^+$	9000329

**CHARMED  
MESONS**

$D^+$	411
$D^0$	421
$D_0^*(2400)^+$	10411
$D_0^*(2400)^0$	10421
$D^*(2010)^+$	413
$D^*(2007)^0$	423
$D_1(2420)^+$	10413
$D_1(2420)^0$	10423
$D_1(H)^+$	20413
$D_1(2430)^0$	20423
$D_2^*(2460)^+$	415
$D_2^*(2460)^0$	425
$D_s^+$	431
$D_{s0}^*(2317)^+$	10431
$D_s^{*+}$	433
$D_{s1}(2536)^+$	10433
$D_{s1}(2460)^+$	20433
$D_{s2}^*(2573)^+$	435

**BOTTOM  
MESONS**

$B^0$	511
$B^+$	521
$B_0^*$	10511
$B_0^{*+}$	10521
$B^*$	513
$B^{*+}$	523
$B_1(L)^0$	10513
$B_1(L)^+$	10523
$B_1(H)^0$	20513
$B_1(H)^+$	20523
$B_2^0$	515
$B_2^{*+}$	525
$B_s^0$	531
$B_{s0}^*$	10531
$B_s^*$	533
$B_{s1}(L)^0$	10533
$B_{s1}(H)^0$	20533
$B_{s2}^*$	535
$B_c^+$	541
$B_{c0}^{*+}$	10541
$B_c^{*+}$	543
$B_{c1}(L)^+$	10543
$B_{c1}(H)^+$	20543
$B_{c2}^{*+}$	545

 **$c\bar{c}$  MESONS**

$\eta_c(1S)$	441
$\chi_{c0}(1P)$	10441
$\eta_c(2S)$	100441
$J/\psi(1S)$	443
$h_c(1P)$	10443
$\chi_{c1}(1P)$	20443
$\psi(2S)$	100443
$\psi(3770)$	30443
$\psi(4040)$	9000443
$\psi(4160)$	9010443
$\psi(4415)$	9020443
$\chi_{c2}(1P)$	445
$\chi_{c2}(2P)$	100445

 **$b\bar{b}$  MESONS**

$\eta_b(1S)$	551
$\chi_{b0}(1P)$	10551
$\eta_b(2S)$	100551
$\chi_{b0}(2P)$	110551
$\eta_b(3S)$	200551
$\chi_{b0}(3P)$	210551
$\Upsilon(1S)$	553
$h_b(1P)$	10553
$\chi_{b1}(1P)$	20553
$\Upsilon_1(1D)$	30553
$\Upsilon(2S)$	100553
$h_b(2P)$	110553
$\chi_{b1}(2P)$	120553
$\Upsilon_1(2D)$	130553
$\Upsilon(3S)$	200553
$h_b(3P)$	210553
$\chi_{b1}(3P)$	220553
$\Upsilon(4S)$	300553
$\Upsilon(10860)$	9000553
$\Upsilon(11020)$	9010553
$\chi_{b2}(1P)$	555
$\eta_{b2}(1D)$	10555
$\Upsilon_2(1D)$	20555
$\chi_{b2}(2P)$	100555
$\eta_{b2}(2D)$	110555
$\Upsilon_2(2D)$	120555
$\chi_{b2}(3P)$	200555
$\Upsilon_3(1D)$	557
$\Upsilon_3(2D)$	100557

**LIGHT  
BARYONS**

$p$	2212
$n$	2112
$\Delta^{++}$	2224
$\Delta^+$	2214
$\Delta^0$	2114
$\Delta^-$	1114

**STRANGE  
BARYONS**

$\Lambda$	3122
$\Sigma^+$	3222
$\Sigma^0$	3212
$\Sigma^-$	3112
$\Sigma^{*+}$	3224 <sup>d</sup>
$\Sigma^{*0}$	3214 <sup>d</sup>
$\Sigma^{*-}$	3114 <sup>d</sup>
$\Xi^0$	3322
$\Xi^-$	3312
$\Xi^{*0}$	3324 <sup>d</sup>
$\Xi^{*-}$	3314 <sup>d</sup>
$\Omega^-$	3334

**CHARMED  
BARYONS**

$\Lambda_c^+$	4122
$\Sigma_c^{++}$	4222
$\Sigma_c^+$	4212
$\Sigma_c^0$	4112
$\Sigma_c^{*++}$	4224
$\Sigma_c^{*+}$	4214
$\Sigma_c^{*0}$	4114
$\Xi_c^+$	4232
$\Xi_c^0$	4132
$\Xi_c^{'+}$	4322
$\Xi_c^{'0}$	4312
$\Xi_c^{*+}$	4324
$\Xi_c^{*0}$	4314
$\Omega_c^0$	4332
$\Omega_c^{*0}$	4334
$\Xi_{cc}^+$	4412
$\Xi_{cc}^{++}$	4422
$\Xi_{cc}^{*+}$	4414
$\Xi_{cc}^{*++}$	4424
$\Omega_{cc}^+$	4432
$\Omega_{cc}^{*+}$	4434
$\Omega_{ccc}^{++}$	4444

**PENTAQUARKS**

$\Theta^+$	9221132
$\Phi^{--}$	9331122

**BOTTOM  
BARYONS**

$\Lambda_b^0$	5122
$\Sigma_b^-$	5112
$\Sigma_b^0$	5212
$\Sigma_b^+$	5222
$\Sigma_b^{*-}$	5114
$\Sigma_b^{*0}$	5214
$\Sigma_b^{*+}$	5224
$\Xi_b^-$	5132
$\Xi_b^0$	5232
$\Xi_b^{'-}$	5312
$\Xi_b^{'0}$	5322
$\Xi_b^{*-}$	5314
$\Xi_b^{*0}$	5324
$\Omega_b^-$	5332
$\Omega_b^{*-}$	5334
$\Xi_{bc}^0$	5142
$\Xi_{bc}^+$	5242
$\Xi_{bc}^{'0}$	5412
$\Xi_{bc}^{'+}$	5422
$\Xi_{bc}^{*0}$	5414
$\Xi_{bc}^{*+}$	5424
$\Omega_{bc}^0$	5342
$\Omega_{bc}^{'0}$	5432
$\Omega_{bc}^{*0}$	5434
$\Omega_{bcc}^+$	5442
$\Omega_{bcc}^{*+}$	5444
$\Xi_{bb}^-$	5512
$\Xi_{bb}^0$	5522
$\Xi_{bb}^{*-}$	5514
$\Xi_{bb}^{*0}$	5524
$\Omega_{bb}^-$	5532
$\Omega_{bb}^{*-}$	5534
$\Omega_{bbc}^0$	5542
$\Omega_{bbc}^{*0}$	5544
$\Omega_{bbb}^-$	5554

**Footnotes to the Tables:**

- \*) Numbers or names in bold face are new or have changed since the 2006 *Review* [8].
- a) Particularly in the third generation, the left and right sfermion states may mix, as shown. The lighter mixed state is given the smaller number.
- b) The physical  $\tilde{\chi}$  states are admixtures of the pure  $\tilde{\gamma}$ ,  $\tilde{Z}^0$ ,  $\tilde{W}^+$ ,  $\tilde{H}_1^0$ ,  $\tilde{H}_2^0$ , and  $\tilde{H}^+$  states.
- c) In this draft we have only provided one generic leptoquark code. More general classifications according to spin, weak isospin and flavor content would lead to a host of states, that could be added as the need arises.
- d)  $\Sigma^*$  and  $\Xi^*$  are alternate names for  $\Sigma(1385)$  and  $\Xi(1530)$ .